Risk Factor Interventions

An Overview of their Effectiveness

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Report Prepared For

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Executive Summary

The Context of this Report

In the spring of 2004 the B.C. Healthy Living Alliance began developing targets for reducing major risk factors consistent with its mandate, namely, "to improve the health of British Columbians through leadership that enhances collaborative action to promote physical activity, healthy eating and living smoke-free." In this broad task, the Alliance finds itself in the forefront of a certain momentum in the province, and in concert with health promotion and disease prevention efforts being launched in many different jurisdictions around the world.

An initial step in the process was to look at the behavioural risk factors of smoking, unhealthy eating and physical inactivity, as well as the closely related risk factor of overweight/obesity. The associated report linked the factors to chronic diseases such as cancer, heart disease and diabetes, identified appropriate indicators, examined the current status in B.C. compared to other provinces, and reviewed the target-setting efforts in other jurisdictions.

BCHLA Targets for 2010

- 9 out of 10 British Columbians aged 12+ will not smoke
- 7 out of 10 British Columbians aged 12+ will be eating at least 5 fruits and vegetables a day.
- 7 out of 10 British Columbians aged 12+ will be physically active
- 7 out of 10 British Columbians aged 20-64 will be at a healthy weight.

The second step was to propose 2010 targets for the four risk factors, which has recently been published in summary form.

Setting targets is one thing; achieving them is another.

The present report offers a comprehensive review of the interventions used over the years to control or reduce the four risk factors already noted, as well as environmental tobacco smoke (ETS) exposure and three other risks particularly connected to cancer: UV radiation, occupational / environmental exposure to carcinogens and infections. The aim was to identify the best evidence-based interventions. Neither time nor resources are unlimited, so the task of looking for methods which have actually worked is an important one. Also on the agenda is considering how to approach the risk factors in a combined way, recognizing that many of the factors inter-relate and that synergistic programs are likely possible.

The final step in the process will be to use the information in this report, combined with an economic analysis, to select the most cost-effective interventions for a province-wide program aimed at reducing risk factors and preventing chronic disease. This last document will also underline the projected personal and economic

benefits which will flow from substantially improving the health of British Columbians by 2010.

Tobacco Use

While much has been accomplished in the control of tobacco use in Canada, much still remains to be done. Even with the country being an international leader in this area, 6,085,209 Canadians over the age of 12 still smoked in 2003.

Interventions aimed at reducing tobacco use fall under the following broad categories:

- interventions to reduce initiation rates, especially among youth
- interventions to increase cessation rates and prevent relapse
- interventions to reduce exposure to second hand smoke

The Five Most Effective Interventions for Tobacco Control

1. Increasing the price of tobacco products
2. Reducing opportunities to promote tobacco products
3. Creating smoke-free public places
4. Counter-advertising
5. Primary care based cessation programs

Reducing Initiation Rates

Adolescents are at the highest risk of initiating smoking behaviour. Indeed, few individuals start smoking after the age of 20. It is this reality that has resulted in the aggressive targeting of adolescents by the tobacco industry in its marketing campaigns.

Preventing the uptake of smoking among youth thus stands out as one of the most vital efforts in public health. The immediate and aggregate benefits over generations can be significant, especially given the demonstrable "multiplier effects" of prevention: non-smoking teens influence their peers in the direction of abstinence; non-smoking adults (and smoke-free homes) influence children similarly. The result of such cumulative trends over a society is a "denormalization" of tobacco, that is, the creation of a social stigma against smoking (and against the tobacco industry) which continues the momentum towards abstinence.

The school environment is a natural platform for health promotion. Unfortunately, the assessment of the many school anti-smoking programs has been somewhat pessimistic. Small positive results have been seen with a social influence training approach, which includes tobacco resistance skills education, recognizing high-risk situations, and so on.

Community-wide campaigns that include counter-advertising, and are sometimes linked to school programs, show more promise. In such cases, the design of the advertising may be the key. Studies show that anti-smoking advertisements should stress the manipulation of tobacco companies and the addictive nature of nicotine even more than health effects per se, since disease impacts many years in the future are highly "discounted" by youth and adults alike.

The most effective interventions to reduce initiation rates, however, are in the arena of regulatory and economic interventions. These fall into three main categories:

- regulation of tobacco sales to minors

- regulations on advertising
- taxation to increase the unit price of cigarettes

Of these three, controlling tobacco sales to minors is the weakest intervention. The main gap in the policy is not recalcitrant shop owners, but the fact that motivated (especially addicted) teens are adept at overcoming all institutional barriers to accessing tobacco. On the other hand, taxation is a highly effective intervention (even today, the financial means of youth are limited), and advertising regulations are an important complement to counter-advertising. An intriguing subset of marketing directed at youth which needs more attention is the influence of tobacco introduced as product placement in movies and television.

Increasing Cessation Rates

While increased taxation is a very effective intervention to reduce initiation rates, it is also very successful in increasing cessation rates. In fact changing the price of tobacco through taxation is probably the single most effective intervention to reduce the prevalence of tobacco use.

Mass media education / counter-advertising campaigns are also an important component of a comprehensive program but tend to have minimal effectiveness on their own.

There is enough support for the effect of smoking restrictions in workplaces, which are now very common, to continue to encourage this form of intervention. Not only do they reduce exposure of non-smokers to second hand smoke, but they also reduce the amount consumed by smokers, possibly leading to increased cessation rates.

Interventions for smoking cessation directed at individuals are varied in format and impact. Counselling a patient to quit, given by a primary care provider, is quite successful, especially when an appropriate level of support is provided and nicotine replacement therapy is utilized. Group therapy can match the results of more intensified one-to-one counselling. A major impediment, however, is the lack of appropriate funding mechanisms to provide financial support for these interventions.

An important “window of opportunity” to counsel smoking cessation may exist when patients face a major health event. In addition, post-surgical results are improved if smokers ‘fast’ from their habit for at least six weeks prior to surgery.

Broader-based interventions such as proactive telephone support lines and self-help materials have a marginal effect on cessation rates. The evidence for the impact of web-based resources such as ‘QuitNet’ is not yet available. Each of these interventions, however, has the advantage of potentially reaching a large number of people at minimal cost. They may also be important in supporting the large percentage of people who manage to quit on their own.

Reducing Exposure to Second Hand Smoke

Interventions related to second-hand smoke, apart from the impact of smoking bans in workplaces noted earlier, have focused on settings where children in particular are exposed and more generally on public spaces. Bans on smoking in public places have been a fixture in British Columbia since 1992 and are now well-accepted in many developed countries. The extension to formerly excluded locations in the

hospitality industry should be made relatively easily given the independent research which shows no negative impact on revenue or employment in these establishments.

Lessons Learned from the Anti-Tobacco Campaign

No single intervention in the campaign to reduce smoking prevalence can account for all the significant changes that have occurred since the 1960s. Each intervention, from media advocacy to school programs to social support systems, is enhanced synergistically by the presence of other components. Supportive systemic changes and social denormalization of both the tobacco industry and the smoking habit were required to achieve the population-based cessation rates that have been observed.

The one possible exception to the preceding principle is tobacco product price increases (usually through taxation), which has been shown to have a strong and sustained effect independent of other interventions

Whether interventions involve taxation or other forms of regulations, senior levels of government must shape their efforts to maximize support for policies and programs operating in local jurisdictions and targeted communities; there must be multi-level, integrated strategizing to ensure the greatest impact on risk factor reduction. In addition, adequate financial and organizational resources must be ensured for all effective efforts over a long time frame.

An important aspect of planning noted in this report is the impact of socioeconomic factors on health and disease. With respect to those in poverty, the unintended consequence on household income of interventions such as taxation, and differential ability to respond to health education, must be considered when setting policy.

Finally, interventions must be available to assist individuals who seek to make a lifestyle change.

Lessons from the campaign against tobacco suggest that successful prevention programs include the following key elements:

- Interventions must address the fundamental behavioural and social causes of disease, illness and disability.
- Multiple approaches must be used simultaneously – education, social and community support, laws, economic incentives and disincentives.
- Multiple levels of influence must be accessed – individuals, families, schools, workplaces, communities, nations.
- Interventions must recognize special needs of specific groups such as teens, seniors, or other at-risk communities.
- Interventions must have long durations because change takes time and needs to be constantly supported for each subsequent generation.
- Interventions need to involve a variety of sectors that are not traditionally associated with “health,” such as business, engineering, urban planning, law, and the media.

- Interventions need to be created with a view to serving all socioeconomic groups effectively.

Overweight and Obesity

In 2003, almost half of Canada's population was overweight and the trends during the last two decades indicate that childhood obesity has increased by over 400% for both boys and girls.

Are the lessons learned from the 'Tobacco Wars' applicable in constructing a population-based approach to obesity?

There are some key differences between tobacco use and obesity. First, food and activity are essential to life, with no messages associated with them equivalent to the simple injunction to "stop smoking." Second, there is a possible negative consequence that must be taken into account, namely, disordered eating. Third, there are, at times, genetic and disease conditions which impact obesity. And fourth, research on the impacts and interventions related to obesity, energy intake and energy expenditure is still in its infancy.

Despite these differences, there are a number of similarities. First, social influences and advertising pressures influence what we eat just as they influenced smoking habits. Second, environmental constraints can lead to limitations on physical activity in much that same way as they can promote or discourage smoking. These two similarities have led some to suggest that we currently live in an 'obesogenic environment' in developed nations and that this is a strong contributor to the current trends in overweight and obesity. And third, some individuals deal with compulsive eating behaviours in a similar way that smokers deal with their habit.

Energy Intake

Changing one's diet is more complex than the more discrete categories of whether one is a smoker or not. A major difference is that, unlike tobacco consumption, eating food is essential to staying alive. Further complicating the scenario is the fact that the most ubiquitous dietary interventions at individual levels (namely, dieting) and in whole populations (*5 A Day* vegetable and fruit campaigns) have produced at best equivocal results.

Nutrition education through mass media and other means can influence the diet of whole populations, though the precise formula for success remains elusive. A region of Finland, for example, has managed to reduce fat consumption and cardiovascular disease. This Finnish program lasted multiple decades, so that sustained, self-perpetuating changes in social norms eventually occurred, similar to the current stigmatization of tobacco in developed countries. In addition, the targeted communities were an integral part of the planning and implementation of the interventions.

Single-focus interventions, such as mass media campaigns to increase vegetable and fruit consumption, have been successful in raising awareness, but not necessarily behaviours.

As with smoking, considerable attention has been placed on possible interventions in the school setting. The conclusion to date is that modest improvements in diet are possible in terms of both fat intake and vegetable and fruit consumption. The most effective interventions have been multi-faceted, incorporating both individual behaviour modification through class curricula and parental support, and environmental changes such as lower prices for healthy food choices in vending machines and the school cafeteria.

Involving families in diet change is vital in both the school and clinical settings.

There are many different modes employed in dietary counselling at the clinical level. Not surprisingly, the most effective counselling occurred over a longer time frame with more appointments and multiple, personalized components designed by specialized clinicians.

What is less clear is precisely which diet, especially which weight loss diet, ought to be recommended by healthcare providers. Dietary treatments to lose weight are both ubiquitous and notorious. A very extensive UK review found little evidence of long-term effectiveness for any diet, though there may be a slight edge for low-fat approaches. Some of the popular commercial weight loss programs use the dynamics of group support to good effect. Weight Watchers is one commercial program that has been found to have a significant and prolonged effect.

Pharmacotherapy and surgery for morbid obesity are generally effective, although side effects can be a problem.

Energy Expenditure

Interventions to increase physical activity are still at an early stage of assessment.

Early results show that informational approaches, used in isolation, produce at best modest changes in physical activity behaviour.

Approaches that involve sustained contact with a specialist or good telephone follow-up can be effective at increasing energy expenditure. Furthermore, interventions that include a social component, such as walking groups, can be quite effective. School-based physical education enhancements have produced strong results, whereas workplaces, in spite of many different theories and models, have not yet been convincing as an intervention platform.

The availability of places for recreational activity and safe communities are important contributors to increasing physical activity.

Transportation planning and other forms of urban development are just beginning to consider enhanced levels of energy expenditures as part of the larger built environment.

Combining Energy Intake and Expenditure

Programs involving both diet and exercise are generally more effective at reducing overweight than the individual risk elements targeted on their own. Comprehensive,

multidisciplinary approaches to healthy diet and physical activity seem to be the most promising for communities, especially if they are sustained over the long-term.

Preventing Overweight

Keeping weight off is an especially relevant goal with children, as obesity in younger years leads to more adverse health effects in adults. Also, not putting a pound on is easier than removing a pound later. The most promising form of overweight prevention and weight reduction with children seems to be decreasing sedentary behaviour and increasing physical activity, with strong support in both the home and school environments.

While taking overweight seriously, caregivers and program leaders need to be on the alert for distorted body consciousness and disordered eating patterns among children and adolescents, especially females. Treatments for full-fledged eating disorders such as anorexia nervosa are not very effective, suggesting again that prevention is the best approach. The latter clearly will depend partly on environmental measures where societal messages concerning "perfect thinness" are counteracted. On the other hand, "fat acceptance" and similar movements must not be allowed to confuse the fact that interventions are truly advisable for unhealthy weight.

Population Health Initiatives

Environmental changes on a more macro level have been suggested by researchers in Canada, Europe and other settings. Some of the initiatives could be considered appropriate for British Columbia, e.g.,:

- Taxes on foods with a low content of a range of nutrients, e.g. soft drinks.
- Restrictions on advertising, promotion, and sponsorship of energy-dense foods and beverages (especially when directed at young people).
- Nutrition signposting based on an agreed standard for fat, fibre, vegetable and fruit content.
- Enhanced nutrition messages that foster an understanding of the relationship between food and health.
- Legislation to regulate portions of a "reasonable" size and enforce disclosure of nutritional content of fast food at point-of-purchase.
- Using taxes and subsidies, change price structures to favour healthy food.
- Remove sales tax on exercise equipment.
- Offer tax incentives to employers providing exercise facilities.
- Taxation to encourage densification and active commuting.
- Urban design to promote walking and bicycling.
- Polices to support adequate income for individuals and families.

The effectiveness of these interventions is not yet known. Many authorities are convinced, in light of the relative ineffectiveness of interventions geared to individuals, that tackling the obesogenic environment is the most beneficial way to move forward.

Applying the Lessons Learned from Tobacco Control

It is vital to understand that the issues surrounding tobacco control and obesity control are not all the same. First, food and physical activity are life essentials, unlike

tobacco. Second, there is a greater complexity associated with weight control than stopping smoking. Third, an inappropriate emphasis can lead to important negative health consequences.

Based on successes in the tobacco control battle, there is a compelling rationale to start with environmental interventions that include economic, regulatory and healthcare policy levers supported by a strong marketing campaign. The intent is to create the kind of supportive socioeconomic world that reinforces other interventions and helps them to be more effective.
Furthermore, parallel and concurrent messages about diet and exercise should be integrated with approaches that tackled them both simultaneously at environmental, program and individual levels.

Reducing overweight and obesity rates will require a full press from every player in healthcare, community agencies and advocacy organizations, not to mention political leaders, parents, educators and role models. Indeed, the unequivocal emphasis from all quarters is an essential part of the "social-normative momentum." The campaign against smoking has taught us that this will likely take decades and will only be successful with full support from all those involved.

Ultraviolet Radiation

Although skin cancer rates are levelling off in Canada and elsewhere, they are still much higher than in past decades. Ultraviolet (UV) radiation is a major contributor to skin cancer initiation, especially non-melanoma varieties. Somewhat like eating food, exposure to UV is an ambiguous risk factor because a certain dose is vital to health (specifically related to vitamin D production).

The long lag time before cancer develops makes it difficult to motivate people to protect themselves, especially when combined with the recent mixed reports about the efficacy of sunscreens. Other effective strategies are available, however, especially educational and policy interventions in primary schools which focus on protective clothing and / or sun avoidance. There is also evidence for the effectiveness of interventions in recreational areas such as beaches.

Most community-wide interventions and stand-alone media campaigns have produced mixed results at best. Environmental approaches may again be the best way forward, though the effectiveness of such interventions has not been rigorously studied. The social norm among youth must become fair skin and the policy for play times at school needs to include protective clothing. Public momentum can be maintained through planting shade trees, regulating protection for outdoor workers, and requiring UV protection factor labels in clothing.

Occupational and Environmental Carcinogens

Although it is estimated that up to 7% of cancers may be attributable to carcinogen exposure at work or the wider environment, research to establish the effectiveness of interventions is at an early stage. Only one systematic review was found in the literature, related to studies in the rubber industry. The obstacles to such research are serious, including the long latency period between exposure and disease development (up to 40 years or more).

The potential benefits of control measures are hard to track over such a long time, though the general thought is that occupational cancers in particular are almost entirely preventable. In fact, successes with controlling asbestos and some other toxic substances have led to somewhat reduced research interest in workplace cancers. The types of interventions are well-established, ranging from societal regulations such as exposure limits and right-to-know policies to engineering and process solutions in the workplace.

Less well defined are both the impacts from and strategies for environmental exposures; clean air policies will probably remain at the forefront of public health campaigns.

Clinicians have an ongoing role to play in identifying potential carcinogen exposure in patients and then alerting point sites or shaping broader pollution agendas. They also need to be alert for risk factor synergies, for example, the well-known multiplier effect of smoking in people exposed to asbestos or radon gas.

Cancer and Infectious Agents

> *At present, information concerning the role of viruses in the pathogenesis of human neoplasms is fragmented and incomplete. It is clear that their role is complex, and a complete understanding of the intricacies involved in viral interaction with the human genome may still take many years.*[1]

The International Agency for Research on Cancer has now confirmed 7 viral or bacterial agents as carcinogenic in humans. Cancers of the stomach, liver and cervix rank among the most prevalent ones with a viral or bacterial origin. These three cancers also represent some of the highest attribution rates with respect to a pathogen (see the table below); for instance, virtually every cervical cancer case is positive for the presence of one or more types of the human papillomavirus.

Agent	*Main associated cancer*	*Annual incidence of cancer (developed countries)*	*Proportion of specific cancer attributable to infection*
Human papillomavirus - various types	Cervix	100,000	90 to 100%
Hepatitis B / C virus	Liver	106,000	80%
Helicobacter pylori	Stomach	333,000	70%
Epstein-Barr virus	Hodgkin's disease; non-Hodgkin's lymphoma	264,000	30-90%
Human immuno-deficiency virus type 1 as co-factor	Kaposi sarcoma	8,600	
Human T cell lymphotrophic v. type I	Leukemia		1%
Human herpesvirus type 8 - probable	Kaposi sarcoma	8,600	

[1] Phelan JA. Viruses and neoplastic growth. *Dental Clinics of North America.* 2003; 47(3): 533-43.

As reflected in the preceding table, the impact of infection-associated cancer is more substantial than sometimes realized by the general public. In fact, in the developed world, about 7% of total cancer incidence has been attributed to one or more infectious agent. After tobacco use, infections as a class may be the most important preventable cause of cancer, a fact of potentially tremendous significance for both individual and population health. Both an ageing population and the effect of disease latency means that cancers with an infectious cause will continue to be a significant burden in Canada for some time to come.

We examine each of the main pathogens seen in developed countries, in order to identify and evaluate the interventions available at various stages of exposure and disease development. These include:

1. Early primary prevention: limiting exposure to the pathogen.
2. Primary prevention: stopping the establishment of infection (e.g., through prophylactic vaccination).
3. Secondary prevention: interrupting full cancer development once infection is present (including detecting and treating the infection or precancerous cells and lesions before cancer becomes established, e.g., using therapeutic vaccination).

While there have been success stories, such as a dramatic drop in cervical cancer incidence, much more progress is needed. The following table summarizes both the current and proposed strategies for the main pathogens discussed in this report.

Agent	*Transmission*	*Successful Prevention*	*Ineffective Approaches*	*Emerging or Debated Measures*
Human papillomavirus - various types	Sexual intercourse	Counselling; Screening & excision	Mass media & education; Condoms	HPV testing; Vaccine; Anti-virals
Hepatitis B / C virus	Contaminated blood; esp. via sexual activity (HBV) & injected drug use (HCV)	Counselling; Needle exchanges (mixed evidence); Protecting the blood supply; HBV vaccine; Anti-virals; Surgery	Mass media & education around sexual practices	Integrated injecting drug use programs; Combination therapies
Helicobacter pylori	Consuming, e.g., contaminated water	Combination therapy; Surgery		Universal screening & eradication
Epstein-Barr virus	Salivary contact			Immune system restoration; Anti-virals; Vaccine
Human immuno-deficiency virus type 1	Various body fluids, esp. in sexual contact	Programs integrating voluntary testing, counselling, and condom use; Programs re: injected drug use; Anti-virals, incl. in pregnancy	Single interventions to modify sexual practice	Vaccine; Prophylactic anti-virals
Human T cell lymphotrophic v. type I	Sexual contact & injected drug use			Preventing exposure
Human herpesvirus-8 - probable agent	Sexual contact, esp. homosexual men, commercial sex workers	Anti-virals		Preventing exposure

Several conclusions and recommendations emerged as we covered the terrain of infection-associated cancers.

Burden: Although some infection-related cancers are dropping in incidence, various factors are keeping the prevalence and mortality burden of these diseases at a high level in the Canadian population. Complacency is not an option.

Levels of Prevention: Intervening to limit the exposure to the pathogen in the first place, if practical, is certainly an ideal. If such early primary prevention is not possible, then classic primary prevention must be pursued; with infections, the "gold standard" approach is prophylactic vaccines which prevent any exposure from becoming a serious problem. If infection does become established, then measures need to be taken to ensure that any detected precancerous or cancerous conditions do not progress any further.

Cost Considerations: A complicating factor is that some interventions are more cost-effective than others. For example, there is debate about whether testing for HPV (to prompt primary prevention, if possible) is worth the expense, especially in reference to highly effective cytological screening, which detects precancer or the early stages of cervical cancer and then prompts appropriate secondary prevention.

A Public Health Focus on Sexually Transmitted Infections: Since many of the pathogens covered in this report are sexually transmitted, much of the discussion of early primary prevention revolves around reducing the risk of sexual behaviours. This is a crucial area of public health, albeit a sensitive and challenging one. A program incorporating multiple interventions should be considered. To learn what a multi-faceted campaign would need to look like, we could closely examine the pilot projects set up in various jurisdictions to help, for example, injection drug users.

Ongoing Investment in Research: Greater insight into transmission, co-factors, and carcinogenesis will allow enhancements of the prevention armamentarium, ultimately allowing the disease burden of the various cancers to be reduced and possibly removed. The development and imminent launch of vaccines for HPV promises a brand new era for cervical cancer prevention, though many implementation questions remain unanswered. Continued study of other potential etiologic agents is vital in the overall battle against cancer. The potential for disease prevention represented by each of the candidate pathogens makes this a truly exciting area of medical research.

The Temptation of Technology: As captivating as new health technologies can be, it is also important to continue focusing on the classic "low-tech" public health options related to early primary prevention, including initiatives involving media advocacy, education and counselling. The modest record of progress in this regard, even with high-profile agents such as HIV, is very sobering. Planners also need to be wary of inappropriately supplanting old technologies with new. For instance, some authorities are suggesting that a new HPV vaccine should work alongside classic screening programs for up to 20 years.

It is clear that a strong coalition between researchers, clinicians, public health managers and funders will be required to navigate through the complex data and policy options and ultimately achieve the sort of prevention breakthroughs desired with the various infections and related cancers described in this report.

Public Health and Clinical Care

Behavioural risk factors can largely be addressed in two different spheres, at the broader environmental level or through interventions focusing on individuals. The former seeks to make changes that influence entire populations whereas the latter addresses the needs of individual patients. In the provision of health care, these distinctions can be seen in the arenas of public health and clinical care.

As has been acknowledged in the campaign against smoking, efforts in both spheres are critically important. Environmental alterations can produce the impetus to change, but it is individuals who make the actual change. Without direct support for individual change, environmental efforts have limited success. On the other hand, individual change is much more difficult in an unsupportive environment.

In health care, this means a close working relationship between those in public health and those in the clinical arena. Although a well-recognized distinction, the two worlds are beginning to converge. Increasingly, comprehensive, community-wide campaigns recruit and shape primary care providers as important allies. Conversely, primary care providers are beginning to see the value in adopting health promotion strategies and partnering with community resources.

Initiating and supporting change efforts at the individual level should also be enhanced by the current reforms in primary health care. A key intent of the current reform process is to provide patients with better access to multidisciplinary teams of health care providers. Such teams should have the diverse skill set and the resources needed to assist individual change efforts.

Addressing Multiple Risk Factors

One of the challenges for both clinicians and community workers is how to influence multiple risk factors simultaneously. The fact that risk factors are inter-related is clear. Focusing on both exercise and diet often provides better weight loss or weight maintenance than either intervention in isolation. A different kind of interaction involves the negative correlation between smoking and weight gain. Additional examples of combined effects have been noted, such as the synergy between tobacco smoke and other carcinogens in the environment. With the clear interdependence of risk factors with each other and with disease, the health benefits of working on several major factors at the same time are potentially enormous.

Conclusion

Interventions designed to enhance healthy behaviours will need to be carefully developed and implemented over the long term. As noted throughout this report, there are a number of possible interventions for which the accumulating evidence is still at an early stage. Furthermore, few successful population-wide strategies exist in the areas of unhealthy diet, physical inactivity and overweight. As noted in *The Path to Health and Wellness: Making British Columbians Healthier by 2010,* "(w)hile proof of successful strategies to reduce obesity and to promote healthy eating and active lives on a population-wide level does not yet exist, many countries are embarking on ambitious programs in a struggle to make a difference".

Given this situation, there will be an ongoing need for evaluation of the effectiveness of interventions taken in the British Columbia environment. ***Taking a leadership role will require risks in implementing interventions before others have shown them to***

be effective. Ongoing evaluation will allow for the continual reassessment of interventions, with appropriate changes based on new effectiveness evidence.

In November of 2004, Colin Hansen (Minister of Health Services) noted that "by the time B.C. welcomes the 2010 Winter Olympics and Paralympic Games, we could be the healthiest population ever to act as host. The true legacy of the Games will be more than new buildings or gold medals. It will be a higher standard of health and wellness for all British Columbians."

The 2010 Olympic Winter Games, with its image of teamwork and peak physical fitness and activity, is a perfect target date for improving population health to levels never before seen in the province. In fact, this may be the opportunity of the century, for it is unlikely that a comparable public focal point with such compatible overtones (i.e., physical health and performance) will come to the province again in the near future. The potential platform for media advocacy alone is staggering. Another advantage is that 2010 is within sight, close enough to begin building some momentum, and yet far enough away to allow some real improvements to be established. And change will beget change, so that there could be a drive towards health improvement that not only builds towards 2010, but extends beyond as one of the real and powerful legacies of the Games.

A positive step in this direction was taken on November 23, 2004 when Premier Gordon Campbell announced an investment of $15.5 million as part of a "comprehensive plan to make B.C. students the healthiest and most physically active in Canada".

The outcomes in a race are easy to see - who crosses the finish line first. It is important to identify the comparable measurement of success in health promotion so that no intermediate measures distract from the ultimate goal. **What is the "finish line" in population health among British Columbians? It is more than changing beliefs and attitudes, or even shifting intentions; it must be a clear focus on manifestly changing risky behaviours so that disease and disability rates are reduced and well-being, quality of life, and productivity in all spheres of human endeavour are increased.** To this end, British Columbia wants to become the "gold standard" for population health by 2010 and beyond, with an enduring legacy of being the healthiest jurisdiction ever to host an Olympics.

To assist in this worthy goal, the BC Healthy Living Alliance has worked with groups throughout the province in establishing targets for physical activity, healthy eating and living smoke-free.

Setting targets is one thing; achieving them is another.

The present report offers a comprehensive review of the interventions used over the years to control or reduce these risk factors.

The final step in this process was to use the information in this report, combined with an economic analysis, to select the most cost-effective interventions for a province-wide program aimed at reducing these risk factors and preventing chronic disease. This plan clearly identifies the resources required, as well as the projected personal

and economic benefits, in order for British Columbia to become the “gold standard” for population health by 2010.

Introduction

Context

This project is part of a broader set of initiatives to support the development of province-wide strategies for chronic disease prevention, with a particular focus on heart disease, cancer, chronic respiratory disease, and diabetes.

In spring of 2004 the B.C. Healthy Living Alliance took on the task of developing provincial advocacy targets for the reduction of four major risk factors by the year 2010. This is consistent with the mandate of the Alliance, namely "To improve the health of British Columbians through leadership that enhances collaborative action to promote physical activity, healthy eating and living smoke-free."

An initial step in this process was the preparation of a document which provided a detailed examination of the four risk factors, namely, smoking, unhealthy eating, physical inactivity, and overweight, and their link to chronic disease. This report, *2010 Target Setting for Risk Factors for Chronic Diseases: Background Document for Consultation*, also reviewed current risk behaviour at the provincial, health authority, and health service delivery area. .

A second step was to develop consensus on provincial population-level targets for the four risk factors for 2010 – targets that take into account the variation in risk behaviour in communities across the province. Once targets had been established, a key question related to the achievement of those targets. Which interventions are effective at assisting in achieving the targets?

This document represents the third step in this process; it is a comprehensive review of the effectiveness of interventions designed to impact selected risk factors. In this project we use the term 'interventions' in its broadest form, including specific programs, policy initiatives, advertising campaigns, and so on, plus more than one approach combined in comprehensive strategies.

In addition to the four major risk factors noted above, exposure to second-hand tobacco smoke, ultraviolet radiation, occupational and environmental carcinogens and infections have been added to this review.

Further work will use the information contained in this report to prioritize interventions (including an evaluation of cost effectiveness) and estimate the resources needed to implement the selected approaches in the British Columbia context. In addition, the potential benefits of achieving targets established for 2010 will be assessed.

This document is a comprehensive review of the effectiveness of interventions designed to impact the following risk factors:

- Smoking
- Exposure to second-hand tobacco smoke
- Overweight and obesity
- Unhealthy eating
- Physical inactivity
- Exposure to ultraviolet radiation
- Exposure to occupational and environmental carcinogens.
- Exposure to infections.

Combining the Factors

Most risk factors do not exist in isolation. This is particularly the situation with smoking, unhealthy weight, unhealthy eating, and physical inactivity, which may exist in combination in the same individual.

There are several arguments for treating key risk factors in this report in an integrated manner. First, for each of the four risk factors it is demonstrable that they have a significant *independent* effect on mortality and morbidity; thus to make the most population health gains, sometimes the factors need to be addressed simultaneously or, at least, in a clearly structured sequence.

The four risk factors noted above are also related to one another to various degrees. One of the key relationships between factors is "overlap." Although there are health impacts of, say, physical inactivity that are in fact independent of other factors, it is also clear that there are a large percentage of impacts that flow from the contribution of inactivity to obesity. Sedentary Canadians, for example, have a 44% higher rate of obesity than physically active Canadians; the effect on related disease rates would thus likely be a combination of the two factors.

The multiplicity of risk factors can extend in more than two dimensions. Just as activity and weight are linked, nutrition can be seen as closely related to both those factors. In fact, unhealthy weight, unhealthy eating and physical inactivity are so inextricably bound together as risk factors for the "metabolic syndrome" which is a precursor to type 2 diabetes and cardiovascular disease, that this report will treat them in an integrated way in a major section.

Smoking, though treated separately in the first major section of this report, also must be brought in to the multi-factorial discussion. Most importantly, smoking heightens the negative health impacts of being obese. Smoking also demonstrates that risk factors sometimes move in opposite directions. The weight gain that can accompany smoking cessation, for example, should be addressed in any integrated risk factor policy.

Smoking also indirectly affects other factors such as obesity through the influence of decades of research and practice around effective interventions. The lessons derived from the "tobacco wars" will help to shape other aspects of this report.

> *"If we were to implement some coherent, coordinated programs with partners, what would we have? We'd definitely have a healthier population, less pain and suffering, less disability, longer lives, improved health status. We'd certainly reduce pressures on the health care system, which would reduce some of the pressures on other government programs, like education and the environment, which in turn could improve health. And it will reduce indirect costs (from productivity losses due to poor health) – and for those of you who like to keep an eye on the bottom line – (create) a more attractive climate for investment as well."* Dr. Perry Kendall, Provincial Health Officer

A final consideration is that the process of targeting multiple risk factors increases the opportunity for collaboration between different stakeholders in the world of prevention and health promotion, and the possibility of focusing limited resources to achieve the greatest benefit. The fact that a short list of major risk factors relate to the same serious chronic diseases multiplies the potential for such initiatives.

Reviewing the Evidence

The plan in this report is to "summarize the summaries." By the 1980s, leaders in medical research and healthcare had begun to realize that critical reviews were needed to put results from individual studies into an appropriate context. As well, the sheer volume of biomedical publishing requires the resources of expert meta-analysis and synthesis. There are an estimated 30,000 medical journals published annually.

All published studies are also not created equal. It is especially important to isolate high-quality research results in order to confidently propose "evidence-based" interventions. Expert reviews of related studies typically use a criteria grid to eliminate low-quality studies and weight the results of the remaining ones according to the scientific rigor of their research methodology. Appendix A contains an overview of the major review sources consulted in this report.

Organizing the Interventions

In the initial scan, the interventions in each major subsection of this report will be organized into all or most of the following seven categories (as appropriate), which themselves are mostly driven by the *setting* where the intervention is implemented:

- Community-based Interventions
- Workplace-based Interventions
- School-based Interventions
- Home-based Interventions
- Clinical Interventions and Management
- Regulatory and Economic Interventions
- Comprehensive Strategies

In this taxonomy, mass media interventions will be classified under community-based interventions; regulatory and economic mechanisms, which certainly also affect whole communities, are separated out as interventions requiring the direct action of senior governments. Comprehensive strategies represent a combination of two or more of the other categories. Sometimes the term "comprehensive" is used loosely to mean "multi-component," but this is a mistake, since *every* one of the categories includes projects which comprise multiple interventions.

No taxonomy of risk factor interventions is perfect, which is why so many have been proposed by different reviewers. For instance, there are local and senior government policy initiatives with specific targets (e.g., *legislated* smoking bans in schools or workplaces)) which will be included under the settings where they most apply.

The Social Context of Human Health

It has been very common in the past to treat risk factor control as a matter of individual behavioural choices and change. While this remains an important dimension of health promotion and disease prevention, increasing attention is being paid to the social dimensions of human life which may either support or impede healthy lifestyle decisions and impact the associated prevalence of disease. Three aspects of human existence which transcend individual behaviour will be woven into this report at different points, including:

- the socio-economic context

- the socio-environmental context
- the socio-cultural context

Many of the concepts under these headings overlap with the concerns of *social ecology*, namely, to consider social networks and supports systems, the historical context of people's lives, cultural milieu (norms, values and expectations), and institutional interactions in the public (e.g., school) and private (e.g., workplace) sphere .[2]

Socio-Economic Context

Risk factors are influenced by socioeconomic factors, sometimes called the social determinants of health. A recent report for the Interior Health Authority described social determinants of health in the following way:

> Social and economic exclusion is not a choice. People who are socially and economically excluded from society experience material deprivation, including barriers to jobs and education. They also tend to experience psychological stress and frequently adopt unhealthy behaviours as a means to cope with these stresses.[3]

This description combines three different, though interrelated, streams in the conceptualization and study of social determinants:[4]

Materialist: disadvantaged people are deprived of the material necessities for health; most of the research so far has focused on income inequalities, rather than, for example, access to education or employment.

Psychosocial: the way psychological stress and limited social support limits the ability to avoid behavioural risks.

Political: looks at systemic forces, including international, national and regional policies that increase poverty and unequal access to health resources.

Socio-Environmental Context

A socio-environmental approach is closely related to the social determinants of health, with the main difference being one of emphasis. While social determinants originally were derived through studies of individual-level socioeconomic measures, an environmental approach considers the impact that area-wide socioeconomic characteristics might have on the prevalence of risk factors.[5] Although the research is still relatively limited, the suggestion is that simply living in a deprived area may have an impact on behaviour not just because of the example and influence of more

[2] See Conceptual Social Ecology at http://www.seweb.uci.edu/cse/cse.html (accessed January 2005).
[3] Interior Health Authority. *Health for All: A Chronic Disease Prevention Plan, 2005-2007.* Draft.
[4] Adapted from Coleman R, Hayward K. *The Tides of Change: Addressing Inequity and Chronic Disease in Atlantic Canada.* 2003.
[5] Crampton P, Salmond C, Woodward A, Reid P. Socioeconomic deprivation and ethnicity are both important for anti-tobacco health promotion. *Health Education & Behavior.* 2000; 27(3):317-27.

risky behaviour in the neighbourhood, but because of the unpleasant, unsafe environment where there are fewer opportunities for making healthy choices.[6]

Socio-Cultural Context

The third social context builds on the ideas that the cultural norms and expectations in a society can exert a powerful influence on behaviour.

Social denormalization is a related phenomenon which describes the point where attitudes match and reinforce behavioural change (which has been brought about by whatever means), so that the wide majority of a population has adopted a new dominant attitude, e.g., smoking in someone's home without permission is unacceptable. This type of attitudinal shift is closely akin to the "diffusion of innovations" theory proposed by Rogers.[7] The theory allows for a stage of idea development or marketing where most people in a community have adopted an innovation.

The application of denormalization to risk factor reduction within a population is clear and appropriate. It represents a call to create *long-term* public health messages within society that eventually produce a sea-change in public sentiment, that in turn might be more effective than any other intervention in changing personal behaviour. This shift in social atmosphere has the advantage of being at least temporarily self-sustaining, i.e., with little or no additional public investment.

A Clinical Caveat

Although population health initiatives will be well-represented in this report, there also will be an emphasis on clinical interventions for both primordial and primary prevention. Although some question whether the limited reach of clinical approaches (compared to the efficiency of population-based interventions) should exclude them from priority consideration, the position of this report regarding increasing clinical capacity is justifiable. Apart from the strong evidence base indicating the effectiveness of clinical interventions for behaviour change and risk factor reduction (see below), there is the simple matter of appropriately supporting the change that motivated individuals who are at-risk want to make. It is hardly socially justifiable to stir up interest in health improvement at a population level, and then not adequately "catch" those who desire to do something about it and would benefit from intensive support measures.

[6] Duncan C, Jones K, Moon G. Smoking and deprivation: are there neighbourhood effects?. *Social Science & Medicine.*1999; 48(4):497-505.
[7] Rogers EM. *Diffusion of Innovations*, 4th ed. Free Press, 1995.

Tobacco Consumption and Environmental Tobacco Smoke Exposure

Tobacco Control: A (Partial) Success Story

In many ways, Canada has led the world in reducing the consumption of tobacco and the adverse health impacts related to smoking.

A case study of Canada's success in tobacco control was prepared in 2003 for the World Bank.[8] The report describes the coordinated efforts over more than 25 years, led by health advocates from inside the government and from a number of important organizations, such as the Canadian Cancer Society and the Heart and Stroke Foundation. Political / legislative actions, as well as key initiatives in prevention, protection, and cessation, have led to dramatic results. One compelling measure of the concerted efforts: the adult smoking rate dropped from 50% to 22% between 1965 and 2001.[9] Some of the most impressive interventions noted by the report are:

- increased taxation on tobacco products; according to the World Bank, the affordability of tobacco products has always proven to be the single biggest factor in predicting per capita consumption.

- extensive protection in the workplace from passive or second-hand smoke, also known as environmental tobacco smoke (ETS),[10] with a gradual expansion of such policies into other public areas (e.g., Canada was the first to ban smoking on international passenger flights).

- restrictions on advertising and on sales to minors, as well as ground-breaking changes in package labelling, which now includes the famous large pictorial warnings.

Perhaps the most significant advances in Canada, and those hardest to measure, are in the arena of public opinion and social norms, i.e., growing negative attitudes towards tobacco companies, smoking in public, and exposing children to tobacco smoke. This process—usually called denormalization (especially in reference to the tobacco industry)[11]—is an explicit part of the national tobacco control strategy established in 1999.[12] Major work remains to be done on this and other fronts, illustrated by the fact that tobacco-related

> *"Let us remember—tobacco remains the only legal consumer product that kills half of its regular users."*
> Dr. Brundtland, Director-General, WHO, Framework Convention on Tobacco Control, Opening Statement. October 16, 2000

[8] Sweanor D, Kyle K. Legislation and applied economics in the pursuit of public health. Available at http://www1.worldbank.org/tobacco/pdf/2850-Ch04.pdf (accessed October 2004).
[9] This is comparable to the results in the "flagship" tobacco control state, California.
[10] By 1983 in the US, 82% of indoor workers faced some restrictions on workplace smoking, and 47% worked in smoke-free environments. Farrelly MC, Evans WN, Sfekas AE. The impact of workplace smoking bans: results from a national survey *Tobacco Control* 1999; 8(3): 272-7.
[11] The B.C. Government Tobacco Control Strategy published in May 2004 notes that First Nations prefer the term "tobacco demarketing" in order to avoid the sense that their traditional / sacred uses of tobacco are not normal.
[12] See the discussion on denormalization at http://www.ncth.ca/ncth_new.nsf/MAINframeset?OpenFrameSet&Frame=BodyFrame&Src=http://www.ncth.ca/NCTH_new.nsf/0/BB9C061688D983AA85256E160077E4C8?OpenDocument (accessed October 2004).

death rates are still high (estimated by Health Canada to be 47,000 per annum), smoking is prevalent among at-risk populations such as First Nations, and too little attention is being given to help smokers quit. In a letter released November 1, 2004, fifty of Canada's most influential health leaders urged the federal government to take more aggressive action in fulfilling the national plan to denormalize "Big Tobacco".[13]

Extensive work has been done recently which expertly reviews all of the current evidence on tobacco control strategies, sometimes incorporating dozens or even hundreds of studies. The Cochrane Tobacco Addiction Group alone currently has 41 online reviews dealing with individual interventions. Three substantial evidence reviews in the US, all from 2000, will also be consulted, as well as a British review dating from the same year. One of these, the US Task Force on Community Preventive Services, has been influential, providing key data to the Australian cancer prevention policy mentioned above.

After introducing a logic model around which the data will be organized, the rest of this section in the report will review the current evidence for best (or better) practices to reduce smoking and decrease the health risks associated with tobacco, in order to promote a state-of-the-art approach to smoking cessation and other pillars of B.C.'s tobacco policy.

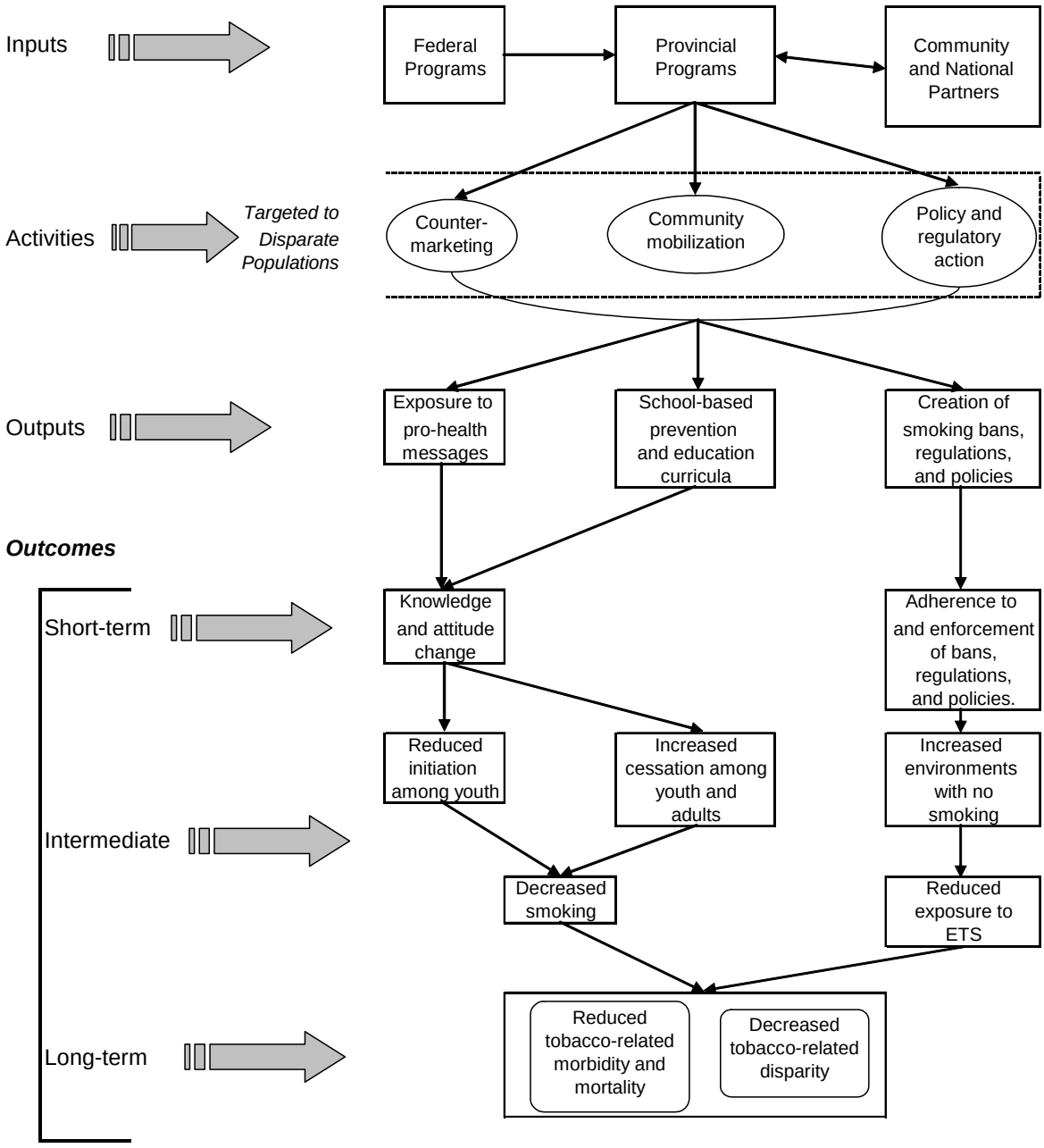
Logic Model and Data Organization

Various logic models relating to tobacco control have been designed, ranging from simple to more complex. The logic model proposed by the Centres for Disease Control in the US, with some minor modifications, is shown on the following page.[14] (See Appendix B for a brief overview of logic models. Note that a version of the following framework has also been developed for tobacco control interventions with youth.[15])

[13] Letter to Ujjal Dosanjh, Federal Minister Of Health, signed by over 50 Canadian public health officials and advocates. November 1, 2004. Available at http://www.nsra-adnf.ca/news_info.php?news_id=238&language=en (accessed November 2004).

[14] Centers for Disease Control. *Advancing Tobacco Control through Evidence-Based Programs.* Available at http://www.cdc.gov/nccdphp/promising_practices/tobacco/opportunities.htm (accessed October 2004).

[15] Centers for Disease Control. *Preventing the Initiation of Tobacco Use Among Young People.* Available at http://www.cdc.gov/tobacco/evaluation_manual/appendixb.html#a (accessed October 2004).



The following intermediate outcomes from the model serve as the outline for this section of the report, which will describe and evaluate tobacco control strategies.

- Interventions to reduce initiation rates, especially among youth
- Interventions to increase cessation rates
- Interventions to reduce ETS exposure, especially in children.[16]

[16] The *Healthy People 2010* project in the US distinguishes the three categories from a fourth category of *environmental* policies involving legislation / regulations on how tobacco is sold, priced, promoted and used in public.
(footnote continued)

Interventions to Reduce Initiation Rates

The focus of this subsection will be on reducing the initiation of tobacco use among adolescents, as this is the age and stage when by far the majority of individuals take up smoking as a long-term habit.

> "*Realistically if our Company is to survive and prosper over the long term, we must get our share of the youth market."* Claude Teague, R.J. Reynolds Tobacco *Research planning memorandum on some thoughts about new brands of cigarettes for the youth market*, February 2, 1973. Bates No. 502987358.

If smoking does not occur in adolescence, it is unlikely to ever occur.[17] As well, adolescents who begin at a younger age are more likely to become regular and heavier smokers, and are less likely to quit.[18,19] Individuals who begin smoking during childhood or early adolescence are also at a higher risk of developing airway diseases and lung cancers than are individuals who start later, likely due to the irreparable damage to the lungs and airway tissues at a point when these organs are still in a developmental stage.[20,21] Most alarming of all, nicotine dependence often begins with the first few cigarettes smoked during adolescence.[22] A study published in November, 2004, notes that children who smoke as few as one cigarette by 5th grade were twice as likely to be current smokers at age 17.[23]

Community-based Interventions

Smoking behaviour, like other health-related behaviour, is influenced by the environment in which adolescents live. This recognition has led to the development of community-wide programs targeted at teens. Community interventions are defined as "co-ordinated, widespread programs in a particular geographical area (e.g. school districts) or region or in groupings of people who share common interests or needs, which support non-smoking behaviour."[24] Such initiatives have the following advantages:

The Cancer Council of Australia identifies a fourth category which falls under the controversial area of harm reduction: reduce the exposure of users to the harmful health consequences of tobacco products. The US Centers for Disease Control and Prevention offers a different fourth category, namely identifying populations disproportionately affected by tobacco use and eliminating such disparities.

[17] Only about 10% of new smokers initiate after age 18 years. Sowden A, Arblaster L, Stead, L. Community interventions for preventing smoking in young people. Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

[18] Tyas SL, Pederson LL. Psychosocial factors related to adolescent smoking: a critical review of the literature *Tobacco Control* 1998; 7: 409-20.

[19] Taioli E, Wynder EL. Effect of the age at which smoking begins on frequency of smoking in adulthood *New England Journal of Medicine* 1991; 325: 968-9.

[20] Knoke JD, Shanks TG, Vaughn JW et al. Lung cancer mortality is related to age in addition to duration and intensity of cigarette smoking: an analysis of CPS-I data *Cancer Epidemiology* 2004; 13(6): 949-57.

[21] Patel BD, Luben RN, Welch AA et al. Childhood smoking is an independent risk factor for obstructive airways disease in women *Thorax* 2004; 59: 682-6.

[22] DiFranza JR, Wellman RJ. Preventing cancer by controlling youth tobacco use *Seminars in Oncology Nursing* 2003; 19(4): 261-7.

[23] Jackson C, Dickinson D. Cigarette consumption during childhood and persistence of smoking through adolescence *Archives of Pediatrics & Adolescent Medicine* 2004; 158: 1050-6.

[24] Sowden A, Arblaster L, Stead L. Community interventions for preventing smoking in young people Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

- multi-dimensionality, with different components working together
- maximizing the chance of reaching all members of a population
- ongoing and broad support for the maintenance of non-smoking behaviour.

As suggested, community programs geared towards any age group usually have multiple components (which also makes it somewhat difficult to compare them in studies). Typical components of programs related to smoking include:

- mass media communications such as counter-advertising
- special (non-curricular) initiatives in schools, e.g., no smoking policies
- age restrictions on the purchase of tobacco products
- increased unit price for tobacco products (i.e., taxation)
- tobacco-free public places

Sometimes the community initiatives are launched by non-profit groups, whereas others are more government-mandated. It is clear that there can be a substantial overlap of content between community programs for adolescents and adults (see below), and possibly good arguments for coordinated initiatives across all ages.

Program Effectiveness

A 2003 Cochrane review[25] of community-wide programs geared to youth found 17 studies of sufficient rigor to include for evaluation. About a third of them offered limited support for the effectiveness of community interventions in preventing the uptake of smoking in young people, especially related to programs that had multiple components (e.g., media, school and homework interventions combined) versus, for instance, a media campaign alone. Of the 13 studies which compared community interventions to no intervention controls, only two reported a lower smoking prevalence. Of three studies comparing community interventions to school-based programs only, one found differences in reported smoking prevalence. One study found a lower rate of increase in a community receiving a multi-component intervention compared to a community exposed to a mass media campaign alone while another reported a significant difference in smoking prevalence between a group receiving a media, school and homework intervention compared to a media component alone. The review concludes that "there is some limited support for the effectiveness of community interventions in helping prevent the uptake of smoking in young people".

Smoking behaviour, like other health-related behaviour, is influenced by the environment in which adolescents live.

The **design** of counter-advertising campaigns is critical to their effectiveness.

These results mirror the equivocal results in the review of school-based programs combined with community programs as described below.[26] One possible explanation is that the particular design of the counter-advertising campaigns in the successful community programs may be the main the driving force for effectiveness.[27] This appears to be an area where further research is warranted, though comparability of conditions remains a problem. For

[25] Sowden A, Arblaster L, Stead L. Community interventions for preventing smoking in young people Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[26] The two Cochrane reviews included 5 of the same studies.
[27] Wakefield M, Flay B, Nichter M et al. Effects of anti-smoking advertising on youth smoking: a review *Journal of Health Communication* 2003; 8(3): 229-47.

instance, the studies which reported no effects on smoking prevalence comprised a wide variety of community programs; understanding the contribution of individual programs and their interaction is a complex task, not to mention assessing the impact of confounding social factors.

School-based Interventions

Over the past three decades, high schools have been a key focus of efforts to affect adolescent smoking behaviour, though few of the tobacco education curricula have been rigorously evaluated. It is vital to assess the evidence that is available, as there continues to be uncertainty about the effectiveness of school-based educational programs and wide variation in how they are implemented in different countries.

Several different categories of curricular interventions have been reviewed:[28]

- **providing basic information**, including health risks of tobacco use
- **affective education**, enhancing social competence and self-management skills, based on the theory that susceptibility to smoking initiation is increased by weak social skills and poor self-concept
- the most widely used (and most studied) type is a **social influence training** approach (e.g. anti-tobacco resistance skills training, such as teaching students to recognize high risk situations); sometimes these programs involve applying social competence and self-management skills to specific anti-tobacco goals
- combining curricular approaches with community-wide programs (see the subsection below)

The Cochrane review (2004) of school-based interventions looked at 76 RCTs.[29] Only 16 of the studies were rated as category one, i.e., meeting all quality criteria and therefore most valid. Category two studies (37 in total) had one or more methodological deficiencies, whereas the remaining category three papers were so flawed their results had to be largely discounted.

Basic Information-Giving, Affective Education & Combined Approaches

The conclusion of the Cochrane review was that there is insufficient evidence for basic information-giving (8 studies, none of them category one), affective education / social competence interventions—including where these were combined with social influence approaches (15 studies, only 2 being category one), or school programs combined with multi-modal community interventions (3 category one studies). Most of the studies in this inventory showed one or more methodological deficiencies. One combined approach, the widely-researched Life Skills Training, has shown good results. In one case, the intervention was delivered to middle-schoolers, including cognitive-behavioural skills for building self-esteem, communicating effectively and developing personal relationships, countering advertising and developing strategies to resist social influences to smoke. This trial stands out, even though rated as a

[28] Thomas R. School-based programmes for preventing smoking Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[29] Thomas R. School-based programmes for preventing smoking Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

category two study, because of long-term follow-up; after 5 years there was less weekly smoking (21-23% vs. 27%) and less monthly smoking (26-27% vs. 33%).[30]

Social Influence Training

There was significant research support for only one type of intervention, i.e., social influence approaches, though even here the evidence was equivocal. The positive results, seen in 8 of the 15 highest quality studies, were mostly small.[31] For example, the well-known Project TNT (Toward No Tobacco Use) studied, among other interventions, social influence techniques. With the best combination of curricular content and a refresher course in grade 8, the increase in the prevalence rate of weekly smokers from grade 7 to grade 9 was reduced from 9% to 4%; otherwise the effects of the curriculum were insignificant.[32]

The largest and most rigorously tested social influence program, the Hutchinson Project, found no sustained effect on smoking prevalence at all.[33] The most widely-used school-based program, Drug Abuse Resistance Education (D.A.R.E.), is found in three quarters of US schools, as well as in B.C. and the rest of Canada. The program is reportedly popular with police officers and parents.[34,35] There have been many D.A.R.E. reviews and evaluations, but few rigorous scientific evaluations. In trial reports from 1996 and 1999, the program was shown to have no effect on smoking prevalence at 5 and 10 year follow-up.[36,37]

Smoke-free Schools

A large cross-sectional survey by Wakefield and colleagues revealed that school smoking bans, as well as limiting environmental tobacco smoke exposure, could produce less intense uptake of smoking and a lower smoking prevalence rate among youth. However, the effects were only significant if the ban was strongly enforced, i.e., "when teenagers perceived that most or all students obeyed the rule."[38]

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[30] Botvin GJ, Baker E, Dusenbury L et al. Long-term follow-up results of a randomized drug abuse prevention trial in a white middle-class population *Journal of the American Medical Association* 1995; 273(14): 1106-12.

[31] An earlier meta-analysis of studies from 1974 to 1991 showed that school-based programs likely would produce at most a 5% reduction in teen smoking, or perhaps as high as 20-30% under optimum conditions. Rooney BL, Murray DM. A meta-analysis of smoking prevention programs after adjustment for errors in the unit of analysis *Health Education Quarterly* 1996; 23(1) 48-64.

[32] Dent CW, Sussman S, Stacy AW et al. Two-year behavior outcomes of project towards no tobacco use *Journal of Consulting & Clinical Psychology* 1995; 63(4): 676-7.

[33] Thomas R. School-based programmes for preventing smoking Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

[34] Source: http://www.hc-sc.gc.ca/hecs-sesc/cds/publications/substanceyoungpeople/chapter4_2.htm (accessed November 2004).

[35] Curtis CK. *The Efficacy of the Drug Abuse Resistance Education Program in West Vancouver Schools*. West Vancouver Police Department, 1999.

[36] Clayton RR, Cattarello AM, Johnstone BM. The effectiveness of Drug Abuse Resistance Education (project DARE): 5-year follow-up results *Preventive Medicine* 1996; 25(3): 307-18.

[37] Lynam DR, Milich R, Zimmerman R et al. Project DARE: no effects at 10-year follow-up *Journal of Consulting & Clinical Psychology* 1999; 67(4): 590-3.

[38] Wakefield MA, Chaloupka FJ, Kaufman NJ et al. Effect of restrictions on smoking at home, at school, and in public places on teenage smoking: cross sectional study. *British Medical Journal.* 2000; 321(7257):333-7. See also Trinidad DR, Gilpin EA, Pierce JP. Compliance and support for smoke-free school policies. *Health Education Research.* 2004 [Epub ahead of print].

Conclusion

The rather pessimistic general assessment of curricular programs in schools has been echoed in other reviews. The recent *National Cancer Prevention Policy* of Australia quotes a World Bank evaluation of such initiatives: "Even programs that have initially reduced the uptake of smoking appear to have only a temporary effect; they can somewhat delay initiation of smoking but not prevent it."[39] This does not mean that efforts to develop effective approaches in the important setting of schools should come to an end. On the contrary, innovative approaches should continue to be explored. One recent clinical trial showed promise: when the curriculum extended to "field work" with student involvement in environmental tobacco smoke advocacy, the prevalence of regular smoking among senior students dropped from 25% to 20%.[40]

The best approach to school-based interventions will likely be comprehensive, including, for example, smoke-free school policies. As will be discussed more fully below, social norms in schools are as important as in other situations. School cultures which have an emphasis on discipline and respect for authority have shown better results in reducing smoking prevalence.[41]

Clinical Interventions and Management

Neither the hospital nor the physician's office has been a primary focus of smoking prevention. Some reviews of interventions aimed at preventing uptake of smoking among adolescent do not even include the clinical category.[42] In fact, a 2003 systematic review of teen smoking prevention only found 4 suitable studies, 2 with interventions related to clinical care and 2 to dental care. Only one study showed a significant difference in smoking prevalence at 12 months (5.1% compared to 7.8% in the control group).[43]

Regulatory and Economic Interventions

Controlling Sales to Minors

Legislative / taxation approaches have proven useful in curbing youth smoking. Age restrictions on the purchase of tobacco products vary around the world, with the main difference being upon whom the sanction for non-compliance falls. The focus has been placed either on the retailer not to sell to minors, or on the young person not to buy or use tobacco products. There is mixed data on the results of such

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[39] Jha P, Chaloupka F. *Curbing the Epidemic: Governments and the Economics of Tobacco Control.* Washington: World Bank, 1999.

[40] Winkleby MA, Feighery E, Dunn M et al. Effects of an advocacy intervention to reduce smoking among teenagers. *Archives of Pediatrics & Adolescent Medicine.* 2004; 158(3):269-75.

[41] Aveyard P, Markham WA, Lancashire E et al. The influence of school culture on smoking among pupils. *Social Science & Medicine.* 2004; 58(9):1767-80.

[42] NHS Centre for Reviews and Dissemination. Preventing the uptake of smoking in young people *Effective Health Care* 1999; 5(5): 1-12. Available at http://www.york.ac.uk/inst/crd/ehc55.pdf (accessed December 2004).

[43] Christakis DA, Garrison MM, Ebel BE et al. Pediatric smoking prevention interventions delivered by care providers: a systematic review *American Journal of Preventive Medicine* 2003; 25(4): 358-62.

interventions, offering both negative[44,45,46,47] and positive[48,49] conclusions, and the debate promises to be lively for some time to come.[50,51,52]

The 2004 Cochrane review on interventions for preventing tobacco sales to minors identified 30 studies in this area, of which 13 were of sufficient quality to include in their review. The reviewers found that giving retailers information was less effective in reducing illegal sales than active enforcement and/or multi-component educational strategies. The 3 papers most relevant to the issue of youth smoking rates, however, showed little effect from limiting tobacco sales to minors. The main problem may be the inability to achieve "sustained levels of high compliance" among retailers.[53] All authorities agree that monitoring and enforcement (which tend to be expensive) are vital to any successful retail policy. The most recent research and discussion seems to be around the impact on youth smoking when high compliance by retailers can be demonstrated.[54] Programs such as Toronto's *Not to Kids!* campaign, which have shown some improvement in retailer non-compliance rates, have yet to be evaluated in terms of their actual effect on youth smoking.[55]

"By emphasizing the adults-only status of tobacco use, tobacco industry programs reinforce young peoples' desire to use tobacco." Ontario Medical Association, 2002

One of the responses by the tobacco industry to legal challenges and public pressures has been to develop and disseminate programs such as "Operation ID" and "Operation ID/School Zone". A review of such programs by the Ontario Medical Association found numerous concerns about the approach and outcomes associated with these programs. They conclude that "since none of (these programs) occupy a legitimate position in best practice-based tobacco control strategy, the OMA recommends that

[44] Woollery T, Asma S, Sharp D. Clean indoor-air laws and youth access restrictions. In: Jha P, Chaloupka F, eds. *Tobacco control in developing countries.* Oxford: University Press; 2000.
[45] Rigotti NA, DiFranza JR, Change Y. The effect of enforcing tobacco-sales laws on adolescents' access to tobacco and smoking behavior *New England Journal of Medicine* 1997; 337: 104-51.
[46] Altman DG, Wheelis AY, McFarlane M et al. The relationship between tobacco access and use among adolescents: a four community study *Social Science & Medicine* 1999; 48(6): 759-75.
[47] Levy D, Friend K. A simulation model of tobacco youth access policies *Journal of Health Politics, Policy and Law* 2000; 25(6): 1023-48.
[48] Chaloupka F, Grossman M. *Price, tobacco control policies, and youth smoking* National Bureau of Economic Research Working Paper Number 5740, 1996.
[49] Cummings K, Hyland A, Saunders-Martin T et al. Evaluation of an enforcement program to reduce tobacco sales to minors *American Journal of Public Health* 1998; 88(6): 932-6.
[50] Fichtenberg CM, Glantz SA. Youth access interventions do not affect youth smoking *Pediatrics* 2002; 109(6): 1088-92.
[51] Ling PM, Landman A, Glantz SA. It is time to abandon youth access tobacco programmes *Tobacco Control* 2002; 11(1): 3-6.
[52] DiFranza JR. Is it time to abandon youth access programmes? *Tobacco Control* 2002; 11(3): 282; author reply 283-4.
[53] Stead LF, Lancaster T. Interventions for preventing tobacco sales to minors *Cochrane Database of Systematic Reviews*, 2004.
[54] DiFranza JR. Is it time to abandon youth access programmes? *Tobacco Control* 2002; 11(3): 282; author reply 283-4.
[55] Source: http://www.city.toronto.on.ca/not_to_kids/nottokids_info.htm (accessed November 2004).

all groups, associations and other interested parties which have formally endorsed them, be asked to withdraw their endorsement".[56]

Taxation

> *"It's expected that the new excise will lessen demand for our tobacco products, but we will, of course, do our best to keep plugging away at marketing programs in order to sustain demand."* Japan Tobacco Inc., Annual Report for the year ending March 31, 1998

Not even the strongest proponents of retail restrictions see them as the final answer. Prohibitions of sales to minors should only be viewed as a complement to other proven strategies. In particular, taxation policies are crucial, being as effective with youth as they are with adults (see below). Bridge and Turpin, in the recent report entitled *The Cost of Smoking in British Columbia and the Economics of Tobacco Control*,[57] note that the most detailed study of the relationship between price and youth smoking showed a "price elasticity" that varies inversely with age; what this means is that price seemed to have the greatest impact on discouraging young experimenting smokers who were not yet addicted. Also, the impact was 6 times higher in terms of discouraging occasional smoking compared with reducing daily smoking, which again bodes well for an intervention targeted at tentative, experimenting smokers.[58] Reports by the US Surgeon General and several others confirm that price is more likely to affect the decision to start smoking than to affect the behaviour of current smokers.[59]

Circumstantial evidence in Canada strongly supports the effectiveness of price in controlling youth smoking; in the 1980s smoking prevalence among young people declined by half, a trend which sharply reversed when taxes on cigarettes were cut in the 1990s.[60]

There is a range of data on the expected impact of taxation; a 10% price increase could reduce teenage smoking prevalence from 6 to 10%; even the lower estimate is in excess of the effect for the general population.[61] The International Union of Health Promotion and Education[62] concurs on the central role of taxation policy: "Imposing sufficiently high taxes on tobacco products is the most successful and

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[56] Ontario Medical Association position statement. *More Smoke and Mirrors: Tobacco industry-sponsored youth prevention programs in the context of comprehensive tobacco control programs in Canada*, February 2002. Available at www.oma.org/phealth/smokeandmirrors.html (accessed November 2004).

[57] Bridge J, Turpin B. *The Cost of Smoking in British Columbia and the Economics of Tobacco Control.* Health Canada, February 2004.

[58] A 10% price increase produced an 18% reduction in occasional smoking, but only a 3% reduction in daily smoking. Harris JE, Chan SW. The continuum-of-addiction: cigarette smoking in relation to price among Americans aged 15-29 *Health Economics* 1999; 8(1): 81-6.

[59] Bridge J, Turpin B. *The Cost of Smoking in British Columbia and the Economics of Tobacco Control.* Health Canada, February 2004.

[60] Stephens T, Pederson LL, Koval JJ et al. The relationship of cigarette prices and no-smoking bylaws to the prevalence of smoking in Canada. *American Journal of Public Health* 1997; 87(9): 1519-21.

[61] Bridge J, Turpin B. *The Cost of Smoking in British Columbia and the Economics of Tobacco Control.* Health Canada, February 2004.

[62] The IUHPE is a leading global network working to promote health worldwide and contribute to the achievement of equity in health between and within countries. One of its key recent publications is *Model Legislation for Tobacco Control: a policy development and legislative drafting manual.*

important tobacco control intervention for preventing youth access to and consumption of tobacco products."[63]

Advertising Control

Although banning the public promotion / marketing of tobacco products, and especially ending advertising directed at teenagers, may seem to be a war that has been largely won in Canada, several battlefronts remain. There is strong circumstantial evidence for the effectiveness of marketing tobacco (and therefore for the importance of maintaining and expanding bans on such business practices). A key fact is that in 2000 almost $9 *billion* was spent by the US tobacco industry on advertising and other types of promotion, with the presumption closely following that the various companies must have a strong rationale to support such expenses.[64]

Unlike other areas of tobacco control, experimental studies cannot ethically be conducted. The relevant Cochrane review therefore depends on observational studies. In all nine papers examined, the non-smoking adolescents who were more aware of tobacco advertising were more likely to have experimented with cigarettes or become smokers at follow-up.[65] For example, Biener and Siegel found that 46% of non-smoking adolescents who owned a tobacco promotion item, and had a favourite brand advertisement, were established smokers 4 years later.[66] Again, the inference is that curtailing marketing, especially to impressionable teens, is an effective means of tobacco control.

Smoking in Movies

Another arena receiving increasing attention as part of a tobacco control policy is the portrayal of smoking in films. Increasingly, movie stars are receiving payment for endorsing or using cigarettes on screen, in so-called product placements. Georgina Lovell[67] quotes a letter from Sylvester Stallone to Brown & Williamson in which he agrees to a sum of $500,000 for the use of Brown & Williamson cigarettes in at least five feature films.

Increasingly, movie stars are receiving payment for endorsing or using cigarettes on screen, in so-called product placements.

Results of a number of cross-sectional studies[68,69,70] suggest that adolescents are more likely to try smoking if their

[63] Source: http://www.fctc.org/modelguide/lsection09.html#98 (accessed November 2004).
[64] Lovato C, Linn G, Stead LF et al. Impact of tobacco advertising and promotion on increasing adolescent smoking behaviours Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[65] Lovato C, Linn G, Stead LF et al. Impact of tobacco advertising and promotion on increasing adolescent smoking behaviours Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[66] Biener L, Siegel M. Tobacco marketing and adolescent smoking: More support for a causal inference *American Journal of Public Health* 2000; 90: 407-11.
[67] Lovell G. *You Are The Target: Big Tobacco: Lies, Scams – Now The Truth*, 2002 Chyran Communication, Vancouver, British Columbia.
[68] Distefan JM, Gilpin EA, Sargent JD et al. Do movie stars encourage adolescents to start smoking? Evidence from California. *Preventative Medicine* 1999; 28: 1-11.
[69] Tickle JJ, Sargent JD, Dalton MA et al. Favourite movie stars, their tobacco use in contemporary movies and its association with adolescent smoking. *Tobacco Control* 2001; 10: 16-22.
[70] Sargent JD, Beach ML, Dalton MA et al. Effect of seeing tobacco use in films on trying smoking among adolescents: cross-sectional study. *British Medical Journal* 2001; 323: 1394-97.

favourite movie stars smoked on screen. A key longitudinal cohort study by Dalton et al[71] found a strong relationship between exposure to smoking in movies and the initiation of smoking in adolescents. After controlling for baseline characteristics, they found that the 25% of adolescents exposed to the highest number of smoking occurrences in movies were 2.7 times more likely to initiative smoking than the 25% of adolescents exposed to the lowest number of smoking occurrences.

Based on this evidence, Dr. Glantz of the Center For Tobacco Control Research in San Francisco met with the Ontario Film Review Board in October, 2004, to propose that movies portraying smoking should be given an 18A rating, i.e., any young person seeing the subliminal pro-smoking message would at least have to have an adult accompanying them. Glantz suggests that "smoking scenes in movies are the number one recruiter of new, young smokers in the United States—390,000 American teens every year."[72]

More recently, the American Lung Association has begun to rate movies using icons of lungs, black for movies depicting heavy smoking and pink for when none of the characters smoke.[73]

The final policy category which affects young people, *bans* on smoking in public places, will be handled below under the topics of workplace interventions and environmental tobacco smoke.

Comprehensive Strategies

Increasingly, it is becoming clear that the division between the above categories can be an artificial one. The trend is towards comprehensive, more fully integrated approaches, though this does make it difficult to scientifically isolate the effect of individual component strategies. Florida has been singled out for investing a large proportion of its settlement with the tobacco industry in a very effective youth anti-smoking campaign. It combined counter-marketing advertising, community-based activities, education and training, and an enforcement program that was able to reduce tobacco use among middle school students from 18.5 to 15.0% and among high school students from 27.4 to 25% between 1998 and 1999. A key focus of the campaign was denormalizing tobacco and the tobacco industry, removing the "glamour" of smoking in the eyes of youth.[74] The funding for Florida's Youth Tobacco Control Program, however, has been consistently eroded since the initial large start-up grant.[75]

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[71] Dalton MA, Sargent JD, Beach ML et al. Effect of viewing smoking in movies on adolescent smoking initiation: a cohort study *The Lancet* 2003; 362(9380): 281-5.
[72] News report. Available at http://www.newswire.ca/en/releases/archive/October2004/29/c6409.html (accessed November 2004).
[73] Cobb C. Anti-smoking campaign targets films. *The Vancouver Sun*, December 20, 2004, pg A8.
[74] Source: http://www.cdc.gov/tobacco/research_data/stat_nat_data/bpfactsheet.htm (accessed November 2004).
[75] Source: http://www.cancer.org/docroot/COM/content/div_FL/COM_4_5x_Florida_Tobacco_Control_Program.asp?sitearea=COM (accessed November 2004).

Social Denormalization

It is clear that youth can be considered an "at-risk" population[76] and that preventing the uptake of smoking among the young is vital. Primary prevention has focused on discouraging experimentation with cigarettes and / or deterring regular use. The importance of these goals cannot be overestimated as communities continue to move towards the denormalization of smoking. If this "tipping point" for tobacco control has not already been achieved, then it may at least be in sight. The challenge is to maintain economic and other policy pressures that will solidify the movement towards making not smoking the expected social reality in developed countries, and then see that movement extend to other parts of the world, and to other aspects of health promotion. Influencing new generations will undoubtedly be both a key and consequence of such social normalization of healthy living.

An influential US report concluded:

> *Cigarette control policies that discourage smoking by teenagers may be the most effective way of achieving long-run reductions in smoking in all segments of the population. A tax hike would continue to discourage smoking for successive generations of young people and would gradually affect the smoking levels of older age groups…[and] aggregate smoking and its associated detrimental health effects would decline substantially.*[77]

An encouraging aspect of tobacco control among adolescents is the synergies that can be derived from adult cessation programs (see the next subsection).[78] It is well-known that parental (and sibling) smoking is a risk factor for adolescent initiation.[79] Research has shown that when parents quit, the odds of their children taking up smoking were significantly reduced.[80] Likewise, teenagers are able to understand and act on cessation advertising directed to adults; there is evidence from the Australian National Tobacco Campaign that adolescents responded similarly to adults, leading to the following somewhat surprising conclusion: *an adult cessation focus may even be more effective that one directly targeting teens.*[81]

> *"The key 15-19 age group is a must for RBH."* Rothmans, Benson & Hedges Inc. *RBH-1134 Strategic Plan 1997/98 Sales & Marketing*

A related phenomenon is the positive "multiplier effect" of peers on teenage smoking. If fewer teens are smoking, fewer other teens want to emulate them. As Grossman and Chaloupka noted in reference to tax policy: "a rise in price curtails

[76] There are a number of factors common to society and youth culture that can promote smoking, including stress, the accessibility and availability of tobacco products, perceptions that tobacco use is normative, the model, influence and approval of peers and lack of knowledge of health consequences. US Centers for Disease Control and Prevention. *Preventing Tobacco Use Among Young People: A Report of the Surgeon-General*, 1994.

[77] Grossman M, Chaloupka FJ. Cigarette taxes. The straw to break the camel's back *Public Health Reports* 1997; 112(4): 290-7.

[78] Hill D. Why we should tackle adult smoking first *Tobacco Control* 1999; 8(3): 333-5.

[79] The Cancer Council Australia. *National Cancer Prevention Policy, 2004-06.*

[80] Farkas AJ, Distefan JM, Choi WS et al. Does parental smoking cessation discourage adolescent smoking? *Preventive Medicine* 1999; 28(3): 213-8.

[81] The Cancer Council Australia. *National Cancer Prevention Policy, 2004-06.*

youth consumption directly and then again indirectly through its impact on peer consumption."[82]

A smoke-free home is also effective in preventing smoking uptake, more so than other place-based restrictions (such as bans in school or public places). One cross-sectional survey concluded: "Banning smoking in the home, even when parents smoke, gives an unequivocal message to teenagers about the unacceptability of smoking."[83]

All of the above agencies and forces spur on the efforts to achieve a "tipping point" in tobacco control.

Interventions to Increase Cessation Rates

Smoking cessation has been called the "gold standard" of prevention strategies in healthcare in that smoking cessation produces additional years of life at costs well below those estimated for many other accepted medical treatments.[84] One comprehensive review of preventive services rated tobacco cessation counselling for adults as second in priority based on effectiveness and cost-effectiveness, second only to childhood vaccinations.[85]

Interventions to increase tobacco cessation rates include strategies to:[86]

- increase the number of users who attempt to quit
- improve the success rate of individual cessation attempts
- achieve both of these goals.

The US Task Force on Community Preventative Services (TFCPS) has produced an influential grid[87] for tobacco control policies that are community-based approaches rather than individual therapies; these can range from government legislation / taxation, to advertising controls or campaigns, to programs directly related to the healthcare system. The TFCPS identified several potential interventions related to cessation:[88]

Community-wide

- increased unit price for tobacco products (i.e., taxation)

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[82] Grossman M, Chaloupka FJ. Cigarette taxes. The straw to break the camel's back. *Public Health Reports* 1997; 112(4): 290-7.

[83] Wakefield MA, Chaloupka FJ, Kaufman NJ et al. Effect of restrictions on smoking at home, at school, and in public places on teenage smoking: cross sectional study *British Medical Journal* 2000; 321(7257): 333-7.

[84] Warner KE. Cost effectiveness of smoking cessation therapies: Interpretation of the evidence and implications for coverage *Pharmacoeconomics* 1997; 11(6): 538-49.

[85] Coffield AB, Maciosek MV, McGinnis JM et al. Priorities among recommended clinical preventive services. *American Journal of Preventive Medicine.* 2001; 21(1):1-9. Providing adolescents with antitobacco messages or advice to quit was also rated highly, though the evidence was less certain.

[86] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.

[87] For example, it informed a key section of Australia's *National Cancer Prevention Policy, 2004-06.*

[88] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.

- mass media education, including counter-advertising
- telephone cessation support

Healthcare System

- provider reminder systems, e.g., highlighted notes in medical records
- provider education systems, e.g., encouragements to physicians to work with patients on cessation plans, combined with offering guidelines and tools
- reminder and education implemented together, sometimes combined with patient education materials
- provider feedback systems, allowing surveillance of the quantity and quality of cessation interventions
- reducing patient out-of-pocket costs for effective cessation therapies
- telephone cessation support

Multi-component

- approaches that combine two or more of the above strategies

Reorganized into the framework being used in this report, each of these interventions will be briefly assessed with a note of the TFCPS recommendation in each case, augmented by other reviews.[89] In addition, the various clinical services offered to individuals will be itemized and evaluated. Methods which are not recommended are not necessarily ineffective, only that they are not yet supported by compelling evidence. Note: policy approaches related to *bans on tobacco use* are noted in other subsections later in the report.

Community-based Interventions

Mass Media Advocacy / Counter-advertising

Mass media interventions are directed either at changing individual smoking behaviour or changing social norms about smoking.[90] In the very successful California tobacco control program of the 1990s, it was calculated that the media component accounted for 17.4% of the decline in cigarette consumption.[91]

> *"Advertising, it seemed, could achieve almost anything if you did enough of it and with verve."* Kluger R. *Ashes to Ashes: America's Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris*, 1997, pg. 73.

The Cochrane review on this topic is only at the protocol stage, but its initial literature summary offered these conclusions:[92]

- there is some support for media campaigns as a component of a comprehensive program

[89] Summarized in: Strategies for reducing exposure to environmental tobacco smoke, increasing tobacco-use cessation, and reducing initiation in communities and health-care systems *Morbidity & Mortality Weekly Report* 2000; 49.
[90] Wellings K, Macdowall W. Evaluating mass media approaches to health promotion: a review of methods *Health Education* 2000; 100(1): 23-32.
[91] Hu TW, Sung HY, Keeler TE. Reducing cigarette consumption in California: tobacco taxes vs. an anti-smoking media campaign *American Journal of Public Health* 1995; 85(9): 1218-22.
[92] Bala M, Strzeszynski L, Hey K. Mass media interventions for smoking cessation in adults Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Review*, 2004.

- while much of the literature focuses on youth, there are some studies of adult campaigns, showing mixed results
- national and state-wide campaigns have been more successful than local ones.

The TFCPS review concluded, based on 14 studies, that high-intensity counter-advertising is a strongly recommended intervention.[93] B.C. can continue to benefit from such campaigns, and should learn from the studies that have determined the best anti-smoking advertisements. The most effective media approaches reportedly are those which attacked the tobacco companies for deceitfulness and manipulation, which revealed the harmful effect of environmental tobacco smoke, and which underlined the addictive nature of nicotine; advertising that rehearsed the well-known health effects of smoking, on the other hand, are less useful.[94,95]

The most effective media approaches attack tobacco companies for deceitfulness and manipulation, reveal the harmful effects of ETS and underline the addictive nature of nicotine, rather than focus on the health effects of smoking.

Self-help Materials

Self-help or patient education materials usually come in print, but sometimes in audio, video or internet format. In spite of some inconsistency in the data, a 2004 Cochrane review of 52 trials[96] offered 3 conclusions:

- standard self-help material might stimulate modest increases in quit rates
- material personalized for individual smokers is more effective than generic material
- there was no evidence that adding self-help material to counselling or nicotine replacement therapy (see below) increased the effectiveness of those interventions; this result may run counter to other reports, namely, the TFCPS review, where self-help materials are recommended as part of a multi-component strategy.

Web-based Cessation Resources

A new type of self-help platform is interactive websites, for example, the QuitNet service operated in conjunction with the Boston University School of Public Health since 1996.[97] In addition to standard tobacco control and health information, the site has several features aimed at encouraging an individual web-user to set a quit date and medication plan, get questions answered, and gain "moral support" through partners and a general on-line conversation. At the point of registering, a modest amount of "tailored" motivation occurs, e.g., calculating, based on smoking intensity,

[93] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.
[94] Goldman LK, Glantz SA. Evaluation of antismoking advertising campaigns *Journal of the American Medical Association* 1998; 279(10): 772-7.
[95] deMeyrick, J. Forget the "blood and gore": an alternative message strategy to help adolescents avoid cigarette smoking *Health Education* 2001; 101(3): 99-107.
[96] Lancaster T, Stead LF. Self-help interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[97] Go to http://www.quitnet.com/ (accessed December 2004).

the amount of money one would save annually if the quit were successful. As of May 2004, QuitNet has 335,000 registered users world-wide.

Formal evaluations of web-based resources encounter numerous methodological challenges, including low response rates, contamination of control groups due to unrestricted access to websites and so on. Initial results from evaluations appear to show an increase in smoking cessation at one month after access to the site but all studies are uncontrolled with a very low response rate.[98,99,100,101]

A key advantage of web-based resources is that they can reach large segments of the population at minimal overall cost. Given that a large proportion of smokers quit on their own,[102] web-based resources may be a helpful adjunct in that process.

Telephone Help Lines

Telephone contact can either be part of a proactive counselling plan, i.e., planned follow-up by telephone, or a reactive one, i.e., responding to smokers calling in to cessation help lines or quit lines. A Cochrane review (of 27 trials in total) supports both types of telephone intervention when compared against interventions that do not involve personal contact, but notes that the greatest effectiveness usually involves multiple contacts with the client.[103] The evidence for reactive help-lines is limited. Trials where proactive telephone support was added to counselling or nicotine replacement therapy failed to detect any additional effect on cessation rates.

The 2000 report *Treating Tobacco Use and Dependence*, a clinical practice guideline sponsored by the US Public Health Service[104] found (based on a met-analysis of 58 studies) that proactive help lines did have a modest effect on abstinence rates, as indicated on the following table.

Format of Intervention	*Estimated Odds Ratio (95% C.I.)*[105]	*Estimated Abstinence Rate (95% C.I.)*
No format	1.0	10.8%
Self-help	1.2 (1.02, 1.30)	12.3% (10.9, 13.6)
Proactive Telephone Counselling	1.2 (1.1, 1.4)	13.1% (11.4, 14.8)
Group Counselling	1.3 (1.1, 1.6)	13.9% (11.6, 16.1)
Individual Counselling	1.7 (1.4, 2.0)	16.8% (14.7, 19.1)

[98] Feil E, Noell, J, et al. Evaluation of an internet-based smoking cessation program: lessons learned from a pilot study *Nicotine and Tobacco Research* 2003; 5(2): 189-94.
[99] Lenert L, Munoz RF, et al. Design and pilot evaluation of an internet smoking cessation program *Journal of the American Informatics Association* 2003; 10: 16-20.
[100] Lenert L, Munoz RF, et al. Automated email messaging as a tool for improving quit rates in an internet smoking cessation program *Journal of the American Informatics Association* 2004; 11: 235-40.
[101] Cobb N, Graham A, Bock BC et al. Initial evaluation of a 'Real World' internet smoking cessation system *Nicotine and Tobacco Research* 2004 (in press).
[102] Fiore MC. The new vital sign. Assessing and documenting smoking status *Journal of the American Medical Society* 1991; 266(22): 3183-84.
[103] Stead LF, Lancaster T, Perera, R. Telephone counselling for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[104] U.S. Department of Health and Human Services. *Treating Tobacco Use and Dependence: Clinical Practice Guideline* June 2000.
[105] C.I. = Confidence Interval, the 95% confidence interval range given means that the 'true' number will fall within the given range 95 out of a 100 times.

Based on this review, notice also that the use of self-help materials marginally increases abstinence rates.

Multi-component Approaches

The TFCPS, based on a literature review of the published evaluations (32 studies in total), strongly recommended a multi-component approach to cessation using, at a minimum, patient education materials and proactive telephone support (see Clinical Interventions and Management below). It was also noted that mass media efforts augmented effectiveness in many cases.

The Task Force result seems to contradict the conclusion of a Cochrane review of community interventions for smoking among adults.[106] Half of the 32 studies included in the Cochrane review featured a single intervention community and a control community, and only a handful used randomization to assign the communities. The pooled results were modest. For example, the estimated net decline in smoking prevalence ranged from -1.0% to 3.0% per year in studies where men and women were combined. The effect on cessation rates was usually not part of the studies.

There is a continuum between community-wide multi-component interventions and comprehensive strategies drawing on different intervention categories (see Comprehensive Strategies below), so that it is sometimes difficult to know how best to label a project.

Other Community-based Interventions

According to the TFCPS,[107] insufficient evidence currently exists for the following interventions:

- televised "how to quit" programs
- community-wide quit competitions
- providing information about reducing ETS exposure in the home

Quit competitions, for example, have been tried and tested in Ontario, with a cessation success rate of only 0.17%.[108]

Workplace-based Interventions

The workplace represents a parallel to the school setting for youth, namely a place where large, stable population of adults spend a large amount of their time, therefore offering a potentially useful venue for encouraging smoking cessation. Although the

[106] Secker-Walker RH, Gnich W, Platt S et al. Community interventions for reducing smoking among adults Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[107] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.
[108] Bains N, Pickett W, Laundry B et al. Predictors of smoking cessation in an incentive-based community intervention *Chronic Diseases in Canada*. 2000; 21(2): 54-61.

nature of the workplace is rapidly changing in today's society, the traditional advantages the workplace offers for public health efforts still pertain, including:[109]

- the potential for sustained peer group support
- occupational health staff may be available to provide support
- employees are not having to dedicate personal time or money, possibly increasing program participation rates.

There is considerable variation from country to country in the extent of workplace tobacco control programs. The involvement of companies in Europe has been relatively low in contrast with the US, where a remarkable 87% of firms had instituted some form of smoking ban according to a 1992 survey.[110]

The key Cochrane review in this area categorizes workplace interventions into those aimed at the workforce as a population and those directed towards individuals. Comprehensive programs that combine the two approaches were also considered, but the evidence is limited.[111]

Environmental and Social Support

Environmental support can include large and small posters and other forms of large group communication; such measures are hard to evaluate because they can be part of comprehensive programs with other, confounding interventions (especially social support). There is limited evidence that poster campaigns are effective.[112,113]

Social support involves a buddy system or peer group, often added to other interventions. Limited research (only 2 studies) did not show a significant differential effect of social support approaches compared with control.[114]

Competitions and Incentives

A variety of rewards have been used in workplaces (salary bonuses, promotional items, luxury goods and holidays) within a variety of systems: [115] reward for attendance at a program or for actual success; competition between staff, peer group basis, or individual rewards; positive incentives versus (rarely) disincentives.

There is limited evidence (based on 6 studies) that participation rates in programs can be increased through competitions and incentives instigated by employers.[116]

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[109] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[110] Linnan LA, Emmons KM, Galuska EC et al. Smoking control at the workplace: current status and emerging issues *Rhode Island Medicine* 1993; 76: 510-514.
[111] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[112] Dawley HH, Dawley LT, Correa P et al. A comprehensive worksite smoking control, discouragement, and cessation program *International Journal of Addiction* 1991; 26: 685-96.
[113] Serra C, Cabezas C, Bonfill X et al. Interventions for preventing tobacco smoking in public places Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[114] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Review*, 2004.
[115] Hey K, Perera R. Competitions and incentives for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[116] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.

Community-based incentive programs may fare better than those in the workplace setting, but the research is incomplete.[117] Upcoming Cochrane reviews will be further examining this issue, as well as programs focused on providing incentives to healthcare professionals for the delivery of smoking cessation interventions.

Individual Cessation Campaigns

Not surprisingly, the individual initiatives found to be effective in other settings, including advice from a health professional, individual and group counselling and pharmacological treatment, provided similar results in the workplace. As noted in the *National Cancer Prevention Policy of Australia*, however, the main problem with individual interventions is that they require a formal commitment that relatively few smokers are prepared to invest the time or money.[118] Even though there is strong evidence that individual programs in the workplace increase cessation rates among the participating employees, and even though the employer is covering most of the costs, the absolute numbers of smokers who quit are low.[119]

Tobacco Bans

Obviously one of the ways to reduce environmental tobacco smoke (ETS) is to reduce smoking; but, conversely, efforts to limit smoking in the workplace or other public places sometimes motivate people to quit smoking or at least reduce consumption,[120,121,122,123,124] though some of the evidence is inconsistent.[125] This provides one of the strong arguments to integrate smoking behaviour changes with the topic of ETS (see below), as we have done in this section of the report.

In addition to general smoking restriction by-laws, the current targets for specific smoking bans are the workplace, home and school; recently, automobiles carrying children have been added to the list. Tobacco bans are the most prevalent workplace intervention; they can take a number of forms, from complete prohibition of smoking on the premises to restrictions of smoking to designated areas (with or without ventilation). As the most studied type of public tobacco restriction, a number of benefits of a smoke-free workplace have been identified in the literature:[126,127,128]

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[117] Nelson DJ, Lasater TM, Niknian M et al. Cost effectiveness of different recruitment strategies for self-help smoking cessation programs *Health Education Research* 1989; 4(1): 79-85.
[118] The Cancer Council Australia. *National Cancer Prevention Policy, 2004-06.*
[119] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[120] Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behaviour: systematic review *British Medical Journal* 2002; 325: 188.
[121] Woodruff TJ, Rosbrook B, Pierce J et al. Lower levels of cigarette consumption found in smoke-free workplaces in California *Archives of Internal Medicine* 1993; 153(12): 1485-93.
[122] Gilpin EA, Pierce JP. The California Tobacco Control Program and potential harm reduction through reduced cigarette consumption in continuing smokers *Nicotine & Tobacco Research* 2002; 4(Suppl2): S157-66.
[123] Chapman S, Borland R, Scollo M et al. The impact of smoke-free workplaces on declining cigarette consumption in Australia and the United States *American Journal of Public Health* 1999; 89(7): 1018-23.
[124] Shields M. *A Step Forward, A Step Back: Smoking Cessation & Relapse* November 2004, Statistics Canada, Catalogue 82-618.
[125] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[126] Harden A, Peersman G, Oliver M et al. A systematic review of the effectiveness of health promotion interventions in the workplace *Occupational Medicine* 1999; 49: 540-8.

- reduced absenteeism and increased productivity
- reduced healthcare and insurance costs
- reduced cleaning costs and lower risk of fires.

There is consistent evidence that workplace tobacco bans can decrease consumption during shifts (and thus exposure to ETS), but, as noted above, conflicting results concerning decreased smoking prevalence.[129] In the Cochrane review of this area, 5 out of 13 studies reported no change in prevalence, and four studies reported small decreases.

Although limited, these and other data provide motivation to continue exploring, expanding and evaluating tobacco bans and smoke-free environments. The recent Canadian *National Population Health Survey* report for 2002/03 confirmed the reduction in consumption expected with smoking bans in workplaces, and also noted that more smokers in smoke-free homes quit over the preceding 8 years compared to homes where other smokers lived (17% versus 12%).[130] Another optimistic result emerged from a US national survey, which estimated that requiring all workplaces in that country to be smoke-fee would reduce smoking prevalence by 10%.[131]

Smoke-free restaurant and bar laws have no negative impact on revenue or jobs.

One of the key issues in this area of tobacco control is the possible negative economic consequences associated with smoking bans, especially in the hospitality industry. Scollo and colleagues[132] reviewed 97 studies that made statements about the economic consequences associated with tobacco bans in restaurants and bars. They found that all studies concluding that there were negative economic consequences (N=35) were supported by the tobacco industry and had serious methodological flaws. None (N=21) of the better designed studies completed by independent researchers found a negative impact on revenue or jobs.

School-based Interventions

Despite the importance of reducing adolescent tobacco use, relatively little research has been conducted in the area of teen smoking cessation, including school-based programs.[133] In the late 1990s, Health Canada conducted a literature review which looked at 6 studies tracking self-initiated cessation; having fewer friends who smoked and being a lighter smoker were predictors of quitting success, whereas family

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[127] Eriksen MP, Gottlieb NH. A review of the health impact of smoking control at the workplace. *American Journal of Health Promotion* 1998; 13(2): 83-104.
[128] Price P. *Passive Smoking: Health Effects and Workplace Resolutions.* Canadian Centre for Occupational Health and Safety, 1989.
[129] Moher M, Hey K, Lancaster, T. Workplace interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[130] Report available at http://www.statcan.ca/english/research/82-618-MIE/82-618-MIE2004001.pdf (accessed December 2004).
[131] Farrelly MC, Evans WN, Sfekas AE. The impact of workplace smoking bans: results from a national survey *Tobacco Control* 1999; 8(3): 272-7.
[132] Scollo M, Lal A, Hyland A et al. Review of the quality of studies on the economic effects of smoke-free policies on the hospitality industry *Tobacco Control* 2003; 12: 13-20.
[133] O'Connell ML, Freeman M, Jennings G et al. Smoking cessation for high school students. Impact evaluation of a novel program *Behavior Modification* 2004; 28(1): 133-46.

influences played less of a role. Only 11 studies were identified which examined adolescent smoking-cessation programs, mainly involving 3 to 6 educational sessions in a high school setting; short-term cessation success was reported, but few data were available regarding long-term follow-up.[134]

Perhaps understandably, more effort has been put in to the prevention of smoking initiation among youth; however the persistence of a teen smoking cohort and ongoing incidence have combined to change the perspective of researchers and policy-makers. At about the same time the Canadian review was being completed, US authorities began to develop more programs to help youth stop smoking.[135]

By 1999, Sussman and colleagues found 17 studies focusing on youth smoking cessation, almost none of them RCTs. On average 21% of teen smokers quit, though this number dropped to 13% at 6 month follow-up, close to naturally occurring quit rates.[136] Two years later the same lead author identified 66 adolescent cessation studies, though this incorporated a wide variety of interventions, including those that normally would be included under policy approaches. Just over half of the studies were controlled; the average quit rate over 8 months was 12% (compared to 7% in control groups).[137]

Clinical Interventions and Management

The 2000 report *Treating Tobacco Use and Dependence*, a clinical practice guideline sponsored by the US Public Health Service (updating its 1996 guideline), identified the following *recommended* counselling modalities:[138] brief physician advice; various kinds of counselling; and arranging support care outside of the clinic per se. Each of these categories will be elaborated below.

Brief Advice and Counselling

Brief tobacco dependence treatment is now the recommended minimum strategy in approaching all cases of smoking in primary care. Such a brief intervention is sometimes referred to as physician advice; it can comprise as little as three minutes of contact. A 2004 Cochrane review of 34 trials[139] suggested that simple advice has a small positive effect on cessation rates. Compared to offering no advice, brief advice produced an absolute increase in cessation rates of 2.5%.

While brief advice is just marginally effective, there is evidence that more intensive advice or counselling is considerably more effective than minimal interventions. Intensified person-to-person contact (individual, group, or proactive telephone

[134] Report archived at http://www.hc-sc.gc.ca/hecs-sesc/tobacco/prog_arc/youth_smoking/index.html (accessed December 2004).
[135] Lamkin L, Davis B, Kamen A. Rationale for tobacco cessation interventions for youth *Preventive Medicine* 1998; 27: A3-8.
[136] Sussman S, Lichtman K, Ritt A, Pallonen UE. Effects of thirty-four adolescent tobacco use cessation and prevention trials on regular users of tobacco products *Substance Use & Misuse* 1999; 34(11): 1469-503.
[137] Unpublished results reported in *Monitor on Psychology* 2001; 32(5). Available at http://www.apa.org/monitor/jun01/cessation.html (accessed December 2004).
[138] U.S. Department of Health and Human Services. *Treating Tobacco Use and Dependence: Clinical Practice Guideline* June 2000.
[139] Silagy C, Stead LF. Physician advice for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

counselling) can include practical tools such as problem-solving, various supportive techniques, and follow-up after cessation (to prevent relapse). A Cochrane review of 15 trials (which specifically focused on cessation specialists rather than regular clinicians) found that counselling was 62% (odds ratio[140] of 1.62) more likely to achieve successful smoking cessation than minimal intervention.[141]

In the report *Treating Tobacco Use and Dependence* the authors summarized the results of 43 studies of various intensity levels of person-to-person contact. Their results suggest a clear relationship between increased intensity of cessation counselling and abstinence rates, as indicated on the following table.

Level of Contact	*Estimated Odds Ratio (95% C.I.)*[142]	*Estimated Abstinence Rate (95% C.I.)*
No Contact	1.0	10.9%
Minimal Counselling (<3 minutes)	1.3 (1.01, 1.60)	13.4% (10.9, 16.1)
Low Intensity Counselling (3-10 minutes)	1.6 (1.2, 2.0)	16.0% (12.8, 19.2)
Higher Intensity Counselling (>10 minutes)	2.3 (2.0, 2.7)	22.1% (19.4, 24.7)

This same report, based on a meta-analysis of 45 studies, also noted a strong relationship between the number of treatment sessions and abstinence rates, as indicated on the following table.

Number of Sessions	*Estimated Odds Ratio (95% C.I.)*	*Estimated Abstinence Rate (95% C.I.)*
0-1 Session	1.0	12.4%
2-3 Sessions	1.4 (1.1, 1.7)	16.3% (13.7, 19.0)
4-8 Sessions	1.9 (1.6, 2.2)	20.9% (18.1, 23.6)
>8 Sessions	2.3 (2.1, 3.0)	22.1% (21.0, 28.4)

Finally, counselling administered by both physician clinicians and non-physician clinicians (e.g. nurses, health educators, psychologists, etc.) effectively increases abstinence rates (based on a meta-analysis of 37 studies), as indicated on the following table.

[140] The odds ratio is used to compare the probability of a certain event occurring in two groups. An odds ratio greater than one implies that the event is more likely in that group.
[141] Lancaster T, Stead LF. Individual behavioural counselling for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[142] C.I. = Confidence Interval, the 95% confidence interval range given means that the 'true' number will fall within the given range 95 out of a 100 times. For there to be a true (statistically significant) difference between the control group and the test group, the 95% CI range for the test group should fall outside of 1.0.

Type of Clinician	Estimated Odds Ratio (95% C.I.)	Estimated Abstinence Rate (95% C.I.)
No Clinician	1.0	10.2%
Self-help	1.1 (0.9, 1.3)	10.9% (9.1, 12.7)
Non-physician Clinician	1.7 (1.3, 2.1)	15.8% (12.8, 18.8)
Physician Clinician	2.2 (1.5, 3.2)	19.9% (13.7, 26.2)

Group Therapy

Group therapy offers individual members the opportunity to learn skills and techniques to change behaviour and stop smoking, as well as to provide each other with psychosocial support. There are over 100 different group therapy programs described in the literature.[143] The groups can be led by professional facilitators, clinical psychologists, health educators, nurses or physicians. The rationale for including group therapy in the arsenal of cessation strategies is that it lies between intensive counselling and self-help approaches, and perhaps is less expensive than the former and more effective than the latter. A range of components are used in group therapy; there is evidence that aids for cognitive and behavioural skills and avoiding relapse are especially useful.

A 2004 Cochrane review of 52 randomized trials[144] offered these conclusions concerning group therapy:

- group programs doubled the cessation rate compared with self-help materials and no intervention
- there was limited evidence that adding group therapy to other interventions (e.g., physician advice, nicotine replacement therapy) increased their effectiveness
- there was no evidence that group therapy was more effective than a similar intensity of individual counselling.

Supportive Care

Suggesting and /or arranging support outside of treatment is commonly promoted as part of the treatment of smokers in primary care. The approaches include creating a smoke-free home, using help-lines and peer groups, partner enhancement, and assigning "buddies." The positive effect (based on survey evidence) of a smoke-free home on youth smoking initiation was highlighted earlier in the report. In the preceding section, the limited evidence for passive help-lines was noted.

A review of "buddy systems" suggested that they may provide some benefit in clinical settings; research methodology in many cases was poor.[145] There is a lack of evidence regarding the efficacy of using "buddies" in community programs.

[143] Hajek P. Current issues in behavioral and pharmacological approaches to smoking cessation *Addictive Behaviors* 1996; 21(6): 699-707.
[144] Stead LF, Lancaster T. Group behaviour therapy programmes for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.

There is more evidence for the role of enhancing partner support, the distinction being that partners are usually known more intimately by the smoker. In the relevant Cochrane review,[146] the RCTs which examined providing a parallel program to enhance the role of partners failed to detect an increase in cessation rates among the smokers being supported; this may be attributed to the fact that the actual level of partner support *did not increase in most cases*. Of the 40 studies considered for this Cochrane review, only 8 were accepted. One Alberta study that was not included did show improvements in cessation rates, but these effects only persisted in men at 1-year follow-up.[147] More study is needed of the effectiveness of using partners to improve cessation rates; the most promise has been shown with live-in, married or equivalent-to-married partners.[148]

A major health event provides a 'window of opportunity' for smoking cessation advice.

Health Events

One of the key issues associated with smoking cessation in individuals is the timing of the intervention. Former smokers frequently note that health concerns were a primary motivator in their cessation attempts. A systematic review of interventions for smoking cessation in hospitalized patients in 2001[149] concluded that "high intensity behavioural interventions that include at least 1 month follow up contact are effective in promoting smoking cessation in hospitalised patients". More recent studies[150,151,152] continue to support the notion that hospitalization offers a 'window of opportunity'. Other studies have found that smoking cessation advice provided in the context of cancer screening[153], to cancer survivors[154] or to individuals with impaired lung function[155] significantly increased quit rates, although these findings are at times ambiguous[156]. Given the evidence, McBride and Ostroff[157] call on health care providers to utilize this 'teachable moment' to promote smoking cessation.

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[145] May S, West R. Do social support interventions ("buddy systems") aid smoking cessation? A review. *Tobacco Control* 2000; 9(4): 415-22.
[146] Park E-W, Schultz JK, Tudiver F et al. Enhancing partner support to improve smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[147] Carlson LE, Goodey E, Bennett MH et al. The addition of social support to a community-based large-group behavioral smoking cessation intervention: improved cessation rates and gender differences *Addictive Behaviors* 2002; 27(4): 547-59.
[148] Park EW, Tudiver F, Schultz JK et al. Does enhancing partner support and interaction improve smoking cessation? A meta-analysis *Annals of Family Medicine* 2004; 2(2): 170-4.
[149] Munafo M, Rigotti N, Lancaster T et al. Interventions for smoking cessation in hospitalized patients: A systematic review. *Thorax* 2001; 56(8): 656-63.
[150] Quist-Paulsen P and F. Gallefoss. Randomised controlled trial of smoking cessation intervention after admission for coronary heart disease *British Medical Journal* 2003; 327(7426):1254-7.
[151] Froelicher E, Miller N, Christopherson D et al. High rates of sustained smoking cessation in women hospitalized with cardiovascular disease. *Circulation* 2004; 109: 587-93.
[152] Hilleman D, Mohiuddin S, Packard K. Comparison of conservative and aggressive smoking cessation treatment strategies following coronary artery bypass graft surgery *Chest* 2004; 125(2): 435-8.
[153] Cox L, Clark M, Jett J et al. Change in smoking status after spiral chest computed tomography scan screening *Cancer* 2003; 98(11): 2495-501.
[154] Emmons K, Butterfield R, Puleo E et al. Smoking among participants in the childhood cancer survivors cohort: the Partnership for Health Study *Journal of Clinical Oncology* 2003; 21(2): 189-96.
[155] Godtfredsen N, Prescott E, Osler M et al. Predictors of smoking reduction and cessation in a cohort of Danish moderate and heavy smokers *Preventative Medicine* 2001; 33(1): 46-52.
[156] Wiggers L, Smets E, de Haes J et al. Smoking cessation interventions in cardiovascular patients. *European Journal of Endovascular Surgery* 2003; 26(5): 467-75.
[157] McBride C, Ostroff J. Teachable moments for promoting smoking cessation: the context of cancer care and survivorship *Cancer Control* 2003; 10(4): 325-33.

Smoking and Post-Surgical Complications

Cigarette smoking has also been associated with an increased rate of post-surgical wound infections and pulmonary and cardiovascular complications. A Cochrane review by Moller et al. in 2001 found observational studies but no RCTs supporting this conclusion.[158] In 2002, Moller and co-authors[159] published the results of an RCT investigating the effect of pre-operative smoking cessation on the frequency of post-operative complications in patients undergoing hip and knee replacement surgery. Patients assigned to the experimental arm met weekly with a nurse who designed individualized smoking cessation programs, including the use of nicotine replacement therapy. In this group, a remarkable 36 of 52 patients were able to quit smoking and the remainder reduced their consumption by at least 50%. Only 4 of the control group patients stopped smoking. As a result, patients in the experimental group had a significantly reduced post-surgical complication rate (18% vs. 52%).

Some health care providers have questioned whether smokers should be given a lower priority on surgical waiting lists if they do not agree to 'fast' from smoking for at least six weeks prior to surgery.

Results similar to those by Moller et al. have more recently been observed by a Vancouver-based group of researchers.[160] This study noted, however, that while cessation rates were higher for the experimental group at 6 months, these differences no longer existed at 12 months post surgery.

Given the evidence, some health care providers have questioned whether smokers should be given a lower priority on surgical waiting lists if they do not agree to 'fast' from smoking for at least six weeks prior to surgery.[161,162]

Summary of Non-pharmacological Interventions

Assessing / comparing the evidence of effectiveness for one-to-one counselling, group therapy and self-help materials are complex tasks. An estimate might order the interventions as follows (in order of declining effectiveness), but the data for firm delineations in each case are not presently available:

- intense face-to-face counselling / group therapy
- brief physician advice
- proactive telephone support (i.e., planned follow-up)
- personalized self-help material
- reactive telephone support (helplines or quitlines)
- websites and other computer applications allowing some tailoring
- standardized self-help material.

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[158] Moller A, Villebro N, Pederson T. Interventions for preoperative smoking cessation *Cochrane Database for Systematic Reviews*, 2001.

[159] Moller A, Villebro N, Pedersen T et al. Effect of preoperative smoking intervention on postoperative complications: a randomised clinical trial *Lancet* 2002; 359(9301): 114-7.

[160] Ratner P, Johnson J, Richardson C. Efficacy of a smoking-cessation intervention for elective-surgical patients *Research in Nursing Health* 2004; 27(3): 148-61.

[161] Peters M, Morgam L, Gluch L. Smoking cessation and elective surgery: the cleanest cut *Medical Journal of Australia* 2004; 180: 317-8.

[162] Mackay B. Taking a stand in Timmens: quit smoking, or forgo surgery *Canadian Medical Association Journal* 2003; 168(12): 1582.

Although standardized self-help material sits low on the list, one motivation to still provide such aids is that most successful quitters achieve success on their own.[163] What this means is that, though more intensive clinical counselling interventions reportedly can produce higher quit rates *among the intervention sample*, such programs currently only reach 5% of the Canadian population.[164] Public health approaches, though less effective, can reach a much wider group. The natural conclusion which follows is that "methods to support otherwise unaided quit attempts therefore have the potential to help a far greater proportion of the smoking population."[165] As such, standardized self-help materials represent "an important bridge between the clinical and public health approaches to smoking cessation."[166]

Nicotine Replacement Therapy

Nicotine replacement therapy (NRT) works by exchanging the high concentrations of nicotine from cigarette smoking for lower doses delivered more slowly. The intervention helps reduce the cravings and withdrawal symptoms often associated with quitting. NRT also does not deliver the tar, chemicals and other harmful elements of tobacco smoke. Introduced in gum form in 1984, nicotine replacement therapy currently is the dominant strategy for individuals quitting smoking.[167] Other non-nicotine pharmaceuticals are also employed as aids to cessation (see below).

Nicotine replacement therapy increases the odds of quitting by approximately 1.5 to 2 times.

The major 2000 report *Treating Tobacco Use and Dependence* noted that several NRTs reliably increase long-term smoking abstinence rates. Each of the current delivery systems can be considered appropriate as a first-line treatment, including: [168]

- gum
- inhalers
- sprays
- transdermal patches

Whereas all of these approaches were recommended for standard clinical practice, independent consumer practice has been more controversial. Over-the-counter NRT is efficacious and produces modest quit rates similar to that seen in prescription practice,[169] though its usefulness *on its own* has been questioned in a recent widely-

[163] Fiore MC, Novotny TE, Pierce JP et al. Methods used to quit smoking in the United States. Do cessation programs help? *Journal of the American Medical Association* 1990; 263: 2760-5.
[164] Health Canada. Guide to tobacco use cessation programs in Canada. Available at http://www.hc-sc.gc.ca/hecs-sesc/tobacco/quitting/cessation/tobtop.html (accessed November 2004).
[165] Lancaster T, Stead LF. Self-help interventions for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[166] Curry SJ. Self-help interventions for smoking cessation *Journal of Consulting & Clinical Psychology* 1993; 61(5): 790-803.
[167] Hebert R. What's new in *Nicotine & Tobacco Research? Nicotine & Tobacco Research* 2000; 2: 313-5.
[168] Summarized in Quick Reference Guide for Clinicians. Available at http://www.surgeongeneral.gov/tobacco/tobaqrg.pdf (accessed October 2004).
[169] Hughes JR, Shiffman S, Callas P et al. A meta-analysis of the efficacy of over-the-counter nicotine replacement *Tobacco Control* 2003; 12: 21-7.

discussed article.[170] A substantial Cochrane review of over 100 studies (comparing NRT to placebo or non-NRT control) disagrees with the latter point, concluding:

> *All of the commercially available forms of NRT (gum, transdermal patch, nasal spray, inhaler and sublingual tablets/lozenges) are effective as part of a strategy to promote smoking cessation. They increase the odds of quitting approximately 1.5 to 2 fold regardless of setting. The effectiveness of NRT appears to be largely independent of the intensity of additional support provided to the smoker. Provision of more intense levels of support, although beneficial in facilitating the likelihood of quitting, is not essential to the success of NRT.* [171]

Other Pharmacological Therapies

Nicotine may have an antidepressant effect on some smokers, which may be one reason why they find it difficult to quit, and why using antidepressants such as bupropion and notriptyline can be effective. Using such drugs not only act as a substitute for the nicotine effect, but also as pre-emptive strike against the depression that can sometimes accompany smoking cessation.

The current practice guidelines in the US recommend the following approach to clinicians working with smokers:[172]

First-line treatments

- bupropion

Second-line treatments

- clonidine
- notriptyline

A Cochrane review[173] of antidepressants for smoking cessation looked at atypical antidepressants bupropion (20 trials) and notriptyline (5 trials). The conclusion was that both agents increased the odds of cessation. In one trial, bupropion plus a nicotine patch was more effective than either therapy singly, but the result was not replicated in a second study.

Various classic antidepressants (e.g. serotonin selective uptake inhibitors) did not show an effect on cessation rates, nor did anxiolytics (which are also meant to impact serotonin and other brain chemicals).[174]

Other drugs have been tested as aids to smoking cessation. Some have proven ineffective, including the nicotine antagonist lobeline.[175] This compares with the

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[170] Pierce JP, Gilpin EA. Impact of over-the-counter sales on effectiveness of pharmaceutical aids for smoking cessation *Journal of the American Medical Association* 2002; 288:1260-4.
[171] Silagy C, Lancaster T, Stead L et al. Nicotine replacement therapy for smoking cessation *Cochrane Database of Systematic Reviews*. 3, 2004.
[172] Summarized in Quick Reference Guide for Clinicians. Available at http://www.surgeongeneral.gov/tobacco/tobaqrg.pdf (accessed October 2004).
[173] Hughes JR, Stead LF, Lancaster T. Antidepressants for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[174] Hughes JR, Stead LF, Lancaster T. Anxiolytics for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2003.

modest benefits of nicotine antagonist mecamylamine, which is used in combination with NRT.[176] The rationale for the use of nicotine antagonists is that they block the rewarding effect of nicotine and thus may reduce the urge to smoke.

Opioid (narcotic) antagonists are also of interest as potential agents to attenuate the rewards of cigarette smoking. A limited investigation of the opioid naltrexone has not demonstrated a definite positive effect.[177]

A final drug, considered a second-treatment, is clonidine, which was originally used to lower blood pressure. Clonidine is an agent which affects the central nervous system and may reduce withdrawal symptoms. In a small number of trials, clonidine did prove effective in increasing smoking cessation, equating absolute increase in the likelihood of quitting of about 9%.[178]

Provider Reminder & Education

The assumption is well-established that physicians, and especially those operating in a primary care setting, are powerful allies in any comprehensive cessation strategy.[179] Over 70% of smokers visit their doctor at least once every year[180], however, "only half of current smokers report having ever been asked about their smoking status or advised to quit by their physician."[181]

It seems likely, then, that systems which prompted physicians to be more proactive with smokers would be useful, either passive reminders built in to patient charts, for example, or continuing education about the value of physician advice around cessation attempts. In fact, the TFCPS does strongly recommend (based on 31 studies) a multi-component program including both provider reminders and education.[182] Such an approach increases provider delivery of advice to quit as well as patient cessation rates.[183] This approach can be further enhanced with the inclusion of self-help cessation materials.

More weakly recommended were provider reminder systems used on their own. There was insufficient evidence of the effectiveness of basic advice to providers that

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[175] Stead LF, Hughes JR. Lobeline for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2003.

[176] Lancaster T, Stead LF. Mecamylamine (a nicotine antagonist) for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2003.

[177] David S, Lancaster T, Stead LF. Opioid antagonists for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2002.

[178] Gourlay SG, Stead LF, Benowitz NL. Clonidine for smoking cessation Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.

[179] Bridge J, Turpin B. *The Cost of Smoking in British Columbia and the Economics of Tobacco Control.* Health Canada, February 2004.

[180] Fiore MC, McCarthy DE, Jackson TC et al. Integrating smoking cessation treatment into primary care: an effectiveness study *Preventive Medicine* 2004; 38(4): 412-20.

[181] Source: http://www.hc-sc.gc.ca/hecs-sesc/tobacco/quitting/cessation/tobtop.html (accessed November 2004).

[182] An example of provider education is the US Public Health Service clinical guidelines described elsewhere in this section. Clinicians are instructed in patient assessment and how to handle those who are willing to quit, those who are unwilling and former smokers who need to be prevented from relapsing.

[183] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.

they "should counsel to quit," or of provider feedback concerning their delivery of cessation advice.

Regulatory and Economic Interventions

Increased Unit Price for Tobacco Products

It has been argued that because nicotine is addictive, the purchase of tobacco products is more "price inelastic" than other non-addictive products i.e. consumers are resistant to stopping their purchase even if the price increases. Despite this argument, Townsend and colleagues[184] calculated that for every 10% increase in cigarette price there would be a 5-6% decline in consumption in Britain; the decline would result from a combination of absolute quitting and reduced amounts of smoking per continuing smoker. The estimates for other high-income jurisdictions have been similar, though the World Bank pegged the expected decline in demand at a more conservative 4%.[185] Nonetheless, given that a tax increase incurs minimal administrative costs, and usually offers a net increase of revenue to governments even with reduced sales, the "cost-effectiveness of tax increases compares favourably with many health interventions."[186] The TFCPS evaluation is consistent with this position; it draws on 17 studies to conclude that raising the unit price of tobacco products through taxation is a strongly recommended intervention.

Raising the unit price of tobacco products through taxation is a strongly recommended intervention.

Reimbursement and Incentives

The TFCPS review[187] found that reducing patient out-of-pocket costs for smoking cessation products was recommended by the evidence, though only weakly. Aspects of a healthcare systems approach noted in another major report, *Treating Tobacco Use and Dependence*[188] (US Public Health Service), include consistent and comprehensive documentation of tobacco users and any clinical intervention, and ensuring that insurance plans cover counselling (as well as pharmacological treatments) and that clinicians are reimbursed for counselling time. No specific evidence was provided concerning systematic documentation (which occupies a very brief section of the report), whereas the financial recommendations had moderate-to-weak support in the literature. In a report from 2000, the US Surgeon General[189] agreed with the basic tenor of the recommendations, concluding (based on two

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[184] Townsend J, Roderick P, Cooper J. Cigarette smoking by socio-economic group, sex and age: effects of price, income and health publicity. *British Medical Journal* 1994; 309: 923-927.

[185] The World Bank *Curbing the Epidemic: Governments and the Economics of Tobacco Control* Washington: The World Bank; 1999.

[186] Ranson MK, Jha P, Chaloupka FJ et al. Global and regional estimates of the effectiveness and cost-effectiveness of price increases and other tobacco control policies *Nicotine & Tobacco Research* 2002; 4(3): 311-9.

[187] Hopkins DP, Briss PA, Ricard CJ et al. Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke *American Journal of Preventive Medicine* 2001; 20(2S): 16-66.

[188] Summarized in Quick Reference Guide for Clinicians. Available at http://www.surgeongeneral.gov/tobacco/tobaqrg.pdf (accessed October 2004).

[189] US Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health, 2000.

citations) that reimbursement policies, financial incentives and institutional support are all critical for effective clinical interventions in tobacco addiction.

Comprehensive Strategies

The Cochrane review noted earlier under Community Programs actually included results for what were properly comprehensive strategies. The intervention was defined in general as a coordinated, multidimensional program involving different segments of the community in a defined geopolitical area (e.g., municipality, region, province). [190] The weak results noted for those programs were confirmed in the US Surgeon General review of 2000. Several famous community trials of comprehensive strategies were conducted in the US in the early 1980s, following and concurrent with projects in other jurisdictions. The summary of the Surgeon General concerning these various trials remarked on "the lack of a consistently positive effect" and the fact that the impact on smoking prevalence was "modest."[191] The two most rigorous trials showed limited evidence that prevalence was affected. The COMMIT study in the US showed no difference between intervention and control communities, whereas the Australian CART study offered some success for quit rates in men.[192,193]

The Surgeon General's assessment of more recent state-wide comprehensive strategies is more positive. Quoting from major reviews of the state campaigns, the conclusion is that smoking prevalence rates have declined, certainly among adults and perhaps among youth, as a result of sustained counter-advertising and other social marketing interventions.[194]

Social Denormalization

The potential usefulness of mass media advocacy or counter-advertising in influencing public attitudes towards tobacco was noted earlier. Sometimes the focus is on the dangers of smoking and the health and economic benefits of quitting. In many jurisdictions there has also been a goal to permanently change the public perception towards the legitimacy of tobacco industry practices. The latter approach, known as

> *"In spite of thousands of scientific studies indicting the habit, tobacco remains one of our most powerful, least-regulated industries*."
> Kluger R. *Ashes to Ashes: America's Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris,* 1997

[190] Secker-Walker RH, Gnich W, Platt S et al. Community interventions for reducing smoking among adults Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.
[191] US Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health, 2000.
[192] The COMMIT Research Group. Community intervention trial for smoking cessation (COMMIT): II Changes in adult cigarette smoking prevalence *American Journal of Public Health* 1995; 85: 193-200.
[193] Hancock L, Sanson-Fisher R, Perkins J et al. The effect of a community action program on adult quit smoking rates in rural Australian towns: The CART Project *Preventive Medicine* 2001; 32: 118-127.
[194] US Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health, 2000.

denormalization[195] (which includes counteracting the tobacco industry's message that smoking is normal and desirable), has been successfully pursued in Canada, Australia, the UK, and several US states. The continued application of such an approach is part of the National Strategy for Tobacco Control in Canada. In that framework, meant to inform provincial plans, denormalization is defined as:

> *activities undertaken specifically to reposition tobacco products and the tobacco industry consistent with the addictive and hazardous nature of tobacco products, the health, social and economic burden resulting from the use of tobacco, and practices undertaken by the industry to promote its products and create social goodwill towards the industry.*[196]

The full realization of results from new social norms surrounding tobacco and tobacco manufacturers remain to be experienced and explored.

[195] Schar EH, Gutierrez KK. Smoking cessation media campaigns from around the world: recommendations from lessons learned. Copenhagen: World Health Organization, 2001.
[196] Available at http://www.hc-sc.gc.ca/hecs-sesc/tobacco/policy/new_directions/executive_summary.html (accessed December 2004).

Interventions to Reduce ETS Exposure in Children and in Public Places

This subsection will focus on the new and important field of children's exposure to ETS. Due to the well-documented risks of environmental tobacco smoke (ETS),[197,198] reducing exposure to ETS in public places and family settings is a widespread public health goal. Many players are involved with the effort to reduce such exposure, including researchers, clinicians, midwives, community and hospital nurses, health departments and tobacco control agencies and organizations.

Children are particularly vulnerable to second hand smoke.

Children are thought to be particularly vulnerable and have received special attention with regard to ETS. Parental smoking, for instance, is a common but preventable source of childhood morbidity and mortality.[199,200] A 1998 study revealed that almost half of Canadian children are exposed to ETS in the home.[201] Of particular concern in some jurisdictions is the uneven distribution of ETS exposure, being higher in children of low-income, less-educated parents.[202]

As with other arenas of tobacco control, ETS exposure in childhood can be reduced through community programs, individual interventions and wider policy shifts. There are complexities involved with measuring trial outcomes. The choice of methods are: self-reported rates of smoking around children (which can be unreliable), reading smoke or chemical levels in the environment (e.g., a room which the child frequents), or detecting biochemical by-products of ETS (e.g., urinary cotinine) in the body. The latter method is subject to less reporting bias, but the validity of the particular chemical chosen and the accuracy of testing remain as ongoing areas of research.[203,204,205]

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[197] Hackshaw AK, Law MR, Wald NJ. The accumulated evidence on lung cancer and environmental tobacco smoke *British Medical Journal* 1997; 315: 980-8.

[198] He J, Vupputuri S, Allen K et al. Passive smoking and the risk of coronary heart disease. A meta-analysis of epidemiologic studies *New England Journal of Medicine* 1999; 340: 920-6.

[199] Roseby R, Waters E, Polnay A et al. Family and carer smoking control programmes for reducing children's exposure to environmental tobacco smoke Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*, 2004.

[200] World Health Organization. *International Consultation on Environmental Tobacco Smoke (ETS) and Child Health*. 1999.

[201] Ashley MJ, Ferrence R. Reducing children's exposure to environmental tobacco smoke in homes: issues and strategies *Tobacco Control* 1998; 7: 61-5.

[202] Emmons KM, Wong M, Hammond K et al. Intervention and policy issues related to children's exposure to environmental tobacco smoke *Preventive Medicine* 2001; 32: 321-31.

[203] Hovell MF, Zakarian JM, Wahlgren DR et al. Reported measures of environmental tobacco smoke exposure: trials and tribulations *Tobacco Control* 2000; 9(Suppl 3): 22-8.

[204] Bono R, Vincenti M, Schiliro T et al. Cotinine and N-(2-hydroxyethyl)valine as markers of passive exposure to tobacco smoke in children *Journal of Exposure Analysis & Environmental Epidemiology* 2004 [E-published ahead of print].

[205] Sexton K, Adgate JL, Church TR et al. Children's exposure to environmental tobacco smoke: using diverse exposure metrics to document ethnic/racial differences *Environmental Health Perspectives* 2004; 112(3): 392-7.

Community-based Interventions

Obviously, children of all ages can benefit to some extent from tobacco bans in workplaces (see above) and, more significantly, from similar programs in public places which they might frequent (see below). Research on other community interventions has been extremely limited; after eliminating two heterogeneous projects based in elementary schools, there was only one study in the entire Cochrane review in this area.[206]

School-based Interventions

School smoking bans were covered earlier, in the section on reducing smoking initiation. As was noted there, enforcement, or at least the perception of enforcement, seems to be the key to compliance.

Theoretically, it is possible that children can take responsibility to either influence their parent's smoking or to move themselves to a smoke-free environment. Only one study from 1993 in China has focused on motivating children in a school setting to create change at home (with some success observed.).[207]

Home-based Interventions

The majority of the programs have been aimed at influencing the behaviour of parents directly, with those and other carers recruited mostly through contact with the healthcare system. (Note: the topic of smoking cessation among pregnant women will be covered in a separate subsection.) Smokers have three options to reduce ETS for their children: quit smoking, reduce smoking or change smoking location (sometimes called avoidance); a combination of the approaches also can be used.

Parents have three options:
- quit smoking
- reduce smoking
- change smoking location

There is limited literature on adult-focused programs. A 2001 review by Emmons et al. rated a mere 5 studies as meeting its stringent requirements, with only one of those recording positive results (as self-reported by carers).[208] The relevant Cochrane review (2004) accessed three times the number of studies, but recorded a similar low rate of success in reducing children's ETS exposure (see details on a key project below).[209] The successful programs involved intensive counselling. Brief interventions were less effective than in projects which focused on adult smoking cessation. There is greater support for concentrating on changes in participants' attitude and behaviours rather than merely transferring knowledge.

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[206] Roseby R, Waters E, Polnay A et al. Family and carer smoking control programmes for reducing children's exposure to environmental tobacco smoke Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*. 3, 2004.

[207] Zhang D, Qiu X. School-based tobacco-use prevention--People's Republic of China, May 1989-January 1990 *Morbidity and Mortality Weekly Report* 1993; 42(19): 370-1, 377.

[208] Emmons KM, Wong M, Hammond K et al. Intervention and policy issues related to children's exposure to environmental tobacco smoke *Preventive Medicine* 2001; 32: 321-31.

[209] Roseby R, Waters E, Polnay A et al. Family and carer smoking control programmes for reducing children's exposure to environmental tobacco smoke Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews*. 3, 2004.

Interventions in the Well Child Healthcare Setting

Opportunistic interventions can be targeted at parents or other carers in the "well child healthcare setting," e.g., maternity hospitals, immunization clinics and routine health checks. Only one positive study fit this category according to Cochrane, namely Project KISS (Keeping Infants Safe From Smoke). In the paper, Emmons and colleagues (2001) report a significant decline in nicotine levels in the home of the intervention group at 3 and 6 month follow-up, though there was no effect on parental smoking rates. *This apparently was the first study that had been effective in reducing objective measures of ETS exposure in households with healthy children.*[210] The intervention consisted of a 30- to 45-minute motivational interviewing session at the participant's home with a trained health educator and 4 telephone follow-ups.

Interventions in the Ill Child Healthcare Setting

Sometimes opportunistic interventions can be targeted at parents of children with health problems such as respiratory illness. Two projects demonstrated modest improvements in ETS exposure, one with asthmatic children and one with a sample drawn from a supplemental nutrition program.[211,212] Again, intensive counselling was the focus of the intervention, and the outcome measure was reduced smoking in the presence of children (self-reported).

Regulatory and Economic Interventions

Smoking bans in public places has been an issue in B.C. since 1992 when the Capital Region banned smoking in all workplaces except restaurants and long-term care facilities. Since then the policy has expanded to other municipalities and begun to cover the excluded locations. While the main purpose of smoking bans is the protection of non-smokers from ETS, a side effect, as noted earlier, is the potential to reduce consumption in smokers and possibly increase cessation rates.[213]

Several studies have shown that assertive requests to refrain from smoking directed at individual smokers (in, for example, offices and businesses) can be a very effective addition to the presence of no-smoking signs.[214] Such a strategy is unlikely to be acceptable as a formal public health intervention,[215] though it may continue to grow as an informal social control mechanism (i.e., passers-by taking matters into their own hands) as health concerns and non-smokers' rights continue to be promoted.

The most significant interventions are likely still to come in the area of ETS (it is notable that apparently the most recent successful clinical project is 5 years old). Apart from more research in order to identify effective interventions, fuller progress on ETS exposure in children may finally require the kind of diffuse "social norm"

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[210] Emmons KM, Hammond SK, Fava JL et al. A randomized trial to reduce passive smoke exposure in low-income households with young children *Pediatrics* 2001; 108(1): 18-24.
[211] Hovell MF, Zakarian JM, Matt GE et al. Decreasing environmental tobacco smoke exposure among low income children: preliminary findings *Tobacco Control* 2000; 9(Suppl 3): 70-71.
[212] Wahlgren DR, Hovell MF, Meltzer SB et al. Reduction of environmental tobacco smoke exposure in asthmatic children. A 2-year follow-up *Chest* 1997; 111(1): 81-8.
[213] Stephens T, Pederson LL, Koval JJ et al. The relationship of cigarette prices and no-smoking bylaws to the prevalence of smoking in Canada *American Journal of Public Health* 1997; 87(9):1519-21.
[214] Leedom C, Persuad D, Shovein J. The effect on smoking behaviour of an assertive request to refrain from smoking *International Journal of Addictions* 1986; 21: 1113-7.
[215] Serra C, Cabezas C, Bonfill X et al. Interventions for preventing tobacco smoking in public places Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

shifts that now exist in other spheres, e.g., the growing stigma surrounding any pregnant mother who smokes. This does not mean that proactive regulation will not play a role. A possibility which remains to be tested is targeted legislation, such as the proposal by the Ontario Medical Association to ban smoking in cars where children are passengers.[216]

A possibility which remains to be tested is targeted legislation, such as a ban on smoking in cars where children are passengers.

Comprehensive Strategies

All the results included in the relevant Cochrane review were from uncontrolled before and after studies.[217] The conclusion from the 11 included studies is that, when carefully planned and resourced, multi-component strategies can reduce smoking within public places. Most of the studies dated from the 1980s or earlier. This seems to be an area of little current research interest, perhaps because ban policies (including legislation) have been largely successful, at least in offices and institutions. It has reached the point where, even in the absence of rigorous testing of effectiveness (e.g., evaluating compliance rates), bans in many public places in developed countries are considered a social norm, where there is even informal "policing" by people being affected by an adjacent smoker.

[216] Source: http://www.no-smoking.org/oct04/10-14-04-5.html (accessed October 2004).
[217] Serra C, Cabezas C, Bonfill X et al. Interventions for preventing tobacco smoking in public places Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.

Special Populations

Most cessation interventions tend to use generic approaches, though the population of tobacco users is quite heterogenous. The theory behind considering the specific treatment needs of special populations is that treatment success may be increased.[218] Smokers may be stratified in many ways (e.g., heavy vs. light, stages-of-change, patient vs. non-patient, age, socioeconomic status, geographic location).[219] The categories below deal with certain populations where there are unusual prevalence rates and / or unusual health risks. Recognizing that teen smoking has already been covered above, the three other populations that stand out are pregnant women, First Nations peoples and the mentally ill. The fine-tuning of such categories in some sense has no end-point; for example, the subset of the mentally ill who abuse alcohol or other substances, as well as tobacco, represent special challenges and opportunities.[220] Note that some aspects of intervening with smokers of low socioeconomic status will be handled below in the section on lessons learned from tobacco control.

Pregnant Women

The negative foetal health impacts of smoking and ETS exposure during pregnancy are well-attested, especially low birthweight. Cigarette smoking may account for up to 14% of preterm deliveries,[221] as well as a proportion of miscarriages, stillbirths, placental problems and other pregnancy complications.[222] Smoking during the prenatal period is the most important modifiable risk factor for poor pregnancy outcomes in developed countries.[223]

The percentage of women who quit smoking during pregnancy has increased steadily over the last decade.

Three significant facts are known about smoking rates among pregnant women in countries such as Canada and the US:

- The percentage of women who quit smoking during pregnancy has increased steadily over the last decade. A sampling of cessation rates among pregnant women tells the story—1986 (US) 39%, 1993-1999 (US) 43%, 2001 (Ontario) 51%.[224,225,226]

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[218] Hatsukami DK. Targeting treatments to special populations *Nicotine & Tobacco Research* 1999; 1(Suppl 2): S195-200, 207-10.

[219] For instance, one study identified these specific traits in youth susceptible to smoking: lower economic status, living in a single-parent home, lack of parental support, lower self-image, low levels of academic achievement and lack of skills to resist influences to use tobacco. US Centers for Disease Control and Prevention. *Preventing Tobacco Use Among Young People: A Report of the Surgeon-General*, 1994. Also, the recently-published B.C. tobacco control policy has chosen to focus on (in addition to aboriginals): young adults (20-24 years) who have the highest smoking rate, and middle-aged adults (25-44 years) who are beginning to manifest smoking-related chronic diseases.

[220] Unrod M, Cook T, Myers MG et al. Smoking cessation efforts among substance abusers with and without psychiatric comorbidity *Addictive Behavior* 2004; 29(5): 1009-13.

[221] Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis *Bulletin of the World Health Organization* 1987; 65: 663-737.

[222] British Medical Association. *Smoking and Reproductive Life*. February 2004.

[223] Colman G, Grossman M, Joyce T. The effect of cigarette excise taxes on smoking before, during and after pregnancy *Journal of Health Economics* 2003; 22: 1053-72.

[224] Fingerhut LA, Kleinman JC, Kendrick JS. Smoking before, during, and after pregnancy *American Journal of Public Health* 1990; 80(5): 541-4.

- As is clear from the above figures, despite considerable public focus and prevention efforts, half or more of pregnant women who are smokers continue to smoke throughout their pregnancy; this represents 19 to 22% of all pregnancies in Canada.[227] An estimated 4,600 babies may have been born to smoking mothers in 1999 in B.C.[228]

- Postpartum relapse rates are very high. Although the "relapse curve" is not as steep as that for non-pregnant smokers in the first weeks after cessation, about 60% of women who quit during pregnancy will return to smoking within 6 months of giving birth, and 80 to 90% by 12 months.[229,230]

Several studies have demonstrated that stopping smoking during pregnancy has health benefits for mother and child.[231] Pregnancy represents a period of high motivation among women to quit smoking (for the sake of their baby's health) and usually have relatively intensive contact with healthcare providers. Thus it represent a "special window of opportunity" to encourage smoking cessation.[232]

Intervention Research

It is vital to pursue further research around effective interventions for cessation in pregnant smokers and, of equal significance, prevention of postpartum relapse.[233] One implication of the latter initiative is the growing evidence of harmful impacts on newborns and infants created by smoking mothers (e.g., increased rates of asthma, lower respiratory disease, and SIDS).[234] Working towards a reduction of neonatal health effects becomes a component of general ETS exposure campaigns, especially those targeted towards exposure in childhood (see the related subsection above).

Three factors are especially associated with ongoing smoking during pregnancy:
- having other smokers in the household
- having other children in the household
- not having post-secondary education.

Continuing analysis is needed of the socioeconomic factors and health correlates related to smoking initiation among women of child-bearing age,[235] cessation resistance among pregnant women, and the disappointing relapse rates. For

[225] Colman GJ, Joyce T. Trends in smoking before, during, and after pregnancy in ten states *American Journal of Preventive Medicine* 2003; 24(1): 29-35.
[226] Johnson IL, Ashley MJ, Reynolds D et al. Prevalence of smoking associated with pregnancy in three Southern Ontario Health Units *Canadian Journal of Public Health* 2004; 95(3): 209-13.
[227] Albrecht SA, Maloni JA, Thomas KT et al. Smoking cessation counselling for pregnant women who smoke: scientific basis for practice for AWHONN's SUCCESS Project *Journal of Obstetric, Gynecolgic, and Neonatal Nursing* 2004; 33(3): 298-305.
[228] Bridge J, Turpin B. *The Cost of Smoking in British Columbia and the Economics of Tobacco Control.* Health Canada, February 2004.
[229] McBride CM, Curry SJ, Lando HA et al. Prevention of relapse in women who quit smoking during pregnancy *American Journal of Public Health* 1999; 89(5): 706-11.
[230] Dolen-Mullen P, Richardson MA, Quin VP et al. Postpartum return to smoking: who is at risk and when *American Journal of Health Promotion* 1997; 11(5): 323-30.
[231] British Medical Association. *Smoking and Reproductive Life.* February 2004.
[232] Orleans CT, Barker DC, Kaufman NJ et al. Helping pregnant smokers quit: meeting the challenge in the next decade *Tobacco Control* 9 (Suppl III): 6-11.
[233] Fang WL, Goldstein AO, Butzen AY et al. Smoking cessation in pregnancy: a review of postpartum relapse prevention strategies.
[234] British Medical Association. *Smoking and Reproductive Life.* February 2004.
[235] The rate of smoking among women peaks between age 25 and 44, which overlaps with the childbearing years.

example, a recent Canadian study showed that 3 factors were especially associated with ongoing smoking during pregnancy—having other smokers in the household, having other children in the household, and not having post-secondary education.[236] Studies from New Zealand, Britain and other jurisdictions agree that "socioeconomically deprived women were more likely to continue to smoke beyond the first trimester of pregnancy and that this needs to be taken into account in the provision of smoking cessation support."[237]

Intervention Categories

Several reviews have been completed of interventions targeting pregnant smokers, though it is perhaps significant that they did not uncover much active research since the 1990s. Most of the investigation has focused on behavioural interventions, which fall roughly into three categories: high intensity, low intensity and minimal.[238] A brief description of each category is given below, followed by fuller treatments of the intervention results. Other types of interventions will be noted at the end.

- High-intensity: usually involves several lengthy face-to-face contacts and multiple strategies with smoking mothers.

- Low-intensity: involves a similar initial contact as in minimal interventions (see below), but with continued brief reinforcement contacts.

- Minimal: delivers a single, brief cessation message to mothers in person or by mail, usually using self-help manuals, messages from healthcare providers, pamphlets or videotapes.

High-intensity Interventions

The 2003 Cochrane review included 34 studies on smoking cessation in pregnant women.[239] The interventions in the trials with positive results were described as intensive, often with a goal of tailoring the details of the plan to each individual smoker.[240] For example, one 1997 Australian study with good results included the following intervention components: brief physician advice, educational video, midwife counselling, self-help manual, possibility of a prize upon success, follow-up counselling, involvement of an adult partner where possible, and (for those resistant to cessation) encouragement to attend an external anti-smoking course.[241]

Many of the reviewed cessation projects demonstrated positive results. The 8 highest quality trials showed an average reduction of 8% in continued smoking rates in late

[236] Paterson JM, Neimanis IM, Bain E. Stopping smoking during pregnancy: are we on the right track? *Canadian Journal of Public Health* 2003; 94(4): 297-9.
[237] McLeod D, Pullon S, Cookson T. Factors that influence changes in smoking behaviour during pregnancy *New Zealand Medical Journal* 2003; 116(1173): U418.
[238] Valanis B, Lichtenstein E, Mullooly JP et al. Maternal smoking cessation and relapse prevention during health care visits *American Journal of Preventive Medicine* 2001; 20(1): 1-8.
[239] Lumley J, Oliver S, Waters E. Interventions for promoting smoking cessation during pregnancy Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[240] Windsor RA, Boyd NR, Orleans CT. A meta-evaluation of smoking cessation intervention research among pregnant women: improving the science and art *Health Education Research* 1998; 13(3): 419-38.
[241] Walsh RA, Redman S, Brinsmead MW et al. A smoking cessation program at a public antenatal clinic *American Journal of Public Health* 1997; 87(7): 1201-4.

pregnancy; for example, in the 1997 study described above, the rate of smoking in the third trimester dropped from 95% to 87% with treatment.[242]

Low-intensity & Minimal Interventions

A 1999 meta-analysis of 16 RCTs[243] suggested that low-intensity approaches also can work, often matching the results of high-intensity approaches.[244] Even a single, 5 to 15 minute counselling session with appropriate self-help materials (and possibly brief follow-up) could more than double the cessation rate in pregnant women compared with the rate of "spontaneous" cessation.[245] One 1996 study, using such methods, increased the cessation rate from 10 to 20%.[246]

Even a single, 5 to 15 minute counselling session with appropriate self-help materials more than doubles the cessation rate in pregnant women compared with the rate of "spontaneous" cessation.

The brief interview format of choice today follows the "5 A's"—ask, advise, assess, assist and arrange. The format was introduced by the US Public Health Service as a *general* guideline to clinicians concerning smoking cessation,[247] so it does not represent a unique protocol for pregnant smokers. The adaptation of the 5 A's to the context of pregnant smokers is currently being evaluated in a total of 13 sites in Canada and the US.[248]

Ineffective "Counselling" Interventions

It is important to note that the positive result for brief counselling does not mean that anything will work. A review of the *very minimal* intervention which is current policy in the UK (written information distributed at the first prenatal visit) concluded that it was not effective.[249]

Peer counselling and partner support approaches have likewise offered mixed results. These forms of intervention depend on positive, motivated involvement either from a non-professional usually not known by the patient (i.e., a peer) or from an intimate partner or sometimes a friend or colleague (i.e., a partner). A study of peer counselling, which involved a cessation program for prenatal smokers led by women from the community, showed reduced consumption but no improvement in cessation rates.[250] In the partner support trial, the partners of smoking pregnant women

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[242] Walsh RA, Redman S, Brinsmead MW et al. A smoking cessation program at a public antenatal clinic *American Journal of Public Health* 1997; 87(7): 1201-4.

[243] Dolen-Mullen P. Maternal smoking during pregnancy and evidence-based intervention to promote cessation. In: Spangler JG, ed. *Primary care: clinics in office practice.* Philadelphia: WB Saunders, 1999; 26: 577-89.

[244] Valanis B, Lichtenstein E, Mullooly JP et al. Maternal smoking cessation and relapse prevention during health care visits *American Journal of Preventive Medicine* 2001; 20(1): 1-8.

[245] Melvin CL, Dolen-Mullen P, Windsor RA et al. Recommended cessation counselling for pregnant women who smoke: a review of the evidence *Tobacco Control* 2000; 9(Suppl 3): 80-4.

[246] Hartmann KE, Thorp JM, Pahel-Short L et al. A randomized controlled trial of smoking cessation intervention in pregnancy in an academic clinic *Obstetrics & Gynecology* 1996; 87(4): 621-6.

[247] A helpful summary of this quideline is available at http://www.smokefreefamilies.uab.edu/smokces.doc (accessed October 2004).

[248] Albrecht SA, Maloni JA, Thomas KT et al. Smoking cessation counselling for pregnant women who smoke: scientific basis for practice for AWHONN's SUCCESS Project *Journal of Obstetric, Gynecolgic, and Neonatal Nursing* 2004; 33(3): 298-305.

[249] Acharya G, Jauniaux E, Sathia L et al. Evaluation of the impact of current antismoking advice in the UK on women with planned pregnancies *Journal of Obstetrics and Gynaecology* 2002; 22(5): 498-500.

[250] Malchodi CS, Oncken C, Dornelas EA et al. The effects of peer counselling on smoking and reduction *Obstetrics & Gynecology* 2003; 101(3): 504-10.

received counselling and materials to increase their ability to be an encourager; partners who smoked also received cessation aids and related counselling. The pregnant women showed no improvement in smoking cessation, even though the partner quit rates were 3 times higher with the intervention. [251]

Pharmacological Interventions

In spite of some foetal risks associated with nicotine replacement therapy (NRT), the benefits of this intervention are being increasingly considered with reference to pregnant smokers.[252] Further clinical studies of efficacy and safety are needed, especially given the over-the-counter availability of NRT agents.[253] In a related area, an advisory was issued by Health Canada in August, 2004, about the potential adverse events in newborns with pregnant women using products such as bupropion. As noted earlier, bupropion is effective in aiding cessation attempts, possibly because it counteracts withdrawal symptoms such as depression.

Policy Interventions

A US study suggested that "the decline in smoking over time among pregnant women was primarily due to the overall decline in smoking initiation rates among women of childbearing age, not to an increased rate of smoking cessation related to pregnancy."[254] Another significant fact is that the largest group of women who stop smoking in pregnancy is those who have already stopped smoking on their own before the first prenatal visit.[255] This suggests that population-level approaches to cessation may be as warranted as clinical interventions. For example, a somewhat surprising result in the arena of regulation / taxation is that higher taxes on cigarettes provided a direct disincentive to continuing smoking during pregnancy and to postpartum relapse; a 10% increase in taxes was estimated to increase the probability of a pregnant woman quitting by 10%, with a similar positive impact on relapse rates.[256]

[251] McBride CM, Baucom DH, Peterson BL et al. Prenatal and postpartum smoking abstinence: a partner-assisted approach *American Journal of Preventive Medicine* 2004; 27(3): 232-8.
[252] Benowitz NL, Dempsey DA, Goldenberg RL et al. The use of pharmacotherapies for smoking cessation during pregnancy *Tobacco Control* 2000; 9(Suppl III): 91-4.
[253] Ebrahim SH, Merritt RK, Floyd RL. Smoking and women's health: opportunities to reduce the burden of smoking during pregnancy *Canadian Medical Association Journal* 2000; 163(3):288-9.
[254] Ebrahim SH, Floyd RL, Merritt RK et al. Trends in pregnancy-related smoking rates in the United States, 1987-1996 *Journal of the American Medical Association* 2000; 283(3): 361-6.
[255] Lumley J, Oliver S, Waters E. Interventions for promoting smoking cessation during pregnancy Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004.
[256] Colman G, Grossman M, Joyce T. The effect of cigarette excise taxes on smoking before, during and after pregnancy *Journal of Health Economics* 2003; 22: 1053-72.

First Nations

The rate of tobacco use among British Columbian First Nation peoples is close to double that of other British Columbians.[257,258] In B.C., 54% of Aboriginal teenagers and 65% of those aged 20-24 misuse tobacco.[259,260] It has also been shown that the proportion of non-smoking Aboriginals exposed to ETS daily is twice that observed for other non-smoking residents in the province.[261,262] On a positive note, compared to other Canadian Aboriginals, British Columbian First Nations have the lowest smoking rates. Aboriginal smoking rates are highest in the Northwest Territories (71% of NWT Aboriginals smoke).[263] For a variety of reasons, including traditional use of tobacco, easy access and low cost of tobacco on reserves, and a general acceptance of tobacco use among aboriginal communities,[264,265] existing tobacco cessation programs have not been as successful with First Nation peoples compared with other populations in Canada.[266] Therefore, intervention programs developed specifically for First Nations are of particular interest.

The rate of tobacco use among British Columbian First Nation peoples is close to double that of other British Columbians.

Most B.C. programs designed to prevent initiation and encourage cessation among Aboriginal peoples are generally community-based and include education, participation of elders and other leaders in program development, and supportive involvement of peers and family.[267] Emphasis is put on distinguishing non-traditional use of commercial tobacco from culturally appropriate use.[268] Evaluations of the majority of BC programs are scarce.

The *Honour Your Health Challenge*, a component of B.C.'s Aboriginal Strategy, involved training aboriginal people to provide support in culturally-appropriate activities related to reducing tobacco misuse. Results from a survey representing 74% of the program participants were positive; the participants demonstrated an

[257] Wardman AE, Khan N. Tobacco cessation pharmacotherapy use among First Nations persons residing within British Columbia *Nicotine Tobacco Research* 2004; 6(4):689-92.
[258] Angus Reid Group. Tobacco use in British Columbia, 1997. Available at http://healthplanning.gov.bc.ca/tobacrs/index.html (accessed October 2004).
[259] Tobacco Control – Tobacco Facts. Available at http://www.tobaccofacts.org/tob_control/strategy.html (accessed October 2004).
[260] Angus Reid Group. Tobacco use in British Columbia, 1997. Available at http://healthplanning.gov.bc.ca/tobacrs/index.html (accessed October 2004).
[261] Angus Reid Group. Tobacco use in British Columbia, 1997. Available at http://healthplanning.gov.bc.ca/tobacrs/index.html (accessed October 2004).
[262] Ministry of Health. Targeting our efforts: BC's tobacco control strategy, 2004.
[263] Health Canada. Guide to tobacco use cessation programs in Canada: priority populations, no date. Available at www.hc-sc.gc.ca/hecs-sesc/tobacco/quitting/cessation/tobrpt2.html (accessed October 2004).
[264] Alberta Alcohol and Drug Abuse Commission. Framework for developing tobacco reduction strategies for young adults *R.A. Malatest & Associates*, 2003.
[265] Ministry of Health. Honouring our Health: An aboriginal tobacco strategy for British Columbia, 2001.
[266] Health Canada. Guide to tobacco use cessation programs in Canada, no date. Available at www.hc-sc.gc.ca/hecs-sesc/tobacco/quitting/cessation/tobrpt2.html (accessed October 2004).
[267] Ministry of Health. Honouring our Health: An aboriginal tobacco strategy for British Columbia, 2001.
[268] Ministry of Health. Honouring our Health: An aboriginal tobacco strategy for British Columbia, 2001.

increase in knowledge, awareness and access to resources.[269] There is no data on the impact on cessation rates or smoking prevalence.

Some research has been conducted on pharmacotherapy agents to reduce tobacco use among First Nations, but the appropriateness and effectiveness of this intervention was not clear.[270]

Increasing tobacco prices has been shown to decrease use, primarily among youth, but this subject has not been rigorously researched within the context of the Aboriginal community.[271]

Increasing tobacco prices has been shown to decrease use, primarily among youth, but this subject has not been rigorously researched within the context of the Aboriginal community.

International Comparisons

The first conclusion from a wider literature search is that much more research is needed in the arena of aboriginal tobacco control. That research needs to be as B.C-focused as possible, since inter-cultural transferability of programs and results is not clear.

One US study showed positive results after providing native American youth with the problem-solving, personal coping and interpersonal communication skills needed to help them resist pressures toward substance abuse.[272] Over the course of the 3.5 year study, rates of smokeless tobacco use among youth with the acquired skills were 43% less than those among youth who did not receive the skills. Cigarette use was unaffected by the intervention. As well, combining skills development with other community intervention showed no added benefit.

Evaluations were found in the literature of five tobacco intervention programs for indigenous Australians. Three of these studies demonstrated some effectiveness. Evaluation of a mainstream advertising campaign showed that knowledge about tobacco had increased.[273] A study to assess the effectiveness of free nicotine patches for indigenous people showed that this program might benefit a small number of smokers; 15% of participants reported that they had quit smoking.[274] Training health professionals in delivering a brief intervention resulted in some changes to practice; however, the study found no evidence that any patient had quit smoking at six-months follow-up.[275] A trial of a CD-ROM resource for use with indigenous school

[269] Tobacco Control – Tobacco Facts. Available at http://www.tobaccofacts.org/tob_control/strategy.htm (accessed October 2004).
[270] Wardman AE, Khan N. Tobacco cessation pharmacotherapy use among First Nations persons residing within British Columbia *Nicotine & Tobacco Research* 2004; 6(4): 689-92.
[271] Ministry of Health. Honouring our Health: An aboriginal tobacco strategy for British Columbia, 2001.
[272] Schinke SP, Tepavac L, Cole KC. Preventing substance use among native American youth: three-year results *Addictive Behaviors* 2000; 25(3): 387-97.
[273] Ivers E. A review of tobacco interventions for Indigenous Australians *Australian & New Zealand Journal of Public Health* 2003; 27(3): 294-9.
[274] Ivers RG, Farrington M, Burns CB et al. A study of the use of free nicotine patches by Indigenous people *Australian & New Zealand Journal of Public Health* 2003; 27(5): 486-90.
[275] Harvey D, Tsey K, Cadet-James Y et al. An evaluation of tobacco brief intervention training in three indigenous health care settings in north Queensland *Australian & New Zealand Journal of Public Health 2002*; 26(5): 426-31.

children and a pilot study of smoke-free workplaces did not show any impact on smoking rates.[276]

[276] Ivers E. A review of tobacco interventions for Indigenous Australians *Australian & New Zealand Journal of Public Health* 2003; 27(3): 294-9.

Mental Illness

Diseases caused by smoking are the second largest killer of people who have a mental illness.[277] The lifetime prevalence of smoking among people suffering from various forms of mental illness is approximately 60%, compared to about 40% in the general population.[278] One study[279] suggested that almost a third of current US smokers have some form of mental illness, including schizophrenia, bipolar disorder, depression or other categories.[280] The risk for depression increases as the number of "nicotine dependence symptoms" increases,[281] while other research concludes that smoking initiation precedes and predicts depression and bipolar disorder.[282,283,284] Conversely, the presence of active psychiatric disorders predicts an increased risk for first onset of daily smoking and for progression to nicotine dependence and, consequently, for the development of chronic disease.[285,286,287,288]

Smoking has an anti-depressant effect. This may be one of the benefits of smoking which causes schizophrenic and depressed smokers to rate the "reward value" of smoking more highly than does the general smoking population.

Canada's National Population Health Survey confirms the connection between depression and smoking. Adolescents with depressive symptoms are more likely than other adolescents to start smoking. On the other hand, people who smoked daily in Canada had increased chances of having a major depressive episode compared with non-smokers—with the odds being almost double for men.[289]

Although progress has been made in understanding the "biology" (including the genetics) of the connection between smoking and mental illness, the phenomenon is

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[277] Source: http://www.sane.org/ (accessed October 2004).

[278] Lasser K, Boyd JW, Woolhandler S et al. Smoking and mental illness: a population-based prevalence study *Journal of the American Medical Association* 2000; 284(20): 2606-10.

[279] Leonard S, Adler LE, Benhammou K et al. Smoking and mental illness *Pharmacology, Biochemistry & Behavior* 2001; 70: 561-70.

[280] Other categories of mental illness include posttraumatic stress disorder, attention-deficit disorder, obsessive-compulsive disorder, and anxiety. Addictive disorders, and especially nicotine dependence, of course represent special areas of interest.

[281] John U, Meyer C, Rumpf HJ et al. Depressive disorders are related to nicotine dependence in the population but do not necessarily hamper smoking cessation *Journal of Clinical Psychiatry* 2004; 65(2): 169-76.

[282] Scarinci IC, Thomas J, Brantley PJ et al. Examination of the temporal relationship between smoking and major depressive disorder among low-income women in public primary care clinics *American Journal of Health Promotion* 2002; 16(6): 323-30.

[283] Gonzalez-Pinto A, Gutierrez M, Ezcurra J et al. Tobacco smoking and bipolar disorder *Journal of Clinical Psychiatry* 1998; 59(5): 225-8.

[284] This interesting result does not suggest that smoking cessation would prevent the onset of mood disorders, as ex-smokers show the same risk for such onset as current smokers. Breslau N, Novak SP, Kessler RC. Daily smoking and the subsequent onset of psychiatric disorders *Psychological Medicine* 2004; 34: 323-33.

[285] Breslau N, Novak SP, Kessler RC. Psychiatric disorders and stages of smoking *Biological Psychiatry* 2004; 55(1): 69-761.

[286] Ismail K, Sloggett A, DeStavola B. Do common mental disorders increase cigarette smoking? *American Journal of Epidemiology* 2000; 152(7): 651-7.

[287] Strine TW, Balluz L, Chapman DP et al. Risk behaviors and healthcare coverage among adults by frequent mental distress status, 2001 *American Journal of Preventive Medicine*. 2004; 26(3): 213-6.

[288] Caroline P, Carney RF, Woolson LJ et al. Occurrence of cancer among people with mental health claims in an insured population *Psychosomatic Medicine* 2004; 66: 735-743.

[289] Source: http://www.statcan.ca/english/studies/82-003/archive/1999/hrar1999011003s0a05.pdf (accessed October 2004).

not fully understood.[290] What is well-known is that smoking cessation often leads to a worsening of symptoms in all of the disorders.[291] One suggestion is that tobacco may be a form of "self-medication." It was already noted in the preceding general discussion of non-pharmacological therapies that smoking has an anti-depressant effect. This may be one of the benefits of smoking which causes schizophrenic and depressed smokers to rate the "reward value" of smoking more highly than does the general smoking population.[292,293,294]

The association between smoking and mental illness has at least four implications for cessation treatment:

- In helping patients give up smoking, healthcare providers need to be aware of any underlying mental health problems that may need attention.
- Adding psychiatric components to treatments should be considered.
- Those treating nicotine dependence must be prepared to monitor and respond to any emergence of depression during the intervention, and should consider the potential benefit of antidepressants.
- There may be an advantage to integrating tobacco dependence treatment with mental health settings.

Approaches to Cessation

In spite of the assumed obstacles to cessation, smokers with a history of mental illness can show substantial quit rates.[295,296,297] One Canadian study found that people with mental disorders were very motivated to join a cessation group.[298] It is suggested that programs should be tailored for such populations, as the symptoms of

[290] McChargue DE, Spring B, Cook JW et al. Reinforcement expectations explain the relationship between depressive history and smoking status in college students *Addictive Behaviors* 2004; 29(5): 991-4.

[291] Dalack GW, Becks L, Hill E et al. Nicotine withdrawal and psychiatric symptoms in cigarette smokers with schizophrenia *Neuropsychopharmacology* 1999; 21(2): 195-202.

[292] Spring B, Pingitore R, McChargue DE. Reward value of cigarette smoking for comparably heavy smoking schizophrenic, depressed, and nonpatient smokers *American Journal of Psychiatry* 2003; 160(2): 316-22.

[293] McChargue DE, Spring B, Cook JW et al. Reinforcement expectations explain the relationship between depressive history and smoking status in college students *Addictive Behaviors* 2004; 29(5): 991-4.

[294] One Australian review provided this inventory of possible benefits of smoking to schizophrenic patients: improved cognition, relaxation, antidepressant effect, modification of psychotic symptoms, reduced side effects from antipsychotic drugs. *Smoking cessation in schizophrenia: general practice guidelines*, 2001. Source: http://www.racgp.org.au/document.asp?id=5319 (accessed October 2004).

[295] Lasser K, Boyd JW, Woolhandler S et al. Smoking and mental illness: a population-based prevalence study *Journal of the American Medical Association* 2000; 284(20): 2606-10.

[296] Hitsman B, Borrelli B, McChargue DE et al. History of depression and smoking cessation outcome: a meta-analysis *Journal of Consulting & Clinical Psychology* 2003; 71(4): 657-63.

[297] John U, Meyer C, Rumpf HJ et al. Depressive disorders are related to nicotine dependence in the population but do not necessarily hamper smoking cessation *Journal of Clinical Psychiatry* 2004; 65(2): 169-76.

[298] Addington J, el-Guebaly N, Addington D et al. Readiness to stop smoking in schizophrenia *Canadian Journal of Psychiatry* 1997; 42: 49-52.

mental illness and the resulting affective, cognitive and social difficulties, may mean that existing cessation approaches are not appropriate.[299]

There is little published literature about targeted treatments, and even less evidence of effectiveness. The types of interventions that have been tried with smokers exhibiting mental illness include:

Nicotine patches and anti-psychotic drugs such as clozapine seem to help reduce smoking, but it takes the addition of group therapy to create significant quit rates.

- Individual counselling, often in conjunction with nicotine replacement therapy (NRT) or other drug treatment; the two approaches together are sometimes called combination therapy.

- One significant form of counselling intervention is cognitive-behavioural therapy (CBT).[300] CBT combines two kinds of psychotherapy, cognitive therapy and behaviour therapy. Behaviour therapy helps patients to weaken the *connections* between troublesome situations and habitual reactions.[301] Cognitive therapy teaches how certain *thinking patterns* are causing symptoms.

- Another form of counselling is motivational interviewing (MI), an intensive, directive, client-centered counselling style for eliciting behaviour change by helping clients to explore and resolve ambivalence. Practitioners of MI propose that the word "motivational" be used only when there is a primary focus on increasing readiness for change.[302]

- Group counselling, using a variety of formats which are to some extent modified to accommodate the limitations of mentally ill participants. Again, such therapy is often accompanied by pharmacological interventions.

- Policy interventions such as total or partial smoking bans in mental health settings.

General practice guidelines have been developed in Australia for smoking cessation in schizophrenia.[303] The guidelines are based partly on the stages-of-change model and include NRT, group counselling and frequent monitoring.

Intervention Results

A 2002 review of cessation strategies in samples of persons with mental illness found 8 studies related to schizophrenia, and 8 related to depression.[304] The studies of persons with schizophrenia mostly were based on small clinical samples. The focus of the investigations was drug treatment and group work, rather than individual counselling (consistent with the thrust of the Australian guidelines noted above).

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[299] Addington J. Group treatment for smoking cessation among persons with schizophrenia *Psychiatric Services* 1998; 49(7): 925-8.

[300] Source: http://www.cognitivetherapy.com/basics.html (accessed October 2004).

[301] Behavioural counselling is sometimes used to prevent relapse.

[302] Source: http://motivationalinterview.org/clinical/whatismi.html (accessed October 2004).

[303] *Smoking cessation in schizophrenia: general practice guidelines*, 2001.
Source: http://www.racgp.org.au/document.asp?id=5319 (accessed October 2004).

[304] el-Guebaly N, Cathcart J, Currie S et al. Smoking cessation approaches for persons with mental illness or addictive disorders *Psychiatric Services* 2002; 53(9): 1166-70.

Nicotine patches and anti-psychotic drugs such as clozapine seem to help reduce smoking, but it takes the addition of group therapy to create significant quit rates; one study demonstrated cessation rates of 42% post treatment, 16% at 3 months and 12% at 6 months.[305]

The studies of people with depression used larger samples. It is important to note that the individuals recruited for such trials, while having a history of major depression, usually were not suffering from a current depressive episode. The most effective interventions involved a combination of cognitive-behavioural therapy and standard smoking cessation strategies, including pharmacotherapy. Quit rates ranged from 31 to 72% at the end of treatment and from 12 to 46% at 12 months. How these rates compared to any control group was not reported in the review. More recent studies with NRT have confirmed its effectiveness in patients with a history of depression, with improvement in cessation rates similar to the non-depressive population.[306,307]

Assessing and comparing the wide range of counselling theories and modalities in the literature is difficult. One 2004 study showed higher rates of cessation among depressed patients using cognitive-behavioural therapy in group sessions compared with basic health education.[308] A randomized controlled trial of motivational interviewing versus brief advice, applied to adolescents with psychiatric disorders, showed no difference in smoking cessation outcomes.[309]

A recent comprehensive review of bans on smoking in mental health settings showed that such policies, on their own, had little or no effect on smoking cessation.[310]

[305] Addington J, el-Guebaly N, Campbell W et al. Smoking cessation treatment for patients with schizophrenia *American Journal of Psychiatry* 1998; 155: 974-76.
[306] Thorsteinsson HS, Gillin JC, Patten CA et al. The effects of transdermal nicotine therapy for smoking cessation on depressive symptoms in patients with major depression *Neuropsychopharmacology* 2001; 24(4): 350-8.
[307] John U, Meyer C, Rumpf HJ et al. Depressive disorders are related to nicotine dependence in the population but do not necessarily hamper smoking cessation *Journal of Clinical Psychiatry* 2004; 65(2): 169-76.
[308] Haas AL, Munoz RF, Humfleet GL et al. Influences of mood, depression history, and treatment modality on outcomes in smoking cessation *Journal of Consulting & Clinical Psychology* 2004; 72(4): 563-70.
[309] Brown RA, Ramsey SE, Strong DR et al. Effects of motivational interviewing on smoking cessation in adolescents with psychiatric disorders *Tobacco Control* 2003; 12 (Suppl 4): 3-10.
[310] el-Guebaly N, Cathcart J, Currie S et al. Public health and therapeutic aspects of smoking bans in mental health and addiction settings *Psychiatric Services* 2002; 53(12):1617-22.

Summary

The logic model reproduced at the head of this section provided a convenient framework for organizing the interventions reviewed in this section of the report. The task that remains is to summarize the results, so that the various approaches are prioritized according to relative effectiveness as indicated by high quality research studies. This summary will use the same three categories as a framework, namely interventions to reduce initiation rates, interventions to increase cessation rates, and interventions to reduce ETS exposure. Inevitably, there are various kinds of overlap between the categories.

The proposed evaluation grid attempts to capture two criteria at the same time: effectiveness and strength of evidence. There are three meta-categories:

1. interventions of proven effectiveness with strong evidence
2. interventions of promising effectiveness with moderate or mixed evidence
3. interventions of no or low effectiveness and / or with insufficient evidence

The effectiveness test relates mostly to actual decreases in smoking (or exposure to second-hand smoke) rather than "softer" targets such as expanded knowledge about the harmful effects of smoking or increased intentions to quit. The evidence test places a high premium on support from multiple RCTs as reviewed by groups such as the Cochrane Collaboration, though other valid research modalities also play a significant role.

It is now commonplace to recommend integrated approaches to health promotion across a wide range of risk factors, chronic diseases and interventions. Although the evidence from controlled trials of community-wide, multi-component programs has been disappointing, the circumstantial evidence, for instance, of California's success with a state-wide tobacco control campaign and Florida's experience with reduced youth smoking, continues to motivate the development of such comprehensive strategies at regional and local levels. Such a commitment, however, does not answer critical questions about selecting, prioritizing and staging the component interventions. What is required in every jurisdiction, including B.C., is to seek and select interventions that will maximize the overall impact on the desired outcomes as efficiently as possible.

Interventions to Reduce Initiation Rates

1. Interventions of proven effectiveness with strong evidence

- Increased taxation on tobacco products (this may be the single most effective intervention).
- Control of activities promoting tobacco consumption (e.g. advertising, power wall displays, sponsorship of sporting events, smoking in movies).

The increased price of tobacco through taxation is the single most effective intervention to reduce initiation rates and increase cessation rates.

2. Interventions of promising effectiveness with moderate or mixed evidence

- School curricular programs focusing on social influence training.
- Smoke-free school policies.
- Multi-component community programs (e.g., school plus media efforts).
- Controlling tobacco sales to minors (effectiveness is very dependent on enforcement).
- Encouragements to not attend movies which glamorize smoking.
- Encouragements to create smoke-free homes.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- School curricula based on methods other than social influence training.

Interventions to Increase Cessation Rates

1. Interventions of proven effectiveness with strong evidence

- Increased taxation on tobacco products (this may be the single most effective intervention, including with pregnant women).
- Consumer utilization of nicotine replacement therapy (over-the-counter).
- Sustained encouragements to physicians to treat smoking.
- Intensive counselling, including group therapy. Youth cessation can be one effective target.
- Regular clinical use of all forms of nicotine replacement therapy (NRT), plus the antidepressant bupropion. Aboriginal smoking cessation may be one effective target for NRT.
- High- and low-intensity counselling of pregnant women who smoke.
- For the mentally ill, drug treatment, combined with group work (in the case of schizophrenic patients) or individual cognitive-behavioural therapy (in the case of depression).

- Cessation advice in the context of an adverse health event, particularly when combined with NRT.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Counter-advertising and other forms of media advocacy (if well-designed).
- Ensuring that insurance and / or public reimbursement plans cover patient costs (for counselling and any drugs).
- Ensuring that clinicians are compensated for counselling time.
- Second-line drug treatment using notriptyline or clonidine.
- Proactive telephone support (especially involving multiple contacts) and partner support (especially when parallel enhancement program is in place).
- Self-help materials (especially when personalized and combined with other interventions).
- Workplace smoking cessation campaigns (the key factor is the employee participation rate).
- Workplace smoking bans and poster campaigns.
- NRTs with pregnant women who smoke.
- Cessation help-lines, particularly if there are multiple pro-active contacts.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Basic encouragements to physicians to treat smoking.
- Use of serotonin selective reuptake inhibitors, anxiolytics and lobeline.
- Televised “how to quit” programs.
- Quit competitions and workplace incentives.
- Partner support with pregnant women who smoke.
- Basic information distributed about pregnancy and smoking.
- Motivational interviewing with adolescent psychiatric patients.
- Web based cessation programs (insufficient evidence).

Interventions to Reduce ETS Exposure (Especially in Children)

1. Interventions of proven effectiveness with strong evidence

- None.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Intensive counselling to reduce ETS exposure, especially identifying parents in healthcare settings.
- Legislating smoking bans in public places.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Assertive requests to refrain from smoking in public places.
- Community-based interventions to reduce ETS exposure (other than bans).
- Brief advice to carers to reduce ETS exposure.
- Legislating smoking bans in mental health settings.

Tobacco Control: Lessons Learned

Several reviewers have recently examined the multi-decade anti-tobacco campaign with a view to abstracting lessons that may be applicable to obesity and other public health challenges. Such lessons not only provide a conceptual context for the preceding intervention summary, but anticipate the evaluation of obesity strategies in the next section of this report.

The important insights derived by Mercer and colleagues in 2003 will offer a framework for the following summary: [311]

General Insights on Comprehensive Strategies

Physician intervention, including brief advice, counselling and pharmacotherapy, is seen to be one of the most effective and cost-effective of all disease prevention strategies; the "returns" in terms of benefits are quicker and the overall public health impact is larger in the short-term compared with any other component in a comprehensive program. One obstacle is that clinical help for smoking is a vastly underutilized resource.

More importantly, neither physician efforts nor any other sectoral intervention were able to single-handedly thwart the "broad cultural acceptability" of tobacco use and the ubiquitous social cues to smoke. Supportive systemic changes and social denormalization of both the tobacco industry and the smoking habit were required to achieve the population-based cessation rates that have been observed in developed countries.

No single component of a comprehensive program can account for all the significant changes with respect to tobacco; each intervention, from media advocacy to school programs to social support systems, is enhanced synergistically by the presence of other components.

No single component of a comprehensive program can account for all the significant changes with respect to tobacco; each intervention, from media advocacy to school programs to social support systems, is enhanced synergistically by the presence of other components.

The one possible exception to the preceding principle is tobacco product price increases (usually through taxation), which has been shown to have a strong and sustained effect independent of other interventions; control through pricing has been shown to be more significant than any media campaign.

Whether interventions involve taxation or other more experimental forms of environmental engineering, senior levels of government must shape their efforts to maximize support for policies and programs operating in local jurisdictions and targeted communities; there must be multi-level, integrated strategizing to ensure the greatest impact on risk factor reduction.

The Influence of Social Determinants

Tobacco control has also taught policy-makers that care needs to be taken with the impact of interventions on lower-income populations. For instance, taxation may lead to unintended consequences: rather than quitting in the face of higher prices, low income smokers may simply switch to cheaper brands or further strain their

[311] Mercer SL, Green LW, Rosenthal AC et al. Possible lessons from the tobacco experience for obesity control *American Journal of Clinical Nutrition* 2003; 77(Suppl): S1073-82.

household budgets (e.g., taking away from purchasing food).[312] There is even evidence that the tobacco industry is exploiting these social dynamics by positioning cheaper brands as still being high-quality and therefore increasing the attractiveness of such brands to low-income smokers who feel constrained to choose them.[313]

It is commonly recognized that tobacco control, including media advocacy and other forms of health education, needs to be as tailored as much as possible to address the needs of particular audiences.[314] People of lower socioeconomic status represent a unique challenge because they often do not have the resources to respond to counter-advertising in the same way as those of higher education.[315] The real and ironic possibility is that certain forms of health messages may be preferentially taken up by those with higher incomes, and thus actually ends up exacerbating social health inequalities.

Focusing on younger generations and reducing the development of behavioural risk factors in the first place are essential to permanently turning the tide on smoking.

Community-Based Interventions

The effect of community programs may be relatively small, but given the large number of smokers and the serious health impacts, the public health benefit may still be high: "the moderate efficacy of community programs is more than offset by their substantial reach."[316]

A critical aspect of community-based planning is the building of "capacity," i.e., increasing the number of organizations and local jurisdictions engaged in cessation education and tobacco control, plus ensuring adequate financial and organizational resources for all effective efforts over a long time frame.

Another key consideration is special populations of high risk. Above all, focusing on younger generations and reducing the development of behavioural risk factors in the first place are essential to permanently turning the tide on smoking.

Interventions need to be sustained over the long haul, but not without suitable surveillance and evaluation of results, and frequent fine-tuning.

Advertising, media advocacy and other forms of counter-marketing are components that cannot be ignored if a community campaign is going to be successful; not only are individual behaviours directly influenced, but a supportive environment is produced which helps other interventions to be more effective.

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[312] Thomson GW, Wilson NA, O'Dea D et al. Tobacco spending and children in low income households. *Tobacco Control*. 2002; 11:372-5.

[313] Tackling health inequalities. *Action on Smoking and Health.* 2001. Available at http://www.ash.org.uk /html/policy/response.html (accessed January 2005).

[314] Crampton P, Salmond C, Woodward A, Reid P. Socioeconomic deprivation and ethnicity are both important for anti-tobacco health promotion. *Health Education & Behavior*. 2000; 27(3):317-27.

[315] See for example the Alberta-based report *Poverty and Health Care Reform.* 2002. Available at http://www.ywcaofcalgary.com/pdf/PovertyHealthReform.pdf (accessed January 2005).

[316] Mercer SL, Green LW, Rosenthal AC et al. Possible lessons from the tobacco experience for obesity control *American Journal of Clinical Nutrition* 2003; 77(Suppl): S1073-82. See the discussion on "reach" and other evaluation criteria in the conclusion of this report.

Community interventions, as already noted, need to comprise multiple components to produce synergistic effects. They also need to be sustained over the long haul, but not without suitable surveillance and evaluation of results, and frequent fine-tuning.

School-based Interventions
As habits such as smoking often get established early, school programs have been useful tools in reducing risk factor incidence. Identifying social influences which promote smoking among youth, and teaching suitable counter-measures, have been particularly useful.

The effectiveness of school programs is increased when there is a sustained multi-stage approach, starting in primary school, intensifying in middle school, and offering "booster" sessions in high school.

Parent involvement in school and other community programs is often a key element in their success.

Clinical Interventions and Management
Even the "brief advice" interventions advocated for physician practices may not be used unless other staff in the clinic are recruited and trained to be partners in the process (e.g., intake interviews, physician prompting, administering referrals and follow-up).

Disincentives such as poor reimbursement of physicians for their time and patients for any out-of-pocket expenses are a barrier to expanding smoking cessation programs in the clinical setting, despite their clear effectiveness.

Regulatory and Economic Interventions
Where there are regulations, e.g., restricting minors' access to tobacco or clean indoor air policies, then enforcement has often made the difference between modest and more significant effectiveness.

The power of "macro-environmental" economic interventions in tobacco control, especially taxation, has already been noted. Marketing restrictions have also been very effective.

Conclusion
There are many critical lessons from tobacco control strategies in the last 4 decades that are highly applicable to other arenas of health promotion.

The US Institute of Medicine has identified the following key elements associated with a successful prevention program: [317]

- Interventions must address the fundamental behavioural and social causes of disease, illness and disability.

- Multiple approaches must be used simultaneously – education, social and community support, laws, economic incentives and disincentives.

[317] Institute of Medicine, *Promoting Health: Intervention Strategies from Social and Behavioral Research*, 2000.

- Multiple levels of influence must be accessed: individuals, families, schools, workplaces, communities, nations.

- Interventions must recognize special needs of specific target risk groups such as teens, seniors, at-risk communities.

- Interventions must have long durations because change takes time and needs to be constantly supported for each subsequent generation.

- Interventions need to involve a variety of sectors that are not traditionally associated with "health," such as business, engineering, law, media and others.

In particular, these lessons provide a map to move forward into the new frontier of obesity control. There have been passing references, however, to the current and absolute differences between obesity and smoking. These vital distinctions will be highlighted further as the report now turns to the other major risk factor challenge in B.C. and the whole developed world. The desire, indeed, the necessity, is to see the same progress on obesity as has been achieved in the area of smoking.

The desire, indeed, the necessity, is to see the same progress on obesity as has been achieved in the area of smoking.

Overweight and Obesity

Balanced Lifestyle

This section of the report initiates a sequence of three highly interrelated topics: overweight, unhealthy eating, and physical inactivity. The essential link is causal. There is evidence that a large percentage of overweight and obese people can trace their excess weight directly to a persistent imbalance between energy intake (i.e., food calories) and energy expenditure (i.e., physical activity). This basic formula gets translated into a set of hypotheses related to healthcare and a *balanced lifestyle*:

This section of the report initiates a sequence of three highly interrelated topics: overweight, unhealthy eating, and physical inactivity.

- reducing intake of food energy and / or increasing physical activity can produce weight loss
- healthy eating (especially an appropriate level of caloric intake) and / or an active lifestyle can prevent weight gain (or regain).

The specific aspects of diet and activity in reference to weight control will be covered in this section. It could be argued that these two risk factors warrant a separate treatment. Unhealthy diet (likely) and physical inactivity (almost certainly) are *independent* risk factors for disease conditions other than obesity. In other words, there is a health benefit for an overweight person to be physically active and to consume a healthy balance of food.

Nevertheless, the interrelationship of physical activity and diet, especially in reference to body weight, stands out much more than their independent impact on health status. These three risk factors, though independent predictors of disease and mortality, are inextricably bound together in terms of biology, personal behaviours, and social environment. This is why risk factor campaigns often integrate them (e.g., the section on Nutrition and Overweight in *Healthy People 2010*), as do national dietary / activity programs (e.g., the Vitality approach of Health Canada).

"We need to recognize that behaviour occurs within the context of social, political and economic systems…If you don't have access to healthy food, you can't choose it. If you don't have access to opportunities for physical activity, you can't choose it…So you can advertise to them, educate them, and market to them and so on, but it is actually changes to the social factors, policies and norms that are necessary for improvement and maintenance of population health."
Dr. Trevor Hancock, Ministry of Health Services.

The reader will notice that there is significantly less research evidence presented for the topics of overweight, unhealthy eating, and physical inactivity than was presented in the preceding section on tobacco consumption and exposure to second-hand smoke. This is largely due to the fact that the relationship between smoking and adverse health effects was clearly identified many decades ago. Three studies published in 1950, one each by Levin et al[318] and Wynder and

[318] Levin ML, Goldstein H, Gerhardt PR. Cancer and tobacco smoking: A preliminary report. *Journal of the American Medical Association* 1950; 143(4): 336-8.

Graham[319] in the United States, and one by Doll and Hill[320] in England, ended "the age of innocence about the blithe charms of the cigarette".[321] Thousands of research studies have probed various aspects of this relationship as well as efforts to reduce initiation rates and increase cessation rates. Understanding the relationship between obesity and adverse health outcomes has been a much more recent project. Likewise, the related and independent effects of physical activity and nutrition on health are still emerging fields of study.

"Other health issues - namely tobacco, seatbelts, breastfeeding, and recycling – have succeeded in generating social change at levels similar to those necessary to address the current obesity epidemic… All of these models began with a crisis; worked from a base of evidence; were grounded in problems with high economic costs; were propelled forward by projections of savings from change; created coalitions that brought people, sectors, and organizations together for a common goal; were supported by media advocacy that created a public will for change; and involved governments with respect to environmental and policy change. As the evidence of the increasing prevalence of obesity increases along with accompanying impacts on health and the economy, and as coalitions, including government, are beginning to form, there appears to be support for a movement toward social-change models to address the obesity epidemic in Canada."
Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective*. August 2004. Canadian Population Health Initiative. Pg. 41.

[319] Wynder EL, GrahamEA Tobacco smoking as a possible etiologic factor in bronchiogenic carcinoma; a study of 684 proved cases. *Journal of the American Medical Association* 1950; 143(4):329-36
[320] Doll R, Hill AB. Smoking and carcinoma of the lung *British Medical Journal* 1950; 221(2): 739-48. Questions about the adverse health effects of tobacco use go back at least to the 1600s when King James wrote *A Counter-Blaste to Tobacco*, published in 1604. See Kluger R. *Ashes to Ashes: America's Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris*. 1997 New York: Vintage Books.
[321] Kluger R. *Ashes to Ashes: America's Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris.* 1997 New York: Vintage Books Pg. 133.

Crisis and Opportunity

The overall Canadian prevalence of adult obesity (BMI>30) increased steadily between 1985 and 1998, more than doubling during the period (5.6% to 14.8%). In 1998, 3.3 million Canadians were obese. Only Quebec and British Columbia, each at 12%, had obesity rates below 15%.[322]

Perhaps even more disturbing are trends in childhood obesity (BMI>30). Between 1981 and 1996 obesity in Canadian children aged 7 to 13 increased by more than 400%, from 2.0% to 10.3% of boys and from 1.7% to 8.9% of girls.[323]

Between 1981 and 1996 obesity in Canadian children aged 7 to 13 increased by more than 400%.

Based on the latest Canadian Community Health Survey (2003), almost half (48%) of the Canadian population is currently overweight (BMI>25). Of particular concern from the perspective of social determinants of health is the fact that increased poverty is associated with increased obesity rates; putting it somewhat differently, it is clear that low socioeconomic status can be a risk factor for overweight, with the strongest evidence relating to women.[324,325] This reality adds a challenge to designing interventions that recognize health inequities.

Obesity has been strongly linked to several chronic conditions and diseases, including hypertension, high levels of cholesterol, coronary heart disease, and diabetes.[326] The motivation for prevention efforts involving a reduction of excess weight is clear. In fact, studies have shown that even a 10% weight loss can lead to substantial health benefits and extended life.[327] As will be seen below, however, weight loss cannot supersede the critical task of preventing obesity before it happens. The epidemic of obesity demands more than a rearguard action involving sometimes frustrating and frustrated attempts to lose weight.

Corresponding Epidemics

The need for intensified research into both the basic science and possible control of overweight and obesity has become very palpable in the last few years. While there have been remarkable reductions in tobacco consumption in developed countries, nutrition and physical activity authorities are alarmed that obesity represents a growing epidemic, one which is fast replacing smoking as the top public health

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[322] Katzmarzyk PT. The Canadian obesity epidemic, 1985-1998 *Canadian Medical Association Journal* 2002; 166(8): 1039-40.

[323] Tremblay MS, Katzmarzyk PT, Willms JD. Temporal Trends in Overweight and Obesity in Canada, 1981 – 1996. *International Journal of Obesity* 2002; 26(4): 538-43.
Tremblay MS, Willms JD. Secular Trends in the Body Mass Index of Canadian Children (correction), 1981 – 1996. *Canadian Medical Association Journal* 2001; 164(7): 970.

[324] Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychology Bulletin.* 1989; 105(2):260-75.

[325] Zhang Q, Wang Y. Socioeconomic inequality of obesity in the United States: do gender, age, and ethnicity matter? *Social Science & Medicine.* 2004; 58(6):1171-80.

[326] Douketis J, Feldman W. Prevention of obesity in adults. In: Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada, 1994.

[327] Oster G, Thompson D, Edelsberg J et al. Lifetime health and economic benefits of weigh loss among obese persons *American Journal of Public Health* 1999; 89(10): 1536-42.

concern in terms of chronic disease development and lowered quality of life.[328] The resulting call for action is understandable.

In spite of conceptual and practical differences between tobacco and obesity control, there are important overlaps as well, including:

1. At the individual level, some people deal with compulsive behaviour around eating which is similar to the addiction experienced by smokers; the phenomenon can be described as "using food for gratification beyond their nutritional requirement."[329]
2. Social influences and advertising pressures affect both smokers and over-eaters and otherwise unhealthy eaters.
3. On the other hand, environmental constraints and circumstances lead some people to limit physical activity in the same way that such factors can promote smoking.

The theoretical base for the socio-ecological determinants of obesity, sometimes known collectively as the "obesogenic environment," includes the following assumptions:

1. Individuals trying to make complex, sustained behavioural changes, or to adopt and maintain healthy behaviours in the first place, need all the help they can get;

2. Behaviours around obesity / overweight are sufficiently similar to smoking behaviours to warrant the same sort of environmental supports or, at least, the removal of impediments.

Obesogenic Environment

The circumstantial evidence is strong for implicating an obesogenic environment in the increase of obesity worldwide.[330,331] Thus interventions in the environmental sphere may become the most powerful in the future. While the research evidence in this area is currently limited,[332] many different approaches are being actively evaluated for preventing overweight and obesity at environmental levels, including: providing price support for healthy food, new food labelling schemes, regulating TV

[328] See for example Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000 *Journal of the American Medical Association* 2004; 291(10): 1238-45 in which the authors suggest that 400,000 deaths annually in the United States are attributable to poor diet and physical inactivity as compared to 430,000 attributable to tobacco. It should be noted that the calculation of the number of deaths attributable to poor diet and physical inactivity in this article are over inflated by at least 80,000 (see www.acpm.org, accessed December 2004) thus tempering the comparison with tobacco somewhat.

[329] Mercer SL, Green LW, Rosenthal AC et al. Possible lessons from the tobacco experience for obesity control *American Journal of Clinical Nutrition* 2003; 77(Suppl): S1073-82.

[330] Chopra M, Galbraith S, Darnton-Hill I. A global response to a global problem: the epidemic of overnutrition *Bulletin of the World Health Organization* 2002; 80(12): 952-8.

[331] Caterson ID, Gill TP. Obesity: epidemiology and possible prevention *Best Practices & Research Clinical Endocrinology & Metabolism* 2002; 16(4): 595-610.

[332] Swinburn B, Egger G. Preventive strategies against weight gain and obesity *Obesity Reviews* 2002; 3: 289-301.

food advertising aimed at children, providing training on prevention to physicians, introducing nutrition standards for school meals and vending machines, regulating restaurant portions and nutritional messages on printed menus, and providing exercise facilities in workplaces.[333,334]

> The term 'obesogenic environment' was first proposed by Swinburn, Egger and Raza in an article entitled "Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity." *Preventative Medicine* 1999; 29: 563-570. They note that *"approaches to obesity, which have been mainly educational, have met with limited success. They appear to be necessary but not sufficient to reduce obesity because people struggle against environments which increasingly promote a high energy intake and sedentary behaviors. The challenge is to create supportive environments for making the healthy choices which are promoted by the education messages."*

Strategies to prevent weight gain in the first place are vital (i.e., primordial prevention). Any help in maintaining a healthy weight will be more cost-effective than treating obesity once it has developed.[335,336] Some insights concerning primordial prevention in relation to children will be found in a special section later in the report.

Prevention will not always work. If excess weight is already present, individuals may well be encouraged to decrease energy intake and / or increase energy expenditure to promote weight loss (i.e., primary prevention). Social environment is important to these preventive efforts as well. Just as has occurred with smoking cessation (a form of primary prevention), comprehensive programs influencing the social context of energy intake and expenditure are vital to enhance the support for individuals who are self-initiating changes and / or being counselled for weight change.

The ultimate implication is that, whether the focus is primordial or primary prevention, multiple facets of the environment need to be changed simultaneously, from home, to work or school, to informal networks of friends, to the whole community and entire societies, in order to address obesity most profoundly.

Energy Intake vs. Expenditure

The individual approach to weight loss involving energy balance remains open to discussion and refinement. For example, the very fact that two behavioural factors contribute to excess weight raises questions about how they interact, and which one (unhealthy eating or sedentariness) is the biggest culprit. Also, how does a primarily "positive" behavioural change (i.e., more exercise) compare with one that has been, up to now, primarily a "negative" one (i.e., eat less, or at least eat less of certain foods). The physical activity category can be cast in negative terms (e.g., watch less

[333] Kumanyika S, Jeffrey RW, Morabia A et al. Obesity prevention: the case for action *International Journal of Obesity* 2002; 26: 425-36.
[334] Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity *Preventive Medicine* 1999; 29: 563-70.
[335] Gill T. Importance of preventing weight gain in adulthood *Asia Pacific Journal of Clinical Nutrition* 2002; 11(Suppl 3): S632-6.
[336] Caterson ID, Gill TP. Obesity: epidemiology and possible prevention *Best Practices & Research Clinical Endocrinology & Metabolism* 2002; 16(4): 595-610.

television or play less video games); likewise, diet change can be cast in positive terms, an advantage which may be a key driver behind campaigns to eat more fibre, vegetables and fruit. Positive or negative, the question remains which is the most effective way to go, and how do the "levers" for change differ in each case? And, unlike the relatively simple categories of "smoking" or "not smoking" (leaving aside for now different types of tobacco use and the controversial issue of cutting consumption or harm reduction), how does a personal change effort or public health campaign select an emphasis amidst the complex range of physical activities and dietary components available?

A final socio-ecological difference between physical activity and diet is that there are few *active* political or commercial agents telling people to exercise less (on the contrary, both business and community leaders are happy to have individuals "buy in" to exercise products and programs, up to and including new video "games" that are designed for tailored exercise routines). By comparison, there are clearly vested industrial interests who will resist appropriate changes to how food is produced and marketed. In this way, for some health advocates, the expanding battle-lines with Big Food appear to be drawn in ways that are reminiscent of the war with Big Tobacco.

The industry, consumers and financial markets are all responding to concerns about healthy diets. *McDonald's Corp*, for example, has seen their stock increase from a nine-year low in March of 2003 of $12.12 to $32.20 on January 6, 2005 after responding to a growing concern about obesity and junk food by introducing salads, and, more recently, sandwiches.
Krispy Kreme Donuts, on the other hand, has seen their stock plummet in price from a high of $49.74 in August of 2003 to $9.82 on January 6, 2005. The Krispy Kreme chief executive notes that there is "a group of consumers who have altered their purchasing habits because of dietary concerns".

Industry Responses

Alarmed by mounting media advocacy, draft legislation, and early litigation attempts, food and restaurant lobbyists are beginning to launch their counterattack. The three main thrusts of their campaign to support the status quo (or at least avoid penalties or forced changes) are:[337]

1. To maintain that the obesity epidemic and its health impacts are exaggerated.
2. To point out that any overweight problem is not so much to do with overeating, and especially not overeating certain unhealthy foods containing too much sugar or fat, but rather is more the result of physical inactivity.
3. To note that voluntary changes have already been adopted in various sectors.

In these communication efforts (which are not wholly without merit[338]), the food industry seems to be following a path very much parallel to tobacco manufacturers

[337] A good review of food industry concerns and positions can be found within the Center for Consumer Freedom, available at http://www.consumerfreedom.com/ (accessed December 2004).
[338] A rather dramatic example of the first point, i.e., inaccurate mortality statistics, was provided by the Centres for Disease Control which recently had to retract the results published in March, 2004, concerning annual US deaths attributable to obesity, as noted in an earlier footnote. News report available at http://www.medicalnewstoday.com/medicalnews.php?newsid=16869 (accessed December 2004). As well, evidence will be presented later in the report that supports the primacy of exercise over dieting as an effective weight control measure.

(indeed, adding to this conclusion, it is notable that some food and tobacco enterprises are housed under the same large corporate umbrella). The perceived corporate intransigence has spurred on recent reviews of the successes in tobacco control; this analysis has been followed by an application of the same principles and strategies to changing diets, as well as other forms of public risk factor prevention and health promotion.[339]

The pattern of interventions and stages of development from tobacco campaigns need to be adopted carefully. For example, it is possible that there may be a major departure from the tobacco control aspect of the overall smoking strategy, specifically in seeing more cooperative partnerships with the food industry. Since eating is not optional, food corporations will undoubtedly still be strong long after tobacco companies have been substantially marginalized.

Data Sources and Intervention Categories

The same pattern will be followed as elsewhere in this report, that is, consulting the results of respected review programs such as Cochrane and the Health Technology Assessment (in the UK), augmented by other published reviews as appropriate and available. As compared with the over 40 Cochrane titles related to tobacco control, there are only about 15 with some connection to weight control, and only a third of those projects have proceeded beyond the protocol stage.

Cochrane reviews-in-process have identified a range of treatment categories related to weight reduction, including: [340]

- pharmacotherapy,
- surgery,
- dieting or meal replacements,
- psychological / behavioural interventions,
- exercise,
- vitamin and mineral supplements,
- intragastric balloons, and
- alternative therapies (e.g., chitosan, herbs such as ephedra).[341]

The long-term effectiveness of many of these interventions has not even been studied, let alone proven. The Cochrane reviews of even mainstream interventions such as exercise and counselling are still in process. However, measurement of effectiveness in the area of population health cannot (indeed, should not) only depend on the randomized clinical trials which are the staple of the Cochrane database (see Appendix A).

Using the best available evidence, then, the key obesity interventions will be outlined below, as well as some promising directions for trial projects and further evaluation.

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[339] Mercer SL, Green LW, Rosenthal AC et al. Possible lessons from the tobacco experience for obesity control *American Journal of Clinical Nutrition* 2003; 77(Suppl): S1073-82.
[340] Vlassov VV. Weight reduction for reducing mortality in obesity and overweight *Cochrane Database of Systematic Reviews*, 2003.
[341] Dunshea-Mooij CAE, Ni Mhurchu C, Bennett D, Rodgers A. Chitosan for overweight or obesity *Cochrane Database of Systematic Reviews*, 2003.

The basic structure of this section on overweight / obesity will be to look at three types of initiatives to reduce the risk factor of excess weight:

- interventions to reduce energy intake
- interventions to increase energy expenditure
- interventions which in some way combine the previous two types

As with tobacco control, a further categorization of interventions will occur under each heading, from community-based to comprehensive strategies.

Interventions to Reduce Energy Intake

Interventions to reduce energy intake mostly relate to various types of diet change, and especially to modified fat or sugar intake. Diet and nutrition have been a focus of extensive research for a number of decades. Working out the scientific details of the biology of food, its biochemical constituents, and their relationship to metabolic functions, has been a major research interest. The actual application of the insights to individual and public consumption practices, however, has been at a lower level of intensity, with the notable exception of a perennial interest in losing weight. Resistance to the widespread adoption of dietary changes may be due to the relatively poor track record of reducing consumption of certain food groups in order to produce a sustained weight loss. There actually is an inconsistent evidence base for several proposed dietary interventions.[342] For example, the best known population-based campaign, promoting *5 A Day* vegetable and fruit servings in the US, has produced what can only be described as equivocal results (see below).

The Canadian and B.C. Diet

Statistics Canada tracks the average diet of the population each year. Red meat and poultry consumption was basically unchanged in 2003 over 2002. Milk consumption overall declined, though more cream was consumed (possibly a result of the growing popularity of caffeinated beverages). Rice consumption increased modestly, continuing a trend; the ingestion of other cereal, and especially wheat flour, products has greatly increased over 10 years, though they were slightly depressed in 2003 (perhaps the "low carb diet" effect).

Canadians ate more fruit, and though vegetable consumption is also rising, potatoes count for nearly half the amount. Surprisingly, fish consumption dipped slightly in 2003, the opposite of the trend over the preceding 10 years. Most tellingly, the overall ingestion of energy-dense oils and fats continued to rise, as did the total consumption of food. The "good news" in this pattern is that the recommended requirement of many lipids, vitamins and minerals is being regularly met, but the price is caloric consumption, which has been rising 1 to 3% year-over-year in the last decade.[343] Although the average young adult needs about 2500 kcal per day (more in men, less in women),[344] according to Health Canada the average caloric intake for the

[342] Nyren O. On the long and winding road to an evidence-based diet *Acta Oncologica* 2003; 42(4): 260-2.
[343] Data summarized at http://www.statcan.ca/Daily/English/040526/d040526e.htm and http://www.statcan.ca/Daily/English/041014/d041014d.htm (accessed November 2004).
[344] Rousseau E. Meeting nutritional needs during adolescence *Pro-Teen* 2000; 9(1&2): 31-49. Available at www.acsa-caah.ca/pdf/ang/pt091.pdf (accessed December 2004).

whole population has been significantly higher, and climbing, since 1995.[345] One factor consistently implicated in weight gain is the increasing consumption of energy-dense, sugary beverages such as soda pop, especially among youth.[346]

A comparison with the BC Nutrition Survey (BCNS) from 1999 for food group consumption is instructive, especially in regard to our vegetable and fruit target. This was the first such comprehensive survey conducted in BC since the Nutrition Canada Survey in the 1970's. The recently published report on the data showed a somewhat lower percentage of the BC population consuming "5 a day" servings of vegetables and fruit when compared with 2000/01 Canadian Community Health Survey (CCHS) data for the province (35.4 versus 40.1%).[347] The BCNS concurred with the positive picture derived from the CCHS concerning average daily servings; though the majority of adult British Columbians did not meet the minimum recommendations for vegetable and fruit intake, *in many cases they only needed to add one or two servings per day to meet that goal.* This suggests the encouraging conclusion that positive movement towards the 2010 target for vegetable and fruit consumption is well within the realm of possibility.

Dietary Change

The dietary goals seen in the most common interventions in clinical care and / or public health programs have included:

- reducing dietary fat or sugar / carbohydrate intake in order to decrease caloric intake or for other health benefits
- increasing vegetable and fruit consumption
- increasing dietary fibre intake.

These intervention categories coincide with Canadian dietary guidelines, as well as recent nutritional risk factor targets in developed countries, e.g., *Healthy People 2010* in the US.

"The high energy densities of many fast foods challenge the human appetite control systems with conditions for which they were never designed."
Prentice AM, Jebb SA. Fast foods, energy density and obesity: a possible mechanistic link *Obesity Reviews* 2003; 4(4): 187-94

The clinical application of limiting overall calories or specific energy-dense foods will be a focus of this subsection of the report, as will be other sorts of setting-specific programs and wider environmental policies directed towards healthy eating and reducing unhealthy weight.

In terms of individual behaviours, the effectiveness of low-calorie and low-fat diets will be reviewed here in the context of healthy weight maintenance as well as some other beneficial effects. The remaining dietary goals, which involve increasing the consumption of reportedly health-enhancing foods, have mostly been applied at population levels, e.g., the well-known promotion of *5 A Day*, or 5 daily servings of

[345] Data summarized at http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/review_food_supply_e.html (accessed November 2004).
[346] Trends in the Health of Canadian Youth. Available at http://www.hc-sc.gc.ca/english/media /releases/1999/99118ebk3.htm (accessed February 2005).
[347] BC Ministry of Health Services, 2004. Forster-Coull L, Barr SI, Levy-Milne R. *British Columbia Nutrition Survey: Report on Food Group Use.*

fruits and vegetables.[348] The goals will receive a more cursory treatment insofar as they only have a tangential impact on weight control.

Community-based Interventions

Community-wide dietary interventions are sometimes referred to as nutrition education; when behaviour change is intended, the common label is nutrition promotion. The most popular framework for health promotion strategies is social marketing, or the adaptation of commercial marketing to the planning, execution, and evaluation of programs to influence the behaviour of target audiences in order to enhance personal and societal welfare.[349]

Multimedia Campaigns

Multimedia campaigns related to dietary change are a major component of nutrition promotion. They exhibit substantial heterogeneity: there are many different media available, the campaign can vary in intensity and duration, messages can range from basic health / nutrition information to more sophisticated prompts for dietary behaviour change, and the intervention may be part of a multi-component strategy looking at more than one risk factor. The multiple interventions in the latter case naturally make it difficult to isolate the effect of mass media.

Many doubt whether mass media campaigns, in the absence of other programming, can create sustained behaviour change.[350] A similar conclusion was recently reached concerning the popular health education strategy of nutritional labels on processed foods. An extensive body of literature underlines that, while using the labels is associated with lower intakes of total fat, saturated fat and cholesterol, the very "consumer use" which is key to the equation is influenced by determinants requiring other interventions. For example, people with high intake of fat do not search for nutritional information as much as healthy eaters do, providing an interesting "catch 22" for public health planners.[351] In spite of these obstacles, the amount of money which is poured into tobacco, food and other advertising provides circumstantial support for continuing to develop effective counter-marketing tools. If it did not work, corporations would not continue to invest billions of dollars in advertising.

To be most effective, multimedia campaigns need to be part of a broader strategy.

There are few studies that have tested the validity of the suggestion just made, that is, whether mass media campaigns for diet change are effective by themselves. Two different studies in West Virginia demonstrated that paid advertising alone was able to change milk-drinking habits towards fat-reduced products, though the effect was not sustained after the campaign ended. In one study, the city where the advertising

[348] Foerster SB, Kizer KW, Disogra LK et al. California's "5 a day--for better health!" campaign: an innovative population-based effort to effect large-scale dietary change *American Journal of Preventive Medicine*1995; 11(2): 124-31.
[349] Alcalay R, Bell RA. *Promoting Nutrition and Physical Activity through Social Marketing: Current Practices and Recommendations.* Center for Advanced Studies in Nutrition and Social Marketing, University of California, Davis, CA, 2000.
[350] Reger B, Wootan MG, Booth-Butterfield S. Using mass media to promote healthy eating: A community-based demonstration project *Preventive Medicine* 1999; 29(5): 414-21.
[351] Lin CT, Lee JY, Yen ST. Do dietary intakes affect search for nutrient information on food labels? *Social Science & Medicine* 2004; 59(9): 1955-67.

occurred showed 13% of the population temporarily switching to 1% milk, compared to 7% in the control city. The study also noted that more intensive public relations or social marketing in a third city produced a 20% switch rate.[352]

The most impressive dietary results have been in programs that offer a consistent message over a long period, e.g., the famous 30- year health behaviour project in North Karelia, Finland, where, among other changes, fat consumption and cardiovascular disease have been dramatically reduced.[353]

Vegetables and fruit

Dietary interventions directed at widespread "free living" populations can be tested through before-and-after surveys, though it is difficult to control for confounding variables.[354] This approach has been used with the *5 A Day* campaign, the prototype of which began in California in 1988, but which is now spread throughout the US. Versions of the US campaign now exist in many other countries.[355] The Canadian program is called *5 to 10 a Day for Better Health*.[356] Although based on the principles and practices of social marketing, the various vegetable and fruit campaigns most typically depend on a mass media effort, thus allowing a partial test of that approach. Other components of the community-wide social marketing approach have included enhanced public relations, point-of-sale promotions, nutrition labelling, cookbooks, and sponsorships, as well as initiatives in schools, workplaces and churches (see below).

Studies have definitely shown that the message got out; for example, awareness in the US of the need for 5 daily servings of vegetables and fruit rose from 7% in 1991 to 19% in 1997.[357] The real test, though, is actual consumption patterns. On the one hand, randomized community intervention research trials of the program in the US have consistently shown an increased consumption of servings ranging from 0.2 to 1.7 per day. An analysis which adjusted for demographic shifts, however, concluded that there had been no significant changes.[358] This is confirmed

Increased awareness of nutrition principles and recommendations is the most common result of mass-media campaigns.

[352] Reger B, Wootan MG, Booth-Butterfield S. A comparison of different approaches to promote community-wide dietary change *American Journal of Preventive Medicine* 2000; 18(4): 271-5.
[353] Pietinen P, Lahti-Koski M, Vartiainen E et al. Nutrition and cardiovascular disease in Finland since the early 1970s: a success story *Journal of Nutrition, Health & Aging.* 2001; 5(3): 150-4.
[354] Fraser GE. A search for truth in dietary epidemiology *American Journal of Clinical Nutrition* 2003; 78(suppl): S521-5.
[355] For example, Dixon H, Borland R, Segan C et al. Public reaction to Victoria's "2 Fruit 'n' 5 Veg Every Day" campaign and reported consumption of fruit and vegetables *Preventive Medicine* 1998; 27(4): 572-82.
[356] Source: http://www.5to10aday.com/eng/index.htm (accessed November 2004).
[357] Stables GJ, Subar AF, Patterson BH et al. Changes in vegetable and fruit consumption and awareness among US adults: results of the 1991 and 1997 5 A Day for Better Health Program surveys *Journal of the American Dietetic Association* 2002; 102(6): 809-17. For an international comparison: Ashfield-Watt PA, Stewart E, Scheffer J. 5+ a day: Are we getting the message across? *Asia Pacific Journal of Clinical Nutrition* 2004; 13 (Suppl): S38.
[358] Stables GJ, Subar AF, Patterson BH et al. Changes in vegetable and fruit consumption and awareness among US adults: results of the 1991 and 1997 5 A Day for Better Health Program surveys *Journal of the American Dietetic Association* 2002; 102(6): 809-17.

by the major US risk factor surveillance system, which showed little change in nationwide vegetable and fruit consumption between 1994 and 2000.[359] Some research work done more in the economic sphere has also cast doubt on the impact of advertising on vegetable sales.[360]

Other components which are sometimes part of a community-wide program for vegetable and fruit consumption have been investigated:

- A newsletter with basic strategies to improve vegetable and fruit consumption resulted in significantly higher intake; there was no difference when the newsletter was "computer-tailored" to match the characteristics of the recipient.[361]

- Point-of-purchase interventions in supermarkets appear to have limited effect,[362] though some positive changes in consumption have been experienced with kiosks providing computer-tailored advice.[363]

Conclusion

A recent meta-analysis of health communication campaigns in the US showed that they have small measurable effects in the short term.[364] This general conclusion is borne out by the results of nutrition promotion campaigns (though the data is very limited). For example, a review noted that the best result expected for an unselected population was 1 to 4% reduction in fat contribution to overall energy.[365] It should be noted that such changes are still useful, and across a whole population may represent a significant public health benefit.

With an understanding of the potential benefits of even a small impact, new strategies within mass media and other community-wide delivery systems may still be worth pursuing. The reality for now, though, is that increased awareness of nutrition principles and recommendations is the most common result of such campaigns, with behavioural change being more elusive, especially once the intervention ceases. The greatest changes are seen, not surprisingly, in subpopulations which are selected for some degree of social cohesion and peer support, e.g., in schools (see below) and

[359] Serdula MK, Gillespie C, Kettel-Khan L et al. Trends in fruit and vegetable consumption among adults in the United States: Behavioral Risk Factor Surveillance System, 1994–2000 *American Journal of Public Health* 2004; 94(6): 1014-8.
[360] Rickersten K. The effects of advertising in an inverse demand system: Norwegian vegetables revisited *European Review of Agricultural Economics* 1998; 25(1): 129-40.
[361] Lutz SF, Ammerman AS, Atwood JR et al. Innovative newsletter interventions improve fruit and vegetable consumption in healthy adults *Journal of the American Dietetic Association* 1999; 99(6): 705-9.
[362] Kristal AR, Goldenhar L, Muldoon J et al. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables *American Journal of Health Promotion* 1997; 11(6): 422-5.
[363] Anderson ES, Winett RA, Wojcik JR et al. A computerized social cognitive intervention for nutrition behavior: direct and mediated effects on fat, fiber, fruits, and vegetables, self-efficacy, and outcome expectations among food shoppers *Annals of Behavioral Medicine* 2001; 23(2): 88-100.
[364] Snyder LB, Hamilton MA, Mitchell EW et al. A meta-analysis of the effect of mediated health communication campaigns on behavior change in the United States *Journal of Health Communication.* 2004; 9(Suppl 1): 71-96.
[365] Roe L, Hunt P, Bradshaw H et al. *Health Promotion Interventions to Promote Healthy Eating in the General Population: A Review*. London: Health Education Authority, 1997.

churches,[366,367] or which are otherwise specially motivated, e.g., people at high risk of disease. Within highly educated and motivated groups, fat intake has been reduced by 10 to 16% of energy, 3 to 4 times the rate seen in unselected groups.[368]

One explanation offered about the success rate in Finland as described above, especially compared to similar US projects, is that there was a relatively high rate of community initiation and participation.[369] Another idea is that the program achieved the ultimate goal of the "diffusion of innovations theory," that is, reaching a critical mass where the message and behaviour impact has a self-sustaining momentum. It should be noted, however, that even sustained changes in the intervention group often are equalled in the long-term by changes in the control group of a study.[370] The Finnish project is further complicated by the confounding factors commonly encountered in epidemiological studies.

Appropriate Meals Available at Restaurants

With the increasing frequency of "eating out" in developed countries (some estimates put the Canadian rate at about 5-6 times every week), focusing on the menu choices in restaurants makes good intuitive sense.

Restaurant food tends to contain more fat and saturated fat, and less fibre,[371] and expanded portion size has also been a growing concern.[372] The menu assessment tools,[373] proposed legislation for nutritional labelling on menus, and other interventions are still being developed.

Outcome studies are in their infancy.[374] For example, one recent project looked at whether a promotional campaign could influence the sale of heart-healthy menu items; the slight increase in such sales was found to not be statistically significant.[375]

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[366] For example, Campbell MK, Demark-Wahnefried W, Symons M et al. Fruit and vegetable consumption and prevention of cancer: the Black Churches United for Better Health project *American Journal of Public Health* 1999; 89(9): 1390-6.

[367] Glanz K, Yaroch AL. Stratrgies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change *Preventive Medicine* 2004; 39: S75-80.

[368] Roe L, Hunt P, Bradshaw H et al. *Health Promotion Interventions to Promote Healthy Eating in the General Population: A Review*. London: Health Education Authority, 1997.

[369] Schwab M, Syme SL. On paradigms, community participation, and the future of public health *American Journal of Public Health* 1997; 87(12): 2049-50.

[370] Roe L, Hunt P, Bradshaw H et al. *Health Promotion Interventions to Promote Healthy Eating in the General Population: A Review*. London: Health Education Authority, 1997.

[371] Glanz K, Hoelscher D. Increasing fruit and vegetable intake by changing environments, policy and pricing: restaurant-based research, strategies, and recommendations *Preventive Medicine* 2004; 39: S88-93.

[372] Young LR, Nestle M. The contribution of expanding portion sizes to the US obesity epidemic *American Journal of Public Health* 2002; 92(2): 246-9.

[373] Cassady D, Housemann R, Dagher C. Measuring cues for healthy choices on restaurant menus: development and testing of a measurement instrument *American Journal of Health Promotion* 2004; 18(6): 444-9.

[374] Glanz K, Hoelscher D. Increasing fruit and vegetable intake by changing environments, policy and pricing: restaurant-based research, strategies, and recommendations *Preventive Medicine* 2004; 39: S88-93.

[375] Fitzgerald CM, Kannan S, Sheldon S et al. Effect of a promotional campaign on heart-healthy menu choices in community restaurants *Journal of the American Dietetic Association* 2004; 104(3): 429-32.

Another strategy is Eat Smart!, Ontario's program to encourage, among other health practices, good nutritional choices on menus; awards of excellence are given to establishments which meet standards. A similar program in Australia is also being applied to childcare center menus.[376] There is limited and somewhat dated evidence that labelling the healthy choices on menus can increase sales of those items.[377]

Access to Fast Food Restaurants

The lower the median income of a neighbourhood, the higher the density of fast food restaurants.

The broader environmental situation regarding restaurants has also been investigated. One recent US study showed that the number of fast food establishments in African-American neighbourhoods was 50% higher than in white ones. Similar results were found when comparing against neighbourhood income levels: the lower the median income, the higher the concentration of fast food restaurants.[378] There is a clear link with the earlier commentary concerning high obesity rates in low income families: the energy-dense, low-cost food in such establishments appeals to those with less disposable income. Fast food consumption in turn has been strongly linked to obesity.[379] The planning tools to construct an intervention for such socio-ecological risk factors are not yet clear, nor have health outcomes from such disparities been fully assessed so as to allow the priority and urgency of response to be determined. What is clear is that the same socioeconomic forces reinforcing health inequities are at work in determining the range of food available in neighbourhood restaurants.

Portion Sizes

"So we have a society that's totally over-sugared, It's over-salted. And the over-sizing and super-sizing. So people become super-sized, too. And now we have to have super-sized coffins."
Dr. Hans Diehl in "Doctor says healthy diet can stave off death" *The Vancouver Sun* December 13, 2004, pg.C5

The issue of large portion sizes has been on the public health agenda for some time. Leisure and disposable income in developed countries, and certain segments of the population in developing countries, allow for such overeating habits, which in turn have been linked to rising obesity. Furthermore, any individual behavioural tendencies are probably reinforced by environmental conditions (e.g., relatively low food prices and the availability / marketing of large, even "super-sized," restaurant meals).[380] Although the issue is becoming increasingly apparent, the appropriate responses are less so; even given the unlikely scenario of fast food restaurants having legislated meal sizes, it is hard to imagine how individual consumers could be prevented from ordering a la carte or simply consuming multiple meals.

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[376] Glanz K, Yaroch AL. Stratrgies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change *Preventive Medicine* 2004; 39: S75-80.
[377] Seymour JD, Yaroch AL, Serdula M et al. Impact of nutrition environmental interventions on point-of-purchase behaviour in adults: a review *Preventive Medicine* 2004; 39: S108-36.
[378] Block JP, Scribner RA, DeSalvo KB. Fast food, race/ethnicity, and income: a geographic analysis *American Journal of Preventive Medicine* 2004; 27(3): 211-7.
[379] Pereira MA, Kartashov AI, Ebbeling CB et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *The Lancet.* 2005; 365(9453):36-42.
[380] Levitsky DA, Youn T. The more food young adults are served, the more they overeat *Journal of Nutrition* 2004; 134(10): 2546-9.

A more effective approach for weight control related to portion size may be to increase fibre in the diet, in particular vegetable and fruit consumption.[381] Aside from other health benefits, good intuition would suggest that filling up on high-fibre foods of low energy density but high satiation might preclude overeating other types of foods that are less healthy.[382] However, research evaluating "reduction" strategies for dietary change against more positive "substitution" strategies is at an early stage.[383]

Low-cost Fruits & Vegetables in Low-income Communities

In Canada, a report from 2003 suggested that access to vegetables and fruit (and milk products) may be constrained in low income families.[384] Personal economics are not the only barrier.[385] Various studies have shown that the range of healthy food available in stores is smaller in low-income areas; as well, proximity and access to the stores was poor.[386]

One study showed that ease of access to a supermarket increased daily household fruit consumption by 84 g per adult.[387] Most of this research has been conducted in the US. One intervention proposed in that jurisdiction has been to regulate stores licensed to receive WIC (Women's Infant & Children) Supplemental Food Program coupons, requiring them to provide a certain minimum display of fresh vegetables and fruit.

Other supermarket-based interventions have been suggested which are potentially useful in a variety of neighbourhoods:[388]

- price reductions or coupons for healthy foods
- point-of-purchase information
- more convenient and attractive displays
- promotional campaigns

A store in one of Winnipeg's poorest neighbourhoods provides fruit baskets at subsidized prices that children can afford as an alternative to purchasing candy.[389]

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[381] Ludwig DS, Pereira MA, Kroenke CH et al. Dietary fiber, weight gain, and cardiovascular disease risk factors in young adults. *Journal of the American Medical Association.*1999; 282(16):1539-46.
[382] Pereira MA, Ludwig DS. Dietary fiber and body-weight regulation. Observations and mechanisms. *Pediatric Clinics of North America.* 2001; 48(4):969-80.
[383] Heald AH, Golding C, Sharma R et al. A substitution model of dietary manipulation is an effective means of optimising lipid profile, reducing C-reactive protein and increasing insulin-like growth factor-1. *British Journal of Nutrition.* 2004; 92(5):809-18.
[384] Kirkpatrick S, Tarasuk V. The relationship between low income and household food expenditure patterns in Canada *Public Health Nutrition* 2003; 6(6): 589-97.
[385] Krebs-Smith SM, Kantor LS. Choose a variety of fruits and vegetables daily: understanding the complexities *Journal of Nutrition* 2001; 131(2S-1): S487-501.
[386] Sloane DC, Diamant AL, Lewis LB et al. Improving the nutritional resource environment for healthy living through community-based participatory research *Journal of General Internal Medicine* 2003; 18(7): 568-75.
[387] Rose D, Richards R. Food stores access and household fruit and vegetable use among participants in the US Food Stamp Program *Public Health Nutrition* 2004; 7(8): 1081-8.
[388] Glanz K, Yaroch AL. Strategies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change *Preventive Medicine* 2004; 39: S75-80.

Few of these strategies have been rigorously evaluated. Studies that have been conducted have shown positive results for measures such as consumer knowledge, but provided little data on consumption patterns themselves. The positive affect of pricing in settings such as schools suggest that this may be a fruitful avenue of intervention. This is especially significant considering that diets high in fat and sugar usually represent a low-cost option to consumers, whereas healthy diets tend to cost more.[390]

The positive affect of pricing in settings such as schools suggest that this may be an important avenue of intervention.

Commercial Diet Programs

Although technically not part of public health, the very popularity of various off-the-shelf diet plans and support programs has generated some research. One 2004 review of well-known programs showed that weight loss certainly was possible over the short term with the various options, depending on the participant.[391] But there was wide variation in the weight loss experienced, and the difference between the approaches was small on average. The main caution about these interventions, as with self-help dieting, is the frequent experience of relapse. A 2005 review confirms that the evidence of effectiveness for commercial programs is suboptimal,[392] except for Weight Watchers; it is the one commercial approach that has recently been found to have a significant effect for up to 2 years.[393].

Workplace-based Interventions

Interventions in workplaces to affect diet are at an early stage, especially compared to the number of smoking cessation programs in the same setting.

Dietary Fat

The 1997 review[394] in the UK mentioned earlier found only 4 high quality studies, a total which has not appreciably changed since then. The most effective projects for fat reduction focused on changing diet (and sometimes serum cholesterol levels) rather than multiple risk factors. They also usually included individual screening and counselling. One study conducted at 16 sites showed a reduction in fat intake of 1% of energy.

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[389] CBC News. *Grocery wins diabetes prevention award,* December 20, 2004 available at http://www.cbc.ca/story/science/national/2004/12/20/diabetes-prevent041220.html?print (accessed December 2004).

[390] Drewnowski A, Darmon N, Briend A. Replacing fats and sweets with vegetables and fruits—a question of cost *American Journal of Public Health* 2004; 94(9): 1555-9.

[391] Truby H, Millward D, Morgan L et al. A randomized controlled trial of 4 different commercial weight loss programmes in the UK in obese adults: body composition changes over 6 months *Asia Pacific Journal of Clinical Nutrition* 2004; 13(Suppl): S146.

[392] Tsai AG, Wadden TA. Systematic review: an evaluation of major commercial weight loss programs in the United States. *Annals of Internal Medicine*. 2005; 142:56-66.

[393] Heshka S, Anderson JW, Atkinson RL et al. Weight loss with self-help compared with a structured commercial program: a randomized trial. *Journal of the American Medical Association.*2003; 289(14):1792-8.

[394] Roe L, Hunt P, Bradshaw H et al. *Health Promotion Interventions to Promote Healthy Eating in the General Population: A Review*. London: Health Education Authority, 1997.

Vegetables and fruit
The Australian review noted earlier found 2 studies which provided findings for vegetables and fruit. The increase in consumption reported amounted to 0.1 to 0.5 servings per day.[395] The elements of effective interventions include:

- coordinator training
- involvement of workers in program design
- social support, especially by family members
- environmental changes, e.g., in the cafeteria
- integrated with wider community campaign.

School-based Interventions

School programs to create dietary change have highly variable components from study to study; typically they draw from one or more of the following: curricular material, school-wide events such as assemblies, contests, snack breaks, posters and related communication methods, and changes in cafeteria menus. Recruiting parent and teacher involvement is also common. It is important to distinguish the traditional public health strategy for eating behaviour change which has focused on individual awareness through educational approaches from the more recent appreciation of environmental influences on dietary choice.[396, 397,398,399] These influences include food availability, price, promotion, role modelling, and more diffuse social norms. Environmental approaches can be thought of as those that do not require the individual to actively select themselves into the program.[400]

Educational Content

The majority of controlled studies found in one 1997 review of health promotion programs were set in schools or universities, though the studies were mostly perceived as poor quality. Most of the programs were directed at children aged 8 to 12.[401] The small number of reliable post-secondary studies included in another review from 2004 were at least 10 years old, and one dated from 25 years ago.[402]

At the younger age level, two programs have been noted, *CATCH* and *Know Your Body*, which decreased fat intake by 2 to 3.5% of energy, within the range seen for

[395] National Public Health Partnership. *An Intervention Portfolio to Promote Fruit and Vegetable Consumption.* 2000. Available at http://www.nphp.gov.au/publications/signal/intfv1.pdf (accessed November 2004).
[396] Glanz K, Mullis R. Environmental interventions to promote healthy eating: a review of models, programs, and evidence *Health Education Quarterly*1988; 15: 395–415.
[397] Glanz K, Lankenau B, Foerster S et al. Environmental and policy approaches to cardiovascular disease prevention through nutrition: opportunities for state and local action *Health Education Quarterly* 1995; 22: 512–27.
[398] Wechsler H, Devereaux RS, Davis M et al. Using the school environment to promote physical activity and healthy eating *Preventive Medicine* 2000; 31: S121–37.
[399] French SA, Story M, Jeffery RW. Environmental influences on eating and physical activity *Annual Review of Public Health.* 2001; 22: 309-35.
[400] French SA, Stables G. Environmental interventions to promote vegetable and fruit consumption among youth in school settings *Preventive Medicine* 2003; 37(6 Pt 1): 593-610.
[401] Roe L, Hunt P, Bradshaw H et al. *Health Promotion Interventions to Promote Healthy Eating in the General Population: A Review.* London: Health Education Authority, 1997.
[402] Seymour JD, Yaroch AL, Serdula M et al. Impact of nutrition environmental interventions on point-of-purchase behaviour in adults: a review *Preventive Medicine* 2004; 39: S108-36.

typical community-wide programs. In general, the most effective interventions in schools included these features:

- a focus on diet alone, or diet and exercise
- longer and more frequent classroom contact (i.e., a higher "dose")
- parental involvement, with or without a home activity.

Most of the studies found by an Australian review in 2000 were from the US and involved low-income children aged 9 to 11.[403] Of the 16 studies examined, 14 achieved a positive effect for either vegetables and fruit or fruit alone. The change ranged from +0.20 to 0.77 servings per day. The studies were heterogenous in quality. The one intervention showing the largest reliable impact included these elements alongside the curricular component:[404]

- food service changes (point of sale promotion, increased variety and better presentation)
- parental and family involvement
- take-home snacks

The other features commonly seen with the most effective interventions include:

- longer-term classroom contact; a "rule of thumb" is that 15 hrs impacts knowledge and 50+ hrs impacts behaviour
- industry involvement
- integrated, supportive school environment

The more comprehensive the program, the more difficult it is to isolate the components that have been particularly effective. A few studies have looked at discrete interventions, some of which show promise and all of which need further research:[405]

- peer modelling and an incentive system[406]
- newsletters to train teachers/carers
- price reduction for targeted food in the school cafeteria; one project which cut prices in half increased fruit sales fourfold.[407]

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[403] National Public Health Partnership. *An Intervention Portfolio to Promote Fruit and Vegetable Consumption.* 2000. Available at http://www.nphp.gov.au/publications/signal/intfv1.pdf (accessed November 2004).

[404] Perry CL, Bishop DB, Taylor G et al. Changing fruit and vegetable consumption among children: the 5-a-Day Power Plus program in St. Paul, Minnesota *American Journal of Public Health* 1998; 88(4): 603-9.

[405] National Public Health Partnership. *An Intervention Portfolio to Promote Fruit and Vegetable Consumption.* 2000. Available at http://www.nphp.gov.au/publications/signal/intfv1.pdf (accessed November 2004).

[406] Lowe CF, Horne PJ, Tapper K et al. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children *European Journal of Clinical Nutrition* 2004; 58(3): 510-22.

[407] French SA, Story M, Jeffery RW et al. Pricing strategy to promote fruit and vegetable purchase in high school cafeterias *Journal of the American Dietetic Association* 1997; 97(9): 1008-10.

Cafeteria Practices

A 2003 review, updating the few additional studies published since the Australian report noted above, generally agrees with the positive assessment of school-based interventions for vegetable and fruit consumption; fruit consumption has been especially enhanced, with increases ranging from 0.2 to 0.6 servings per day.[408]

This more recent review also includes an expanded treatment of stand-alone environmental influences, including 3 studies focusing on vegetables and fruit and 4 which had a different main focus, namely, dietary fat, but which also measured vegetable and fruit consumption.

The primary focus of environmental interventions in schools has been cafeteria practices, for example, the pricing strategy noted above; some results have been promising, but in one 2004 study Perry and colleagues reported on a cafeteria intervention which only showed very modest gains, mainly related to fruit. Their conclusion, based on this and other work, is that the multi-component programs described above are more potent than stand-alone cafeteria strategies.[409] This is the same conclusion reached by the US Agency for Health Care Research and Quality in 2001.[410]

Vending Machines and Other Food Choices

Even if only part of the prevention story, the environmental approach to "healthy schools" is becoming a stronger feature of planning and research.[411] For instance, vending machines are increasingly a target. One recent Minnesota study showed that only a third of school vending machine items qualified as low-fat.[412] A 2003 report by the BC Provincial Health Officer noted that 90% of middle and high schools sell soft drinks, with about 10% having exclusive contracts with manufacturers. [413]

There is increasing concern about soft drink consumption, especially in association with childhood obesity, though the evidence is not conclusive.[414,415,416] Nevertheless,

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[408] French SA, Stables G. Environmental interventions to promote vegetable and fruit consumption among youth in school settings *Preventive Medicine* 2003; 37(6 Pt 1): 593-610.
[409] Perry CL, Bishop DB, Taylor GL et al. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children *Health Education & Behavior* 2004; 31(1): 65-76.
[410] Ammerman A, Lindquist C, Hersey J et al. Efficacy of interventions to modify dietary behavior related to cancer risk. Evidence Report/Technology Assessment No. 25: AHRQ, 2001.
[411] See, for example, Berenbaun S. *Nutrition in Saskatchewan Schools: Policy, Practice and Needs.* 2004. Available at http://ww1.heartandstroke.sk.ca/Images/English/SK-Nutrition-Report-April-2004.pdf (accessed November 2004).
[412] French SA, Story M, Fulkerson JA, Gerlach AF. Food environment in secondary schools: a la carte, vending machines, and food policies and practices *American Journal of Public Health* 2003; 93(7): 1161-7.
[413] Kendall PRW. *An Ounce of Prevention: A Public Health Rationale for the School as a Setting for Health Promotion,* 2003.
[414] Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *The Lancet.* 2001; 357:505-8.
[415] French SA, Hannan PJ, Story M. School soft drink intervention study *British Medical Journal* 2004; 329(7462): E315-6.
[416] Field AE, Austin SB, Gillman MW et al. Snack food intake does not predict weight change among children and adolescents. *International Journal of Obesity & Related Metabolic Disorders.* 2004; 28(10):1210-6.
(footnote continued)

New York City recently banned all sweetened drinks and snacks from school vending machines; a ban has been recently instituted for elementary schools in Ontario, and is being considered in B.C.[417] Such initiatives are still relatively new, and the evidence base for dietary (and other health) effects is not yet well-developed.

Other researchers are pursuing incentives rather than bans, for instance, the effect of pricing on food choices.[418,419] One study from 2001 showed that reducing the price of low-fat snacks in vending machines by 10, 25 or 50% increased sales of those items by 9, 39 and 93%, respectively; another pertinent result is the fact that profits per machine were not affected.[420] This study updated and confirmed earlier work by the same authors.[421] Recent research in the context of a teacher lounge showed that increasing the availability of low-fat items in vending machines and adding some promotional material increased sales of such items, though the results were deemed to be suggestive rather than statistically significant.[422]

Reducing the price of healthy foods in vending machines significantly increases sales of these items.

In general, one study showed that price decreases may be a more powerful incentive to choose healthy food than, say, health messages.[423]

Home-based Interventions

Family-oriented weight loss treatments have been studied in comparison with individual approaches. This usually involves recruiting family members to participate together in a weight loss program, or otherwise engaging the family or friends of a subject to play a supportive role.

The results have been mixed. In 1992, for example, a group of Mexican American women were randomly assigned to a control group (basic information distributed), individual group (information plus in-class training), or family group (spouses and children attended the classes as well). Although both intervention groups lost significantly more weight than the control, there was no difference between them.[424]

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[417] News stories at http://www.bcctv.ca/displayresults.jsp?id=/news/stories/2004/11/news-20041107-06.htm and http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/1096472213533_91881413?hub=Health (accessed November 2004) and http://www.torontofreepress.com/2004/weinreb102604.htm (accessed February 2005).

[418] Hannan P, French SA, Story M et al. A pricing strategy to promote sales of lower fat foods in high school cafeterias: acceptability and sensitivity analysis *American Journal of Health Promotion* 2002; 17(1): 1-6.

[419] French SA, Wechsler H. School-based research and initiatives: fruit and vegetable environment, policy, and pricing workshop *Preventive Medicine* 2004; 39: S101-7.

[420] French SA, Jeffery RW, Story M et al. Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study *American Journal of Public Health* 2001; 91(1): 112-7.

[421] French SA. Story M. Jeffery RW et al. Pricing strategy to promote fruit and vegetable purchase in high school cafeterias *Journal of the American Dietetic Association* 1997; 97(9): 1008-10.

[422] Fiske A, Cullen KW. Effects of promotional materials on vending sales of low-fat items in teachers' lounges *Journal of the American Dietetic Association* 2004; 104(1) :90-3.

[423] Horgen KB, Brownell KD. Comparison of price change and health message interventions in promoting healthy food choices. *Health Psychology.* 2002; 21(5):505-12.

[424] Cousins JH, Rubovits DS, Dunn JK et al. Family versus individually oriented intervention for weight loss in Mexican American women *Public Health Reports* 1992; 107(5): 549-55.

A study published in 1999 was more promising: individuals recruited with 3 friends or family members for a 4-month behavioural treatment maintained their weight loss at 6-month follow-up at almost 3 times the rate of subjects recruited individually.[425] Pooled results from 4 studies showed an overall increased weight loss of almost 3 kg with social support.[426]

As with smoking cessation, physician advice to change exercise and dietary habits is a strong predictor of motivation and attempts to change.

In spite of the equivocal evidence, many jurisdictions are persuaded that a focus on the family is vital for obesity control, especially in children.[427,428] This was in part the motivation behind the major report *Healthy Weight 2008 Australia's Future: The National Action Agenda for Children and Young People and their Families.*[429]

Clinical Interventions and Management

Brief Advice

The brief physician advice which is most feasible in the primary care setting is enhanced in effectiveness when combined with self-help materials and interactive communications such as telephone follow-up. Such minimal interventions should not be underestimated. One RCT found that merely giving people a one-sentence assessment of their fat intake as a percentage of total energy was enough to create significant decreases in fat consumption.[430] As with smoking cessation, physician advice to change exercise and dietary habits is reported to be a strong predictor of motivation and attempts to change.[431]

Counselling

Apart from the patient education related to diet, which is sometimes called "nutritional counselling," there are many different types of true psychological intervention used directly for weight control. Behaviour therapy and cognitive behaviour therapy seem to be the methods of choice.[432] They can be used by physicians or by other members of the healthcare team to which an overweight person may be referred.

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[425] Wing RR, Jeffery RW. Benefits of recruiting participants with friends and increasing social support for weight loss and maintenance *Journal of Consulting & Clinical Psychology* 1999; 67(1): 132-8.
[426] Avenell A, Broom J, Brown TJ et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement *Health Technology Assessment* 2004; 8(21).
[427] Dietz WH, Gortmaker SL. Preventing obesity in children and adolescents *Annual Review of Public Health* 2001; 22: 337-53.
[428] Glenny AM, O'Meara, Melville A et al. The treatment and prevention of obesity: a systematic review of the literature *International Journal of Obesity* 1997; 21(9): 715-37.
[429] Source: http://www.asso.org.au//freestyler/gui/files/healthy_weight_2008.pdf (accessed December 2004).
[430] Armitage CJ, Conner M. Efficacy of a minimal intervention to reduce fat intake *Social Science & Medicine* 2001; 52(10): 1517-24.
[431] Thomas RJ, Kottke TE, Brekke MJ et al. Attempts at changing dietary and exercise habits to reduce risk of cardiovascular disease: who's doing what in the community? *Preventive Cardiology* 2002; 5(3): 102-8.
[432] Liao KL. Cognitive-behavioural approaches and weight management: an overview *Journal of the Royal Society of Health* 2000; 120(1): 27-30.

Behavioural treatments aim to provide the individual with coping skills to handle various cues to overeat and to manage lapses in health-enhancing diet or physical activity; therapeutic techniques include goal-setting and self-monitoring.[433]

Cognitive strategies, on the other hand, seek to identify and modify aversive thinking patterns and mood states.[434] When combined, the two forms of therapy appear to improve weight loss and prevent regain.[435] The Cochrane review in this area is still in process. It notes that counselling appears in major clinical guidelines for obesity control mostly because "diet and exercise combined with psychological interventions comprise an intuitively powerful weight loss program."[436]

Unfortunately, the evidence base for this claim is limited. There are still major gaps in knowledge concerning diet, physical activity, or a combination of the two in structured or "lifestyle" approaches, and the specific role and benefit of counselling, whether behavioural, cognitive, person-centred, or even full-fledged psychoanalysis. The counselling delivery mode has also not been well-investigated, though preliminary research suggests that group interventions may be at least as effective as individual ones, presumably due to the benefits of social support.[437]

Nutritional counselling is distinguished by a direct focus on diet for a variety of health benefits, which often includes weight loss. A comprehensive review of counselling for healthy eating was undertaken for the US Preventive Services Task Force in 2003.[438] A total of 21 studies met the eligibility criteria, e.g., following an RCT design; 17 of the studies looked at dietary fat, 10 at vegetables and fruit, and 7 at dietary fibre.

Counselling for reduction of total saturated fat was effective in all cases, and showed medium-to-large decreases in 12 studies. In the 9 studies that specifically measured change in percentage of calories from saturated fat, net reductions ranged from 0.9 to 5.3%. To put this in context, the upper limit of this range represents a reversal of the increased calories from fats and oils over 10 years in Canada.

Of the 10 studies focusing on vegetable and fruit consumption, 8 showed only small to medium increases (<0.8 servings per day), though in some cases this would be enough to move an individual into the range of recommended "dosage." The two studies with large effects increased consumption by 1.4 and 3.2 servings.

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[433] Shaw K, Kenardy J, O'Rourke P et al. Psychological interventions for obesity Cochrane Metabolic and Endocrine Disorders Group *Cochrane Database of Systematic Reviews*, 2003.
[434] Wilson GT. Cognitive behavior therapy for eating disorders: progress and problems *Behaviour Research & Therapy* 1999; 37(Suppl 1): S79-95.
[435] Cooper Z, Fairburn CG. A new cognitive behavioural approach to the treatment of obesity *Behaviour Research & Therapy* 2001; 39(5):499-511.
[436] Shaw K, Kenardy J, O'Rourke P et al. Psychological interventions for obesity Cochrane Metabolic and Endocrine Disorders Group *Cochrane Database of Systematic Reviews*, 2003.
[437] Hayaki J, Brownell KD. Behaviour change in practice: group approaches *International Journal of Obesity & Related Metabolic Disorders* 1996; 20(Suppl 1): S27-30.
[438] Pignone MP, Ammerman A, Fernandez L et al. Counseling to promote a healthy diet in adults: a summary of the evidence for the U.S. Preventive Services Task Force *American Journal of Preventive Medicine* 2003; 24(1): 75-92.

Counselling for increased dietary fibre produced small positive effects (0.3-1.6 g per day) in 5 studies, with the remaining 2 projects showing net changes of about 3 g per day at 1-year follow-up (and 6 g for women in one case).

The literature examining the effect of dietary counselling in primary care and other settings is complex. For example, there are many possible counselling components, including dietary assessment, self-help materials, interactive reinforcement (computer-tailored mailings, telephone counselling), small groups, family involvement or other social support, and goal-setting. The characteristics of the most successful interventions were:

- higher intensity counselling (more time, more frequent, more personalized)
- well-trained counsellors
- special research clinic setting (rather than primary care)
- using a greater number of counselling components

One of the main limitations, common to most risk factor interventions, is the scarcity of long-term outcome data with respect to counselling and diet. Given that, even the modest impacts of counselling on dietary change seen in this review need to be treated with caution.

A comparison of individual and group-based treatment has also been the focus of a small number of trials. The results show a very modest benefit in weight loss with group programs over shorter follow-up (e.g., 0.74 kg at 18 months), but an opposite effect later (e.g., smaller weight loss in group settings after 5 years).[439]

Dietary Treatment

Sometimes behavioural changes aimed at weight loss are encapsulated in a "dietary prescription" which is often supported by various types of counselling. The general results of this classic approach have not been encouraging; the pattern usually seen is moderate weight loss, followed by gradual weight regain.[440]

The only completed Cochrane review related to diet examined low-fat approaches in comparison with classic low-calorie options. A small number of studies were included which provided results at 6, 12 and / or 18 month follow-up. There was no significant difference in weight loss between the two diets at any point, nor for other outcome measures such as serum lipids, blood pressure and fasting plasma glucose. The conclusion was that fat-restricted diets are no more effective than calorie-restricted ones in achieving long-term weight loss.[441]

Group interventions may be at least as effective as individual ones due to the benefits of social support.

For reasons that are not clear, the Health Technology Assessment (HTA) program in the UK only looked at one of the studies which compared low-fat and low-calorie diets,

[439] Avenell A, Broom J, Brown TJ et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement *Health Technology Assessment* 2004; 8(21).
[440] Dunshea-Mooij CAE, Ni Mhurchu C, Bennett D et al. Chitosan for overweight or obesity *Cochrane Database of Systematic Reviews*, 2003.
[441] Pirozzo S, Summerbell C, Cameron C et al. Advice on low-fat diets for obesity *Cochrane Database of Systematic Reviews*, 2004.

noting that there was a modest benefit for the low-fat approach.[442] The RCTs comparing these diets to no intervention controls actually leaned in the opposite direction, giving an edge to the low-calorie approach, so the final conclusion about the optimum weight loss plan remains unclear. However, the overall impact is clear: reducing calories by any means produces a weight loss (providing energy expenditure is not decreased).

Two of the low-fat diet studies also reported prevention of type 2 diabetes onset, as well as reduced use of hypertension drugs. The HTA notes that the low-fat category contained the greatest number of RCTs, and it is the diet most commonly recommended in the UK.

Given the small number of studies, HTA did not ultimately find sufficient evidence of benefit for low-calorie or very low-calorie diets versus control. Three RCTs comparing these two approaches generally revealed no significant difference in effectiveness. It is worth noting, however, that the greatest weight loss of any study was seen in the case of one very low-calorie diet with a small sample of obese patients.[443]

The HTA did find a significant short-term improvement in weight loss with a protein-sparing modified fast versus a low-calorie diet (3.57 kg at 12 months), but the effect disappears over longer follow-up; at 18 months the weight loss was 0.69 kg, and there were no statistically significant changes in blood lipids.

The current popularity of modified low-carbohydrate diets undoubtedly will prompt a systematic review of the growing literature on such interventions, some of which seems to be supportive of the health benefits of a low-carbohydrate intake.[444]

Approved Drug Treatment

Two main drugs have been approved in Canada, the US and other jurisdictions for long-term treatment of unhealthy weight: orlistat and sibutramine. Orlistat reduces fat absorption from the intestine, and hence caloric intake, by inhibiting gastrointestinal lipases. Sibutramine is an appetite suppressant, thought to work via norepinephrine and serotonergic mechanisms in the brain. It reduces food intake by producing a feeling of satiety. These two drugs are normally only recommended for obese patients, or those overweight and with significant comorbidities.

Both drugs have significant side effects. Orlistat may reduce the absorption of fat-soluble vitamins (A, D, E) and nutrients; as well, there can be gastrointestinal problems associated with fat malabsorption, unless fat is restricted in the diet while taking the drug. Sibutramine may increase blood pressure and induce tachycardia (increased heart rate), as well as cause stroke and disturbances of vision such as eye

[442] Avenell A, Broom J, Brown TJ et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement *Health Technology Assessment* 2004; 8(21).
[443] Stenius-Aarniala B, Poussa T, Kvarnstrom J et al. Immediate and long term effects of weight reduction in obese people with asthma: randomised controlled study *British Medical Journal* 2000; 320(7238): 827-32.
[444] For example, Miyashita Y, Koide N, Ohtsuka M et al. Beneficial effect of low carbohydrate in low calorie diets on visceral fat reduction in type 2 diabetic patients with obesity *Diabetes Research & Clinical Practice* 2004; 65(3): 235-241.

pain and eye haemorrhage. There were 28 reported adverse reactions associated with the use of sibutramine in Canada from December 28, 2000 to February 28, 2002. As a result, this drug is undergoing a safety review in Canada and in other countries.

Cochrane reviewed 11 RCTs which focused on the effect of orlistat on weight loss as well as on other risk factors.[445] All studies showed greater weight reductions for orlistat plus diet versus placebo plus diet. The average weight loss seen in the pooled data was about 2.9% more with the drug, or 2.7 kg, after 12 months. The weight loss in lower-risk patients was slightly higher.

In the five studies reporting on waist circumference (WC), orlistat consistently produced greater reductions compared with placebo, ranging from 0.7 to 3.4 cm. Pooled results also showed orlistat-treated patients achieved greater reductions in total cholesterol levels by 0.33 mmol/L. Positive results for low density lipoproteins were of a similar order, but more marginal for triglycerides; the high density lipoproteins, which are the "good" cholesterol, were marginally reduced. In addition, nine of the trials showed a decrease in blood pressure with orlistat and five had statistically significant lower fasting blood glucose levels.

In four of the studies, a second year was spent studying weight maintenance. Orlistat-treated patients regained 7 to 22% less weight than those on placebo therapy. Gastrointenstinal adverse events were the most commonly reported, e.g., fecal incontinence in eight of the studies; in the three studies reporting incontinence as a separate end-point, the incidence was 6% higher in orlistat-treated patients. No study reported clinical vitamin deficiency as an endpoint.

A recent review of RCTs confirmed the positive assessment by Cochrane of orlistat's effectiveness for weight loss and other risk factor reduction.[446]

Cochrane also reviewed three sibutramine weight loss studies, which showed an average reduction of 4.3 kg (4.6%) greater than in placebo therapy after 12 months, or somewhat higher than with orlistat. Sibutramine-treated patients also demonstrated larger reductions in WC (4 to 5 cm), waist-to-hip ratio and body mass index (BMI). Most biomarkers were not significantly different between intervention and control, except for triglycerides (0.18-0.23 mmol/L lower with the drug) and the "good" high-density lipoproteins (marginally elevated). Sibutramine was also tested in two weight maintenance studies, where it performed better than placebo (27% more patients maintained at least 80% of their original weight loss). Adverse effects included statistically significant increases in blood pressure and pulse rates.

The weight loss results for orlistat and sibutramine are consistent with previous health technology assessments which reviewed studies up to June 2000,[447,448] as well

[445] Padwal R, Li SK, Lau DCW. Long-term pharmacotherapy for obesity and overweight Cochrane Metabolic and Endocrine Disorders Group *Cochrane Database of Systematic Reviews*, 2004.
[446] Hutton B, Fergusson D. Changes in body weight and serum lipid profile in obese patients treated with orlistat in addition to a hypocaloric diet: a systematic review of randomized clinical trials *American Journal of Clinical Nutrition.* 2004; 80(6):1461-1468.
[447] O'Meara S, Riemsma R, Shirran L et al. A rapid and systematic review of the clinical effectiveness and cost effectiveness of orlistat in the management of obesity *Health Technology Assessment* 2001; 5(18).

as an assessment dating from May 2004.[449] As well, a meta-analysis of 108 studies in 2002 confirmed that modest weight losses is all one can expect with any drug.[450]

The Cochrane review asks the pertinent question: is the mild degree of weight loss of benefit? Various kinds of studies have shown that even modest weight loss (5 to 10% of original weight) leads to an improvement in cardiovascular risk factors such as high cholesterol and high blood pressure. The results of the Cochrane review are consistent with such findings. What is missing from the literature are RCTs strongly linking weight loss to reduced cardiovascular events and related mortality.[451]

The best evidence for a link between weight loss and reduced disease burden has been in the context of diabetes where lower incidence and associated mortality have been achieved with drugs such as metformin and acarbose[452] over medium-term follow-up periods (2.5 to 3.3 years). The studies showed a modest weight loss, which may have contributed to the preventive effect.[453,454] The suggestion of these and other studies is that even a small amount of weight loss (less than 5 kg in some cases) can be associated with a significant reduction in the incidence of diabetes (and related mortality), though no direct connection has yet been made (based on RCTs) between weight loss and a reduced burden of diabetes or any other specific disease.

Even modest weight loss (5 to 10% of original weight) leads to an improvement in cardiovascular risk factors such as high cholesterol and high blood pressure.

Other Drugs

There are many other weight loss drugs being investigated, especially those in the same category as sibutramine, i.e., suppressing appetite through interfering with the neurotransmission of norepinephrine, dopamine and serotonin. Some of these agents are approved for short-term use in appetite suppression, but there are frequent adverse side effects. No high-quality studies exist for any of these products that met the Cochrane criteria of at least one-year follow-up.

Two drugs used in the treatment of diabetes, which is often associated with obesity, have been connected with weight loss. Metformin helps regulate glucose levels and acarbose inhibits the digestion of starch and sucrose. These drugs are sometimes used as diet aids, but neither drug is officially approved as a therapy for weight loss per se.

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[448] O'Meara S, Riemsma R, Shirran L et al. The clinical effectiveness and cost effectiveness of sibutramine in the management of obesity: a technology assessment *Health Technology Assessment* 2002; 6(6).

[449] Avenell A, Broom J, Brown TJ et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement *Health Technology Assessment* 2004; 8(21).

[450] Haddock CK, Poston WSC, Dill PL et al. Pharmacotherapy for obesity: a quantitative analysis of four decades of published randomized clinical trials International *Journal of Obesity and Related Metabolic Disorders* 2002; 26: 262-73.

[451] Padwal R, Li SK, Lau DCW. Long-term pharmacotherapy for obesity and overweight Cochrane Metabolic and Endocrine Disorders Group *Cochrane Database of Systematic Reviews*, 2004.

[452] Note that these drugs do not cause weight loss directly, but rather enhance insulin availability.

[453] Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin *New England Journal of Medicine* 2002; 346: 393-403.

[454] Chiasson JL, Josse RG, Gomis R et al. Acarbose for prevention of type 2 diabetes mellitus: the STOP-NIDDM randomised trial *The Lancet* 2002; 359: 2072-7.

Three RCTs with metformin from the 1990s were reviewed by the Health Technology Assessment; all three showed modest weight loss at 12 months, and a longer term project (UK Prospective Diabetes Study) demonstrated small losses at 5, 10 and 15 years.[455] In 2002, some evidence for weight reduction was demonstrated for both metformin and acarbose used in patients at risk for developing diabetes.[456,457] The 2002 acarbose study was the only one included by the Health Technology Assessment (HTA) program. Neither drug made it into the Cochrane review, and the conclusion of HTA is that both were relatively ineffective for weight loss therapy.

Surgical Treatment

Bariatric surgery[458] is considered an intervention of last resort with morbid obesity, where patients have attempted other forms of medical management. Morbid or severe obesity is usually defined as a BMI of 40 or more, or 35 or more with serious comorbidities.[459] Approximately 3% of Canadian and US adults are morbidly obese, with the rate in the UK being somewhat lower.[460,461]

The main surgical procedures for morbid obesity resistant to other therapies include biliopancreatic diversion[462], gastric bypass[463], gastroplasty[464], and gastric banding[465], though many variations exist.[466] Jejunoileal bypass[467] is an older procedure no longer recommended in the US or Europe due to poor safety. The aim with each procedure is to restrict intake and /or malabsorption of food, with, it is hoped, a consequent modification of eating behaviour, i.e., smaller

Surgery is considered an intervention of last resort with morbid obesity, where patients have attempted other forms of medical management.

[455] Avenell A, Broom J, Brown TJ et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement *Health Technology Assessment* 2004; 8(21).
[456] Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin *New England Journal of Medicine* 2002; 346: 393-403.
[457] Chiasson JL, Josse RG, Gomis R et al. Acarbose for prevention of type 2 diabetes mellitus: the STOP-NIDDM randomised trial *The Lancet* 2002; 359: 2072-7.
[458] Surgery on the stomach and/or intestines to help the patient with extreme obesity lose weight.
[459] National Institute for Clinical Excellence. *Guidance on the Use of Surgery to Aid Weight Reduction for People with Morbid Obesity.* Technology Appraisal Guidance 46, 2002.
[460] Colquitt J, Clegg A, Sidhu M et al. Surgery for morbid obesity *Cochrane Database of Systematic Reviews*, 2003.
[461] Trakas K, Oh PI, Singh S et al. The health status of obese individuals in Canada *International Journal of Obesity & Related Metabolic Disorders* 2001; 25(5): 662-8.
[462] A surgical procedure which diverts pancreatobiliary secretions via the small intestine into the large intestine, the remaining small intestine being grafted to the stomach after removal of half of the stomach.
[463] Surgical procedure in which the stomach is transected high on the body. The resulting stomach portion is grafted to a loop of the small intestine.
[464] Surgical treatment of the stomach to reduce it's size.
[465] A gastric band device is introduced into the abdomen and is placed around the upper part of the stomach. The resulting pouch (or the "new stomach") dramatically reduces the functional capacity of the stomach.
[466] Colquitt J, Clegg A, Sidhu M et al. Surgery for morbid obesity *Cochrane Database of Systematic Reviews*, 2003.
[467] A surgical procedure consisting of the grafting of two parts of the intestine in order to bypass the nutrient-absorptive segment of the small intestine.

quantities of food consumed more slowly.[468] All such surgeries are considered major interventions with risks of significant morbidity and perioperative mortality. Techniques such as vertical banded gastroplasty[469], which can be done laparoscopically (i.e., small incisions and camera-guided), demonstrate fewer complications than open surgery and a shorter recovery period.[470] Whatever the side effects, they are generally thought to be outweighed by the benefits.[471]

A recent Canadian study followed two cohorts of morbidly obese patients for a maximum of 5 years; the treatment group (n=1,035) underwent bariatric surgery, whereas the age- and gender-matched control group (n=5,746) were not surgically managed. The initial excess weight loss with surgery was 67% (no weight loss data was reported for the control group).[472]

A UK review from 1997 concluded that all types of surgical interventions, and especially gastric bypass and vertical banded gastroplasty, were effective (though the included studies were rated poor in quality).[473] The effectiveness of bariatric surgery for weight loss and other health benefits was confirmed over *10-year* follow-up in a 2004 controlled study in Sweden.[474]

The 18 studies included in the most recent Cochrane review mostly compared different surgical procedures.[475] Ordered by decreasing weight loss effect, the surgeries would currently be evaluated as follows: gastric bypass>gastric banding>vertical banded gastroplasty>horizontal banded gastroplasty. These results were confirmed by the NICE review mentioned above, as well as by the extensive Health Technology Assessment review of 2002.[476] In all cases the superiority of gastric bypass for weight loss was noted, along with the fact that it is a technically demanding operation.

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[468] Restrictive surgery, which includes gastroplasty and gastric banding, reduces the size of the stomach so that the patient feels full with less food. Malabsorptive procedures, which include biliopancreatic bypass and gastric bypass, parts of the gastrointestinal tract are surgically bypassed so that absorption of food is limited. National Institute for Clinical Excellence. *Guidance on the Use of Surgery to Aid Weight Reduction for People with Morbid Obesity.* Technology Appraisal Guidance 46, 2002.

[469] Creation of a small pouch in the upper stomach with a narrow outlet reinforced by a mesh band to prevent stretching. The pouch fills quickly and empties slowly with solid food, producing a feeling of fullness. This restricts food intake.

[470] Colquitt J, Clegg A, Sidhu M et al. Surgery for morbid obesity *Cochrane Database of Systematic Reviews*, 2003.

[471] National Institute for Clinical Excellence. *Guidance on the Use of Surgery to Aid Weight Reduction for People with Morbid Obesity.* Technology Appraisal Guidance 46, 2002.

[472] Christou NV, Sampalis JS, Liberman M et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. Annals of Surgery 2004; 240(3): 416-23.

[473] NHS Centre for Reviews and Dissemination. *Systematic Review of Interventions in the Treatment and Prevention of Obesity*, 1997.

[474] Sjostrom L, Lindroos AK, Peltonen M et al. Swedish Obese Subjects Study Scientific Group. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *New England Journal of Medicine.* 2004; 351(26):2683-93.

[475] Colquitt J, Clegg A, Sidhu M et al. Surgery for morbid obesity *Cochrane Database of Systematic Reviews*, 2003.

[476] Clegg AJ, Colquitt J, Sidhu MK et al. The clinical effectiveness and cost-effectiveness of surgery for people with morbid obesity: a systematic review and economic evaluation *Health Technology Assessment* 2002; 6(12).

Based on the limited evidence, the comparative safety and effectiveness of different surgical procedures remains uncertain. As a comparison, a 2004 meta-analysis of a much wider range of studies yielded somewhat different results for the comparative effectiveness of procedures, as measured by the percentage of excess weight loss:[477]

Type of surgery	*% excess weight loss*
Biliopancreatic diversion	70.1
Gastroplasty	68.2
Gastric bypass	61.6
Gastric banding	47.5

The focus of this meta-analysis was primarily the impact of bariatric surgery on co-morbidities. The results showed that diabetes was resolved in 76.8% of patients and hypertension was resolved or improved in 78.5%.

Laparoscopic versus open methods of surgery, when used with the same procedure, showed no difference in weight loss.[478]

Regulatory and Economic Interventions

Nutrition Labelling / 'Signposting'

The existing regulations for nutrition labels on package foods is already very clear and comprehensive (see *2003 Guide to Food Labelling and Advertising*[479]). Labels using a standard format for ingredients and quantities per recognized unit weight have been mandated by the Dietitians of Canada, and companies need to comply by 2007. However, there are advocates who want to see the system extended beyond the current applications.

A major Canadian legislative initiative, Bill C-398, was withdrawn in March, 2004, for further study. In addition to expanded nutrition labelling on meat and processed foods, it would have required fast food chains to post the calorie content next to items on menu boards, and full-service restaurant chains to disclose the saturated fat, trans fat and sodium levels of its meals. One of the responses of the Canadian restaurant industry was to point out that voluntary nutritional changes were already happening, e.g., low fat and low-carbohydrate menu options, the elimination of trans fats in some settings, and promotions focusing on healthy lifestyles.[480]

In nutritional signposting, food manufacturers whose products meet defined nutritional criteria are allowed to display a logo on the product. In New Zealand, a

[477] Buchwald H, Avidor Y, Braunwald E et al. Bariatric surgery: a systematic review and meta-analysis *Journal of the American Medical Association* 2004; 292(14): 1724-37.
[478] National Institute for Clinical Excellence. *Guidance on the Use of Surgery to Aid Weight Reduction for People with Morbid Obesity.* Technology Appraisal Guidance 46, 2002.
[479] Available at http://www.inspection.gc.ca/english/fssa/labeti/guide/toce.shtml (accessed February 2005).
[480] News release at http://www.crfa.ca/newsroom/2004/menu_labelling_legislation.asp (accessed November 2004).

signposting campaign in concert with the food industry to reduce the amount of salt saw substantial reductions of salt in breads, breakfast cereals and margarine.[481]

The main caution with signposting is the confusion that can result if every food company or store creates their own system; legislation to create consistent criteria and symbols would be prudent.

Food Regulation

Trans fat, a by-product of fat hydrogenation, is found in 40,000 food products. Used for over 75 years, it has recently been shown to increase the risk of heart disease.

On November 23, 2004, the Canadian Parliament voted to set up a task force to recommend ways to reduce trans fats "to the lowest possible levels."[482] Although exploring such approaches is on the agenda of other countries, so far only Denmark has banned partially hydrogenated oil in its food supply (in 2003). The fast food industry in that country has adapted to the new regulations.

By 2005, Canada will have the most stringent nutrition label requirements in the world.[483] Health Canada estimates that the new labels could save over $5 billion in direct and indirect costs over 20 years. The food industry suggests that the fact that trans fat levels will appear on all processed food products should be sufficient government intervention to protect consumer health.

Taxation and Other Economic Levers

Fats contain approximately double the amount of calories per gram than carbohydrates or protein, making them a highly dense form of energy. Certain animal or saturated fats may be more harmful than those derived from plants and fish. So, apart from the direct health impact of consuming fats that elevate serum cholesterol levels (e.g., saturated fats, trans fats), excessive intake of all forms of energy-dense fat may be a problem in terms of creating overweight. One suggested regulatory response to this scenario has been to tax high-fat foods in a targeted manner similar to tobacco taxation. In 2003, the British Medical Association recommended a 17.5% value-added tax on fatty foods; an earlier estimate suggested that such a policy could save up to 1,000 premature deaths a year in the UK.[484] Similar taxes have been proposed for foods that are high in sugar.[485] Perhaps the most likely proposal in B.C. is a tax imposed on soft drinks and other snack foods, similar to that already seen in the past in several US states (though two-thirds of them repealed the tax in the 1990s).[486] This coincides with the double reality that evaluating high-fat foods is a complex undertaking, and that the real culprits in obesity (and other aspects of poor health) is

> The British Medical Association recommended a 17.5% value-added tax on fatty foods.

[481] Young L, Swinburn B. Impact of the Pick the Tick food information programme on the salt content of food in New Zealand. *Health Promotion International* 2002; 17: 13-19.
[482] News report at http://www.google.ca/search?q=cache:jLJMDtoFQDIJ:news.tradingcharts.com/futures/6/0/61439406.html+canada+votes+to+ban+trans+fats&hl=en (accessed December 2004).
[483] News report at http://www.cbc.ca/news/background/food/foodlabels.html (accessed December 2004).
[484] News report at http://news.bbc.co.uk/1/hi/health/2973914.stm (accessed December 2004).
[485] Jacobson M, Brownell KD. Small taxes on soft drinks and snack foods to promote health. *American Journal of Public Health* 2000; 90: 854-7.
[486] Jacobson MF, Brownell KD. Small taxes on soft drinks and snack foods to promote health. *American Journal of Public Health.* 2000; 90(6):854-7.

energy-dense, nutrient-lacking food sources. As the BC Nutrition Survey of 1999 confirmed, 30% of the province's energy intake comes from outside the four recommended food groups, i.e., from foods such as donuts, alcohol and candy.[487]

Directing consumers towards low-fat foods using price controls also may not automatically reduce the obesity problem. A 2003 study noted that when people chose low-fat foods they tended to eat larger portion sizes so that almost the same amount of energy was consumed compared to those opting for high-fat foods.[488]

Review articles have suggested a more complex relationship between portion size and energy density, possibly even a moderating effect linked to the *order* in which food types are consumed.[489]

Although much more research is needed, some studies have shown that combining advice to eat more vegetables and fruit with advice to eat less fat is an effective intervention for weight management.[490] From a regulatory point of view, it would be potentially effective to extend what is known from smaller scale settings such as school cafeterias to the macro-level, i.e., subsidize fruits and vegetables or otherwise lower their cost in order to stimulate purchase rates. This "eat more" strategy has the additional advantage of reflecting a positive behavioural message, similar to "exercise more," which may be more psychologically palatable and powerful than prohibitions, i.e., "eat less fat and sugar."

A different economic approach than taxation is to provide individual families with the means to purchase better food. As the Dietitians of Canada report *The Cost of Eating in BC* notes: "Those living on income assistance are three times more likely to report food insecurity."[491] Given the strong link between lower socioeconomic status and both poor diet and obesity, policies that address inadequate incomes could contribute to more healthy living, including weight management.[492]

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[487] BC Ministry of Health Services, 2004. Forster-Coull L, Barr SI, Levy-Milne R. *British Columbia Nutrition Survey: Report on Energy and Nutrient Intakes.*

[488] Matthiessen J, Fagt S, Biltoft-Jensen A et al. Size makes a difference *Public Health Nutrition* 2003; 6(1): 65-72.

[489] Kral TV, Rolls BJ. Energy density and portion size: their independent and combined effects on energy intake *Physiology & Behavior* 2004; 82(1): 131-8.

[490] Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between vegetable and fruit consumption and weight management? *Nutrition Reviews* 2004; 62(1): 1-17.

[491] Report available at http://www.bcasw.org/currentnewsPDF/coeibc2004_fullreport.pdf (accessed February 2005)

[492] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.

Interventions to Increase Energy Expenditure

Research on the relationships between physical inactivity and health is complex due to the variety of interventions, activity measures and target outcomes that can be considered.

The concept of exercise itself, for example, needs to be fine-tuned. Experts identify three types of activities to maintain a healthy body: endurance, flexibility and strength exercises. Even choosing to focus on the general category of physical activity is not so simple, because it needs to be distinguished from various forms of physical *fitness*. Nevertheless, the most commonly targeted risk factor in this area is basic physical inactivity or sedentariness as measured by the time spent during the day in certain types of work-related functions or leisure-time exercise.

The rationale for pursuing exercise in weight control includes the evidence that maintenance of weight loss is enhanced with adherence to exercise programs.[493] There is also a theoretic base for utilizing exercise in weight reduction. Energy is expended in the body in a number of ways:[494]

- thermic effect of physical activity; this can range from 0% of total expenditure to more than 50% in elite athletes
- thermic effect of food (10-15% of expenditure relates to digestion and absorption)
- resting metabolic rate, the amount of energy needed to maintain the structure and function of the body, accounting for 60-70% of all expenditure

Exercise can increase the expenditure in each of these pathways, as well as sometimes affecting the other side of the equation and reducing energy (i.e., food) intake; the latter effect may be primarily psychological, i.e., improved body image, self-esteem and mood allowing for better adherence to healthy eating.

Standard guidelines for physical activity commonly suggested 30 minutes or more of moderate-intensity physical activity on all, or most, days of the week; the recommended length of time per day has recently been increased to 60 minutes, especially for children.[495,496] The following are considered examples of moderate-intensity physical activities:[497] normal walking, golfing on foot, slow biking, raking leaves, cleaning windows and light restaurant work. Jogging, brisk walking, shovelling snow and racquet sports are examples of vigorous activities.

Recommended: 30 minutes or more of daily moderate-intensity physical activity such as walking

[493] Shaw K, Del Mar C, O'Rourke P et al. Exercise for obesity *Cochrane Database of Systematic Reviews*, 2004.
[494] Shaw K, Del Mar C, O'Rourke P et al. Exercise for obesity *Cochrane Database of Systematic Reviews*, 2004.
[495] See, for example, the US Surgeon General's *Call to Action to Prevent and Decrease Overweight and Obesity*, 2001. Available at http://www.surgeongeneral.gov/topics/obesity/ (accessed November 2004).
[496] Nutrition Recommendations for Canadians: Draft Recommendation on Energy. Available at http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/comment_period_rec_on_energy_e.pdf (accessed November 2004).
[497] A moderate amount of physical activity uses approximately 150 Calories (kcal) of energy per day, or 1,000 Calories per week.

The benefits of more strenuous exercise must be weighed against potential adverse effects, including injury, osteoarthritis and myocardial infarction. As another incentive for following a moderate daily regime, data has shown that risks associated with occasional vigorous exercise decrease when a person is engaged in regular physical activity.[498]

Data Sources

Several reviews will be consulted to evaluate the effectiveness of interventions aimed at increasing the level of physical activity. Cochrane is just beginning its work in this area. Of the 36 reviews in their database with either "exercise" or "physical activity" in the title, most are related to activity as an intervention in itself for various disease conditions, and only a few looked at physical activity as a preventive measure. The projects examining interventions that promote physical activity are still in the protocol stage.

> *"Physical activity is perhaps the most obvious of the variables which might reduce overall lifetime morbidity."*
> Fries J. Physical activity, the compression of morbidity, and the health of the elderly *Journal of the Royal Society of Medicine* 1996; 89(2): 64-68.

The Canadian Task Force on Preventive Health Care (under its previous title, the Canadian Task Force on the Periodic Health Examination) offered a brief review of promotion in the primary care setting in 1994.[499] A more extensive review of interventions to increase physical activity was completed in 2001 by the US Task Force on Community Preventive Services (TFCPS), the group which also contributed a valuable synthesis of data on smoking interventions used in the previous section of this report. This provided an update of the literature review in the landmark US Surgeon General report of 1996, *Physical Activity and Health.* The UK Health Development Agency, which is cautious about some of the non-experimental studies included by the TFCPS, offers a useful "review of reviews" to test and augment the conclusions reached by the US Task Force.

The TFCPS divides the interventions to increase physical activity into four major categories, the last two still being under development:

- informational approaches,
- behavioural and social approaches,
- environmental and policy approaches, and
- urban planning approaches.

The TFCPS outline will be adapted to fit the grid which has been developed in previous sections.[500]

As has been the pattern in this report, each intervention will be briefly described and the evidence base outlined. In the end, many of the interventions currently

[498] Beaulieu MD. Physical activity counselling. In: Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada, 1994.
[499] Beaulieu MD. Physical activity counselling. In: Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada, 1994.
[500] Source: http://www.thecommunityguide.org/pa/default.htm (accessed November 2004). Also in Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.

demonstrate a scarcity of high-quality research data and / or a lack of consistent positive effect on physical activity behaviour.

Community-based Interventions

These interventions are large-scale, intense projects with messages directed to large audiences through different types of media, including radio and television, newspapers, billboards and mailings. The information transferred is meant to change knowledge about the benefits of physical activity, enhance awareness of opportunities to increase physical activity, and explain methods for overcoming barriers and negative attitudes impeding access to those opportunities.[501]

Community-wide campaigns have typically been a multi-component effort that also included support groups, counselling, risk factor screening and education, community events, and environmental efforts such as creating new walking trails or building exercise facilities. A complication of such interventions is the impossibility of isolating individual components for evaluation.

In a review of 10 studies, community-wide campaigns were effective in increasing physical activity, with the pooled results suggesting a median 4% growth in the proportion of people who were active.[502] This result seems to contradict the 3 well-known field trials conducted in the US in the 1980s; the studies (2 of which were included in the 10 studies noted above) were all geared towards reducing cardiovascular disease and included a range of interventions. Generally, the effectiveness of these and other community-wide approaches were described by the US Surgeon General report as "disappointing" as the gains in physical activity were mixed and, when present, modest.[503] The US Surgeon General report depended on a more limited range of studies; the pessimistic conclusion may reflect the original high hopes that surrounded the launch of these large-scale, expensive projects. The "bottom-line" is that 4% growth in physical activity, though significant, would have to be described as modest.

Mass Media Campaigns

Promotional and informational campaigns can use various media to reach a large, undifferentiated audience. These interventions are distinguished from community-wide projects by the absence of other intervention components.

One review found only 3 relevant studies. The outcome measures were the percentage of people doing a specified level of activity, change in energy expenditure and /or the percentage of the population which was sedentary. Some but not all measures showed a modest trend towards increasing levels of physical activity. The

[501] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[502] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[503] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996.

TFCPS rated the small number of studies as low in quality, and recommended caution around this intervention.[504]

The US Surgeon General report also concluded that mass media campaigns have had little impact on physical activity rates in populations.[505] However, given the intense commitment to and effectiveness of advertising in other spheres (e.g., marketing unhealthy lifestyles), it does not seem prudent to abandon this mode of intervention quite yet. The fact is that each media campaign is unique, and the most effective ones may still be in the future.

A promising example is the *10,000 steps* initiative in various jurisdictions, which has sometimes been paired with pedometer (step counter) give-aways.[506] Although the research is still at an early stage,[507] many people can reach 10,000 steps a day by adding a 30-minute walk to their other routines, which can lead to significant health benefits, including weight loss.[508] Dr. Plotnikoff of the University of Alberta is testing four different strategies to encourage people with type 2 diabetes to get regular physical activity, including the use of pedometers combined with booklets to record the number of steps taken each day.[509] A much larger "natural experiment" was launched across Canada a year ago which involved the distribution of thousands of pedometers, mass advertising and a web-based evaluation system.[510]

Point-of-Decision Prompts

Signs can be placed by elevators and escalators that encourage people to use nearby stairs, with messages stressing either health benefits or weight loss. Note that this intervention can also be categorized under regulatory and economic approaches (see below).

Point-of-decision prompts increase healthy behaviour choices

In 5 single-intervention studies (i.e., only looking at the effect of the signs), posted messages were found to increase the number of people using stairs. Baseline rates of stair use were generally low, ranging from 4.8% to 39.6%. Adding point-of-decision prompts increased stairway usage by an average of 54%.[511]

Individually-Adapted Health Behaviour Change

These interventions focus on teaching behavioural management skills, usually in the context of social environments structured to support individuals making changes. Group or individual behavioural counselling is often part of the intervention,

[504] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[505] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996.
[506] For example, see the description of the Queensland, Australia project at http://www.centre4 activeliving.ca/Publications/WellSpring/2003/ Spring/10000Steps.html (accessed December 2004).
[507] Tudor-Locke C, Bassett DR. How many steps/day are enough? Preliminary pedometer indices for public health *Sports Medicine* 2004; 34(1): 1-8.
[508] See for example the results summarized on the website at http://www.diabetesincontrol.com/ studies/steps.pdf (accessed December 2004).
[509] For details see http://www.google.ca/search?q=cache:XdB6dQ1gXBIJ:www.cihr-irsc.gc.ca/e/ 25276.html+british+columbia+pedometers&hl=en (accessed December 2004).
[510] CIHR Institute of Nutrition, Metabolism and Diabetes (at Simon Fraser University). Available at http://www.cihr-irsc.gc.ca/e/18058.html (accessed December 2004).
[511] Task Force on Community Preventive Services. Available at http://www.thecommunityguide.org/pa/ default.htm (accessed November 2004).

typically with involvement by friends or family. These kinds of interventions sometimes are found in the home, school, or work environment.

There are behaviour change programs that teach skills to individuals to help them incorporate physical activity into everyday life. The programs, which usually are tailored to individual interests and readiness for change, include goal-setting, building social support, problem-solving and relapse resistance.

"Just like athletes, British Columbians will need 'coaches', venues and supportive policies to adopt healthier lifestyles." Standing Committee on Health, *The Path to Health and Wellness: Making British Columbians Healthier by 2010.* November 2004.

All of the interventions evaluated by the TFCPS were delivered in group settings or by mail, telephone and other directed media. In 18 studies, behaviour change maneuvers directed at individuals were effective in increasing physical activity as measured by various indicators. The median estimates based on pooled results indicated a 35% increase in the time spent being physically active and 64% increase in energy expenditure. The studies recruited participants from communities, workplaces and schools. A limitation in this review was the lack of information about length of follow-up.[512]

As a comparison, the UK Health Development Agency noted two reviews covering a total of 13 RCTs where individuals were drawn from the community for treatment. Interventions included: weekly group counselling, mailed self-help materials (some based on the stage-of-change approach), exercise testing and prescription, telephone advice and support, supervised exercise in a facility, and behaviour modification. The evidence suggested the following conclusions:[513]

- interventions targeting individuals are effective in producing short-term changes in physical activity, and could even be effective over longer terms (though, according to the US Surgeon General review, the evidence for sustained changes is not strong)

- sustained changes are most likely with behavioral modification skills adapted to individual needs and /or regular contact with an exercise specialist

- longer-term changes are possible with a focus on moderate intensity physical activity such as walking; recourse to vigorous sport or exercise facilities is not essential for health benefits[514]

Sustained changes are most likely with behavioral modification skills adapted to individual needs and /or regular contact with an exercise specialist.

[512] Task Force on Community Preventive Services. Available at http://www.thecommunityguide.org/pa/default.htm (accessed November 2004).
[513] Hillsdon M, Foster C, Naidoo B et al. *The Effectiveness of Public Health Interventions for Increasing Physical Activity* Health Development Agency, 2004.
[514] A study has shown that those with the highest cardiorespiratory fitness levels consistently walked more than those with lower levels. Stofan JR, DiPietro L, Davis D et al. Physical activity patterns associated with cardiorespiratory fitness and reduced mortality: the Aerobics Center Longitudinal Study *American Journal of Public Health* 1998; 88(12): 1807-13.

Community (Non-Family) Social Support

There are interventions that focus on building and maintaining social networks that support behaviour change, e.g., buddy systems, walking groups, and workplace networks.

A review identified 9 relevant studies, the majority of which showed an increase in the time spent in, or frequency of, physical activity. The median net increase in time spent in physical activity increased by a range of 20-44%.[515]

Workplace-based Interventions

Workplaces have been seen to afford unique opportunities to enhance physical activity levels for the same reasons that tobacco control is often emphasized in such settings. One of the main attractions is simply the amount of time people spend at work, creating an accessible population possibly open to health promotion initiatives.

Examples of interventions, which are mostly directed at individuals, include:[516]

- health screening and counselling for physical activity
- goal-setting, reinforcement and relapse prevention
- testing, prescription and instruction at workplace fitness facilities

The TFCPS did not isolate the workplace as a platform for physical activity enhancement, though some occupational results are incorporated in its other categories. This lack of focus is perhaps surprising in that workplace physical activity programs are reported to reduce short-term sick leave and health care costs and increase productivity.[517] It is true, on the other hand, that the evidence support for such claims appears to be meager. The same is true for overall obesity control: "very little literature explicitly addresses the promotion of healthy weights through worksite policies."[518]

Workplace programs were evaluated in the Surgeon General report, as well as by one other major review article. [519] The conclusion is that typical workplace interventions have yet to demonstrate a significant increase in physical activity or fitness. One reason for this might be low program participation rates by employees.

Some research has examined ecological or multi-level approaches in the workplace.[520] The theoretical framework, which is not particular to occupational

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[515] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10

[516] Dishman RK, Oldenburg B, O'Neal H et al. Worksite physical activity interventions *American Journal of Preventive Medicine* 1998; 15(4): 344-61.

[517] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996.

[518] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.

[519] Dishman RK, Oldenburg B, O'Neal H et al. Worksite physical activity interventions *American Journal of Preventive Medicine* 1998; 15(4): 344-61.

[520] Stokols D, Pelletier KR, Fielding JE. The ecology of work and health: research and policy directions for the promotion of employee health *Health Education Quarterly* 1996; 23(2): 137-58.

settings or physical activity, looks at improving a health category across a whole system in a community. The levels which can be identified include:[521]

- intrapersonal or individual factors, e.g., employee fitness level
- interpersonal or social factors, e.g., peer and boss influences
- institutional / organizational / cultural factors, e.g., the leadership commitment to promoting physical activity
- community factors, e.g., integration with wider physical activity campaigns
- public policy, e.g., governmental incentives for focusing on physical activity

Note that the physical environment is meant to be incorporated in the other levels.

Many institutional level interventions have been suggested for physical activity in the workplace, including:[522]

- providing activity breaks
- encouraging "walking meetings"
- on-site exercise facilities or reimbursement for off-site access
- incentives for employees who "active commute" by bicycle, etc.
- install lockers, showers and convenient bike storage
- attractive stairwells conveniently located
- communication and collaboration with employees to value health
- friendly competition and rewards for group success

According to the Alberta Centre for Active Living, the ecological or multi-level approach to workplace physical activity intervention holds the greatest promise for increasing participation rates and activity levels; no experimental or other evidence is offered to support this claim.[523]

School-based Interventions

There are curricular programs in schools which focus on providing information about physical activity. These health education classes, which typically also address other issues such as smoking and nutrition, are often aimed at the behavioural skills for good decision-making.

A review of 10 studies showed highly variable effects, with a balance between intervention groups which showed increased physical activity and those which showed negative changes in self-reported behaviour.[524]

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[521] McElroy KR, Bibeau D, Steckler A et al. An ecological perspective on health promotion programs *Health Education Quarterly* 1988; 15: 351-377.
[522] *Fruits and Vegetables and Physical Activity at the Worksite*. California 5 a day Worksite Program, no date. Available at http://www.phi.org/pdf-library/dhs-worksite.pdf (accessed November 2004).
[523] Program description at http://www.centre4activeliving.ca /Research/2003Workplace/ BeforeYouStart.htm (accessed November 2004).
[524] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22 (Suppl 4): 73-10.

One systematic review from 2002 found 2 physical activity trials that specifically measured BMI changes. No significant improvements were noted in the students of the intervention groups.[525]

School-based Physical Education

Programs exist which seek to change physical education curricula to make physical education classes longer and / or more frequent, or to have students be more active during the class while at the same time enhancing the health education aspects.

Of the 13 studies identified in one review, 4 specifically measured time spent in moderate to vigorous physical activity in class and found an average increase in time was 50%. A total of 11 studies reported a significant increase in aerobic capacity.[526] These sorts of results have been part of the motivation for extensive physical education advocacy initiatives in North America, for example, PE4Life.[527]

College-age Physical and / or Health Education

Programs exist on campuses which are geared to educate post-secondary students about physical activity and encourage participation. Both a behavioural change component and actual supervised physical activity are usually included.

Only 2 studies were found in one review, with consistent increases in physical activity in the short-term, but a decline back to baseline at 2 year follow-up.[528]

Home-based Interventions

The most successful of the behavioural change programs adopted a home-based supervised physical activity, where the supervision was delivered by telephone and supported by printed material. The telephone support may be crucial; an Australian study published in 2004 showed no benefit at 2 and 8 month follow-up with stage-of-change physical activity materials which were simply mailed to participants.[529] The US Surgeon General report of 1996 confirms that most effective intervention components use frequent telephone contact as well as self-monitoring and incentives.[530]

Health Education to Reduce TV Viewing & Video Game Playing

Some interventions have focused on educating children about the importance of physical activity in combination with a behavioural challenge to eliminate or reduce time in front of the TV or video game screen.

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[525] University of York. The prevention and treatment of childhood obesity *Effective Health Care* 2002; 7(6).

[526] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.

[527] Website available at http://www.pe4life.org/ (accessed November 2004).

[528] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.

[529] Marshall AL, Bauman AE, Owen N et al. Reaching out to promote physical activity in Australia: a statewide randomized controlled trial of a stage-targeted intervention *American Journal of Health Promotion* 2004; 18(4): 283-7.

[530] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996. See also King AC. Role of exercise counselling in health promotion *British Journal of Sports Medicine* 2000; 34: 80-1; and the review in Castro CM, King AC. Telephone-assisted counseling for physical activity *Exercise & Sport Sciences Reviews* 2002; 30(2):64-8.

A review of 3 studies, though observing sizable decreases in time spent with television and video games, did not see a consistent, significant concomitant increase in physical activity.[531]

In a 1999 study, Robinson provided curricular material geared to reduce time watching television and other video material, and found significant change in body fat measures after 7 months.[532] Although the result is being reported in the physical activity section of this report, reflecting the assumption that a reversal of sedentariness mediated the weight changes, it very well could represent a combined intervention which includes dietary improvements. As a November, 2004, review concluded: "the usual depiction of food and obesity in television has many documented negative consequences on food habits and patterns."[533]

Involvement of Family Members

Programs can enlist the involvement of family members, sometimes with specific enhancements to encourage support of each subject receiving the main physical activity intervention. The supportive relationship can be between parents and children or between spouses. Interventions typically include joint or separate educational sessions on health, goal-setting, problem-solving, or family behavioural management. Actual physical activity may be included, plus other events if the intervention is linked to a wider school program. The combination of techniques makes it difficult to isolate the family support component.

A review of 11 studies demonstrated mixed evidence, with some producing more physical activity and some less. When home and school interventions were specifically compared with school-only approaches, there was no difference in effectiveness.[534]

Clinical Interventions and Management

The healthcare setting is potentially significant as a high proportion of Canadians visit a physician at least annually.[535] Patients report that primary care clinicians are expected sources of preventive health information.[536] The Canadian Health Promotion Survey showed that 60% of people making improvements in physical activity levels did so because of information about the dangers of being sedentary.[537] Other surveys suggest that less than 50% of physicians counsel patients about

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[531] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[532] Robinson TN. Television viewing and childhood obesity *Pediatric Clinics of North America* 2001; 48(4): 1017-25.
[533] Caroli M, Argentieri L, Cardone M, Masi A. Role of television in childhood obesity prevention *International Journal of Obesity* 2004; 28(Suppl 3): S104-8.
[534] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[535] Wilson D, Ciliska D. Family physicians and exercise counselling; can they be influenced to provide more? *Canadian Family Physician* 1992; 38: 2003.
[536] Whitlock E, Orleans C, Pender N et al. Evaluating primary care behavioural counselling interventions: an evidence-based approach *American Journal of Preventive Medicine* 2002; 22(4): 267-84.
[537] Beaulieu MD. Physical activity counselling. In: *Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care*. Ottawa: Health Canada, 1994.

physical activity,[538] and even when it is provided, the counselling tends to be brief.[539,540]

A recent review in the UK[541] assessed the following interventions:

- brief physician advice or counselling in primary care,
- referral to exercise specialists for education and counselling, and
- input and support in outpatient clinics or health education classes

Brief Advice / Counselling

Brief advice can be effective, though only leading to modest, short-term gains in physical activity.[542,543] The best results for brief advice (sometimes with back-up material) focuses on a single-factor intervention, i.e., physical activity only, and specifically activities of moderate intensity.

The Canadian Task Force on the Periodic Health Examination suggested there was insufficient evidence to show that intensive counselling interventions by general practitioners will influence sedentary individuals to be more active.[544] This is consistent with the assessment of US Preventive Services Task Force.[545,546] Several other recent reviews have also reported on the scarcity and variability of evidence linking increased physical activity with counselling in primary care.[547,548,549] One Canadian reviewer suggested the opposite conclusion, stating that intensive and

[538] Wechsler H, Levine S, Idelson RK et al. The physician's role in health promotion revisited--a survey of primary care practitioners *New England Journal of Medicine* 1996; 334(15):996-8. Some estimates are as low as 12% of physicians prescribing exercise appropriately in their practice.
[539] Wells KB, Lewis CE, Leake B et al. The practices of general and subspecialty internists in counseling about smoking and exercise *American Journal of Public Health* 1986; 76(8): 1009-13.
[540] Walsh H. Exercise counselling by primary care physicians in the era of managed care *American Journal of Preventive Medicine* 1999; 16(4): 312.
[541] Hillsdon M, Foster C, Naidoo B et al. *The Effectiveness of Public Health Interventions for Increasing Physical Activity* Health Development Agency, 2004.
[542] Hillsdon M, Foster C, Naidoo B et al. *The Effectiveness of Public Health Interventions for Increasing Physical Activity* Health Development Agency, 2004. This report looked at 5 reviews covering 22 studies.
[543] This conclusion is fully supported in Smith BJ. Promotion of physical activity in primary health care: update of the evidence on interventions *Journal of Science & Medicine in Sport* 2004; 7(1 Suppl): 67-73.
[544] Beaulieu MD. Physical activity counselling. In: *Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care*. Ottawa: Health Canada, 1994.
[545] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. a systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.
[546] Berg AO. US Preventive Services Task Force. Behavioral counseling in primary care to promote physical activity: recommendation and rationale *American Journal of Nursing* 2003; 103(4): 101-7.
[547] Eaton CB, Menard LM. A systematic review of physical activity promotion in primary care office settings *British Journal of Sports Medicine* 1998; 32, 11-16.
[548] Eakin EG, Glasgow RE, Riley KM. Review of primary care-based physical activity intervention studies: effectiveness and implications for practice and future research *Journal of Family Practice* 2000; 49(2): 158-68.
[549] Eden KB, Orleans CT, Mulrow CD et al. Does counseling by clinicians improve physical activity? A summary of the evidence for the U.S. Preventive Services Task Force *Annals of Internal Medicine* 2002; 137(3): 208-15.

repeated counselling by primary healthcare providers can increase physical activity.[550]

Future studies may alter this ambiguous scenario, but in the meantime, guided by a spirit of "intuitive prudence" concerning the known health benefits of physical activity, many health agencies continue to recommend routine physical activity counselling in the primary care setting.[551] The conclusion of an Australian review is that "interventions in primary care will not be sufficient to increase physical activity levels in the population and need to be incorporated within multi-faceted, community-wide strategies to address this risk factor."[552]

"Interventions in primary care will not be sufficient to increase physical activity levels in the population and need to be incorporated within multi-faceted, community-wide strategies to address this risk factor."

A few studies examine efforts outside of primary care. The evidence is equivocal about interventions in an outpatient clinic, but referral to exercise specialists can produce long-term physical activity improvements; in the latter case the result depended on a personalized exercise plan and incentives (i.e., reduced costs at a recreation centre).[553] Trained nurse practitioners have conducted effective physical activity promotion teaching.[554] One other venue that has produced good results for older patients is health education classes run by well-trained counselors.[555]

Continuing Medical Education

The key intervention that has been examined at the healthcare system level is attempting to improve the physical activity counselling skills and motivation of physicians through continuing medical education or other special programs. One study noted that counselling methods adopted for physical activity are sometimes ineffective.[556]

Canadian surveys of physicians have reported the following barriers to regular, effective physical activity counselling:[557]

- time constraints

[550] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.
[551] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996.
[552] Smith BJ, Merom D, Harris P et al. *Do Primary Care Interventions to Promote Physical Activity Work?* 2002. Available at http://www.cpah.unsw.edu.au/NICS.pdf (accessed November 2004).
[553] Hillsdon M, Foster C, Naidoo B et al. *The Effectiveness of Public Health Interventions for Increasing Physical Activity.* Health Development Agency, 2004.
[554] Rehman L, Thompson A, Campagna P. *Physical Activity Counselling by Healthcare Professionals in Nova Scotia: The Need For a Consistent Message.* 2003. Available at http://www.cancercare.ns.ca/media/documents/PhysicalActivityCounsellingFinalReportJune1.pdf (accessed November 2004).
[555] Mayer JA, Jermanovich A, Wright BL et al. Changes in health behaviors of older adults: the San Diego Medicare Preventive Health Project *Preventive Medicine* 1994; 23(2): 127-33.
[556] Orleans CT, George LK, Houpt JL et al. Health promotion in primary care: a survey of U.S. family practitioners *Preventive Medicine* 1985; 14(5): 636-47.
[557] Tobin M. *Physical Activity Counselling by Health Professionals.* 2000. Available at http://www.cfpc.ca/English/cfpc/programs/patient%20care/physical%20activity/research/physical%20activity/default.asp?s=1 (accessed November 2004).

- lack of financial incentives
- lack of standard protocols
- lack of success in counselling role
- lack of appropriate training

Physicians in Canada who have been trained in physical activity counselling report greater confidence and up to a fourfold increase in the frequency of such counselling in their practice.[558,559] One recent response to the variability of protocols was the suggestion in Nova Scotia,[560] following the lead of the Canadian Task Force on Preventive Health Care, to adopt the same "5 As" format which has been used in smoking cessation:

- assess physical activity level, capacity and knowledge;
- advise about risks and benefits;
- agree on goals and a personalized action plan;
- assist in finding community resources and creating social support; and
- arrange follow-up and reinforcement[561]

Only 3 studies were found by the 1996 US Surgeon General report which looked at improving the physical activity counselling skills of physicians. The results point to small positive effects, with 7 to 10% of sedentary patients starting to be physically active.[562] One study included additional policy-level features, namely, reimbursement for counselling time and automatic reminders built into the physician's practice.[563]

Exercise Therapy

It was already noted that the Cochrane review of exercise in unhealthy weight is still in process. The available effectiveness data will be outlined, but the most significant results will be found under combined interventions in the next major section of this report. This is because it is relatively rare to find exercise studied in isolation from a modified diet.

A 1995 meta-analysis of 28 exercise studies suggested that the level of weight loss achieved by increased exercise alone, i.e., without controlling caloric intake, is small.

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[558] Wilson D, Ciliska D. Family physicians and exercise counselling; can they be influenced to provide more? *Canadian Family Physician* 1992; 38: 2003.

[559] Tobin M. *Physical Activity Counselling by Health Professionals,* 2000. Available at http://www.cfpc.ca/English/cfpc/programs/patient%20care/physical%20activity/research/physical%20activity/default.asp?s=1 (accessed November 2004).

[560] Rehman L, Thompson A, Campagna P. *Physical Activity Counselling by Healthcare Professionals in Nova Scotia: The Need For a Consistent Message,* 2003. Available at http://www.cancercare.ns.ca/media/documents/PhysicalActivityCounsellingFinalReportJune1.pdf (accessed November 2004).

[561] Estabrooks PA, Glasgow RE, Dzewaltowski DA. Physical activity promotion through primary care *Journal of the American Medical Association,* 2003; 289(22): 2913-6.

[562] *Physical activity and health: a report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, 1996.

[563] Logsdon DN, Lazaro CM, Meier RV. The feasibility of behavioral risk reduction in primary medical care *American Journal of Preventive Medicine* 1989; 5(5): 249-56.

For instance, men only lost 3 kg more than sedentary controls over 30 weeks.[564] Another meta-analysis rated weight training as a more effective exercise than running, walking or cycling; it allowed men to lose 0.13 kg per week.[565]

Although the evidence to support using exercise in weight loss is limited, large-scale cross-sectional and longitudinal studies such as the Canadian Fitness survey have shown the efficacy of exercise in weight maintenance: "people who were habitually more active were found to be less obese."[566] Thus exercise and general physical activity may have a role in preventing obesity and preventing worsening of already established overweight. Of course, it is important to remember that exercise has health benefits beyond weight reduction.

Regulatory and Economic Interventions

To affect whole populations, interventions in this category are directed to physical and organizational structures rather than to individuals. The aim is to increase physical activity through changing social networks or norms, creating new laws and policies, and sometimes enhancing community resources and facilities, or at least access to them (e.g., policies related to disability).

Various innovative but untested policy proposals have been put forward, such as removing taxes on exercise equipment and offering incentives to employers who promote physical activity and fitness.[567]

Transportation Policy to Encourage Non-Motorized Transit

Several agencies are conducting major review projects on the connection between transportation policy and physical activity levels, though most work is still at the stage of identifying the general links between transportation and health.[568] A US Department of Transportation roundtable began to engage this topic more thoroughly in 2004. An excerpt from their summary report reveals the close connection between transportation planning and the next major category of this report, namely, urban planning (see below):[569]

> *Because transportation systems affect options available for physical activity, transportation planners can have a substantial impact on the health of their communities. A community designed with sidewalks and bicycle trails that connect people's homes to their neighbors and to schools, stores, offices, parks, and other destinations encourages higher physical activity levels than one where most daily destinations can only be reached by automobile.*

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[564] Garrow J, Summerbell C. Meta-analysis: effect of exercise, with or without dieting, on the body composition of overweight subjects *European Journal of Clinical Nutrition* 1995; 49: 1-10.
[565] Ballor D, Keesey R. A meta-analysis of the factors affecting exercise-induced changes in body mass, fat mass and fat-free mass in males and females International *Journal of Obesity* 1991; 15: 717-26.
[566] Shaw K, Del Mar C, O'Rourke P et al. Exercise for obesity *Cochrane Database of Systematic Reviews*, 2004.
[567] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.
[568] See the comprehensive bibliography at http://www.cdc.gov/nccdphp/dnpa/pdf/aces-workingpaper2.pdf (accessed November 2004).
[569] Source: http://www.planning.dot.gov/Documents/Health/IntHealthTA.htm#over2 (accessed November 2004).

Good motivation exists to pursue this avenue of physical activity enhancement. It is well known that many trips currently involving automobiles are very short; an alternative such as cycling or walking a half hour a day would halve the risk of developing heart disease, equivalent to the effect of not smoking.[570] Although useful literature is beginning to emerge,[571,572,573,574] incorporation of physical activity and health goals into transportation planning is a new and evolving area.

Incorporation of physical activity and health goals into transportation planning is a new and evolving area.

Financial levers that discourage urban sprawl and automobile commuting, such as gasoline taxes, tolls, subdivision fees and commuter subsidies, may lead to walking-friendly communities and / or more active commuting patterns, e.g., walking to transit stations.

In the only systematic review of this area, which focused on walking and cycling in particular, the best evidence suggested that such interventions have not yet proven effective, and certainly are no better than publicity campaigns or behaviour change programs.[575]

An integrated approach is certainly the "exception rather than the rule" as indicated by a 2002 review of US transportation plans which could not yet identify any examples of substantive integration of health and activity goals.[576] A major literature review of this area identified the research agenda for the future:[577]

> *Transportation planning agencies considering whether to include physical activity dimensions require analytical methods and scientific data to determine the significance of relationships between transportation, activity, and health, and relevance to their jurisdictions. Planners will also benefit from documentation of experiences of peers incorporating health and activity goals into planning processes. This should include before and after technical evaluations of short- and long-term effects to demonstrate the extent*

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[570] Dora C. A different route to health: implications of transport policies *British Medical Journal* 1999; 318(7199): 1686-9.
[571] Shriver K. Influence of environmental design on pedestrian travel behavior in four Austin neighborhoods *Transportation Research Record* 1997; 1578: 64-75.
[572] Litman T. Integrating public health objectives in transportation decision-making *American Journal of Health Promotion* 2003; 18(1): 103-8.
[573] Killingsworth RE, Schmid TL. Community design and transportation policies: new ways to promote physical activity *The Physician & Sportsmedicine* 2001; 15(2).
[574] Ogilvie D, Egan M, Hamilton V et al. Promoting walking and cycling as an alternative to using cars: systematic review. British Medical Journal 2004; 329: 763-68.
[575] Ogilvie D, Egan M, Hamilton V, Petticrew M. Promoting walking and cycling as an alternative to using cars: systematic review *British Medical Journal* 2004 (published on-line).
[576] Noerager K, Lyons W. *Evaluation of Statewide Long-Range Transportation Plans*, 2002. Available at www.fhwa.dot.gov/hep10/state/evalplans.htm (accessed November 2004).
[577] Integrating Health and Physical Activity Goals IntoTransportation Planning. April 2004. Available at http://www.planning.dot.gov/Documents/Health/Bibliography.htm (accessed November 2004). See also Handy S. Understanding the link between urban form and nonwork travel behavior *Journal of Planning Education and Research* 1996; 15: 183-98.

to which transportation affected physical activity and, ultimately, whether community health improved.

Urban Planning Approaches

The link between zoning, land use and built form, and various aspects of health, including physical activity, is an active area of research and discussion.[578,579] According to a survey of studies, one of the more important determinants of physical activity is a person's immediate environment (i.e., neighborhood).[580] Relevant environmental variables for enhanced activity include the presence of sidewalks, traffic calming, adequate street lighting, dog control, enjoyable scenery, regular observation of others exercising, and low crime levels. The growing conclusion is that new insight is required in urban design and planning in order to reverse the unhealthy trends of suburban sprawl:

One of the more important determinants of physical activity is a person's immediate environment. Relevant environmental variables for enhanced activity include the presence of sidewalks, traffic calming, adequate street lighting, dog control, enjoyable scenery, regular observation of others exercising, and low crime levels.

> *While older cities and towns were planned and built based on the practical idea that stores and services should be within walking distance of residences, the design of most new residential areas reflects the supposition that people will drive to most destinations. Work, home, school, and shopping are often separated by distances that not only discourage walking but may even necessitate the use of a car in order to reach any destination safely.*[581]

The US Active Living by Design national program office, a leading agency on the connection between urban planning and physical activity, made a presentation to Health Canada in 2004 which laid out a framework for development in this category:[582]

- Preparations: building partnerships, vision, and a plan of action
- Promotions: mass media for awareness and public education
- Programs: e.g., safe routes to school, trail events, bicycle friendly communities
- Policies: site schools to be pedestrian-friendly, zoning for mixed use
- Projects: build network of paths, traffic calming, scenic landscaping.

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[578] Hoehner CM, Brennan LK, Brownson RC et al. Opportunities for integrating public health and urban planning approaches to promote active community environments *American Journal of Health Promotion* 2003; 18(1): 14-20.

[579] *Improving Physical Activity Through Community Design.* Available at http://www.bikewalk.org/Assets/PDF/IPA_full.pdf (accessed November 2004).

[580] King AC, Castro C, Wilcox S et al. Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women *Health Psychology* 2000; 19(4): 354-64.

[581] Creating A Healthy Environment: The Impact of the Built Environment on Public Health. Available at http://www.sprawlwatch.org/health.pdf (accessed November 2004).

[582] Source: http://www.activelivingbydesign.org/fileadmin/template/documents/health_canada_feb2004.ppt#1 (accessed November 2004).

One of the potentially useful tools being promulgated for planners is the Health Impact Statement which, similar to an environmental assessment, would be recommended or required for any development proposal. The World Health Organization defines a health assessment as "a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population."[583]

To have full confidence in any of these approaches will require an increase in basic information. Even such a central "doctrine" of environmental health planning as the association between the degree of suburban sprawl and obesity rates[584] has been recently called into question.[585] In fact, the strongest proponents of the connection between urban planning and physical activity admit that the best evidence of a connection between environmental factors and, say, utilitarian walking and biking, comes from transportation studies, and that these "are insufficient to conclude community design impacts overall physical activity."[586] Actually isolating specific urban planning interventions and testing their impact on physical activity (and other health determinants) will be a major research challenge in the next decades.[587]

Comprehensive Strategies

There are various efforts made by workplaces, community coalitions and government agencies to change the local environment in terms of the opportunities for physical activity. The initiatives can include creating walking trails, building exercise facilities or improving access to existing resources. Usually such projects are part of multi-component program, where the individual initiatives cannot be isolated. Hence the whole package is evaluated as a unit. The additional components can include training in using exercise equipment, risk factor screening and referral to healthcare providers, and fitness campaigns. According to one review, creating or improving access to places for physical activity increased the frequency of exercise by a median of 48%.[588]

Creating or improving access to places for physical activity increase the frequency of exercise.

[583] Source: http://www.who.int/hia/about/defin/en/print.html (accessed November 2004).
[584] Ewing R, Schmid T, Killingsworth R et al. Relationship between urban sprawl and physical activity, obesity, and morbidity *American Journal of Health Promotion* 2003; 18(1): 47-57.
[585] Cox W, Utt RD. Sprawl and Obesity: A Flawed Connection. Available at http://www.heritage.org/Research/SmartGrowth/wm337.cfm?renderforprint=1 (accessed November 2004).
[586] Source: http://www.activelivingbydesign.org/fileadmin/template/documents/health_canada_feb2004.ppt#1 (accessed November 2004).
[587] Frank LD, Andresen MA, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine*. 2004; 27(2):87-96.
[588] Kahn EB, Ramsey LT, Brownson RC et al. The effectiveness of interventions to increase physical activity. A systematic review *American Journal of Preventive Medicine* 2002; 22(Suppl 4): 73-10.

Combined Interventions

As in many other areas of health promotion and prevention, comprehensive programs incorporating multiple intervention categories are popular approaches in weight loss. Combining diet, exercise and counselling for optimal and sustainable weight loss makes good intuitive sense. However, there are still large gaps in understanding the individual and combined role of diet, exercise, and counselling in different settings.

Community-based Interventions

The conclusion of the World Health Organization in 2000 was that there had not yet been any "well-evaluated and properly organized public health programmes aimed at the population-level management or prevention of obesity."[589] This suggests the need for more program development and more outcomes research.

School-based Interventions

A total of 5 trials were included in a 2002 systematic review.[590] The multifaceted interventions usually included both diet and physical activity education and sometimes actual exercise periods. Significant reductions in body fat were observed in some projects. Ironically, an architect of Singapore's decade-long school program equated their results to one of the least successful trials noted above. However, there have been positive results in Singapore over the long-term, i.e., about a 2% decline in obesity rates among 11-12 and 15-16 year olds, which was statistically and clinically significant.[591] (In general, that country has seen success in its health promotion and chronic disease control efforts, which were further intensified in 2000.[592]) Another school-based program that takes a comprehensive health approach is the Kiel Obesity Prevention Program (KOPS) in Germany.[593]

Clinical Interventions

The evidence concerning combined clinical programs is limited, but generally the results of weight loss trials involving multiple interventions continue to be equivocal.[594] For example, a 1994 RCT that added exercise and behaviour therapy to diet did not show statistically significant additional weight changes.[595] A similar result was seen in another project where exercise and cognitive-behavioural therapy were added to diet.[596] The pooled results from several RCTs of exercise added to diet

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[589] World Health Organization. *Obesity: Preventing and Managing the Global Epidemic.* Geneva, 2000.

[590] University of York. The prevention and treatment of childhood obesity *Effective Health Care* 2002; 7(6).

[591] Toh CM, Cutter J, Chew SK. School based intervention has reduced obesity in Singapore *British Medical Journal* 2002; 324: 427.

[592] Toh CM, Chew SK, Tan CC. Prevention and control on non-communicable diseases in Singapore: a review of national health promotion programmes *Singapore Medical Journal* 2002; 43(7): 333-9.

[593] Muller MJ, Asbeck I, Mast M et al. Prevention of obesity—more than an intention *International Journal of Obesity* 2001; 25(Suppl 1): 66-74.

[594] Liao K. Cognitive-behavioural approaches and weight management: an overview *Journal of the Royal Society of Health* 2000; 120(1): 27-30.

[595] Blonk MC, Jacobs MA, Biesheuvel EH et al. Influences on weight loss in type 2 diabetic patients: little long-term benefit from group behaviour therapy and exercise training *Diabetic Medicine* 1994; 11(5): 449-57.

[596] Avenell A, Brown TJ, McGee MA et al. What interventions should we add to weight reducing diets in adults with obesity? A systematic review of randomized controlled trials of adding drug therapy, exercise, behaviour therapy or combinations of these interventions *Journal of Human Nutrition & Dietetics* 2004; 17(4): 293-316.

and behaviour therapy showed an additional weight loss of only 3 kg at 12 months and just over 2 kg at 24 months.[597] By comparison, the results of 11 studies of diet, behaviour therapy and exercise versus no intervention control showed an overall weight loss at 12 months of 4 kg, similar to that of diet programs combined with drug therapy.[598] Weight regain continues to be a concern even with multiple interventions. *All combinations of diet, exercise, and behaviour therapy showed more weight loss at 12 months than at 24 months.*[599]

"Binary" studies where a single treatment is added to diet have produced the clearest positive results for weight loss, an assessment that was confirmed in the recent HTA report.[600] The two most effective combinations are adding exercise to diet or behaviour therapy to diet. Pooled results from 5 studies showed a modest reduction of about 2 kg at 12 months with exercise added to diet.

Combined results from 4 studies where behaviour therapy was added to diet showed positive results against diet alone up to 5 years, as seen in the following table.[601]

Follow-up, in months	*Weight loss, in kg*
12	7.67
18	4.18
36	2.91
60	1.90

Overall, one reviewer concluded that the most effective counselling-based weight loss interventions are those sustained over the long-term and which focus on diet and exercise in a multidisciplinary way.[602]

Regulatory and Economic Interventions

Policies aimed at environments are unproven. Some would say that the urgency of the obesity problem should prompt action anyway, whereas others call not for the adoption of specific policies, but instead for immediate and intensive research.[603] For instance, the evidence linking BMI to types of land-use mix have been contradictory.[604] In general, the analysis of determinants within obesogenic environments is complex.[605,606,607]

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[597] Avenell A, Brown TJ, McGee MA et al. What interventions should we add to weight reducing diets in adults with obesity? A systematic review of randomized controlled trials of adding drug therapy, exercise, behaviour therapy or combinations of these interventions *Journal of Human Nutrition & Dietetics* 2004; 17(4): 293-316.
[598] Ibid.
[599] Ibid.
[600] Ibid.
[601] Ibid.
[602] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.
[603] Ibid.
[604] Rutt CD, Coleman KJ. Examining the relationships among built environment, physical activity, and body mass index in El Paso, TX *Preventive Medicine* 2004 (in press).
[605] Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity *Preventive Medicine* 1999; 29(6 Pt 1): 563-70.

Development of policy to inform macrosystem changes, e.g., healthier built form in urban settings, will require political will at various levels of government. Coalition-building and increasing public support can begin with working together on smaller initiatives. Some of these environmental initiatives need to begin right away with children, adolescents, and their families (see the relevant section under Key Issues below). As a recent Australian initiative concluded: "Obesity develops over time and once it has developed, it is difficult to treat. The prevention of weight gain, beginning with childhood, offers the most effective means of achieving healthy weight in the population."[608]

Comprehensive Interventions

A case was made earlier in this report for assembling comprehensive plans on the absence of complete results data. An example of a best-practice approach for physical activity and other health improvement has just been launched in B.C.[609] Although Action Schools! B.C. (ASBC) is the "headline" component, it really is part of a planned initiative by the government that encompasses both physical activity and diet. The proposed plan, which is directed at students, includes:

"Obesity develops over time and once it has developed, it is difficult to treat. The prevention of weight gain, beginning with childhood, offers the most effective means of achieving healthy weight in the population."

- expanding the physical activity pilot project (ASBC) to the whole province and all grades
- discontinuing junk food sales in schools (within four and half years, a time lag that is not fully explained)
- promoting healthy food
- recognizing schools that make strides on program implementation and see results
- with local and national partners, researching and developing a wider framework for health promotion, including new standards for physical education and health curricula

ASBC itself has 6 levels of intervention, namely, encouraging:[610]

- policies that enhance an 'environment of opportunity' for physical activity
- scheduling at least 150 minutes of physical education per week
- adoption of classroom-based physical activity ideas
- partnerships with families and community practitioners
- expanded options for extracurricular physical activity
- communication in the school that builds enthusiasm for the program goals

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[606] Carter MA, Swinburn B. Measuring the 'obesogenic' food environment in New Zealand primary schools *Health Promotion International* 2004; 19(1): 15-20.
[607] Hinde S, Dixon J. Changing the obesogenic environment: insights from a cultural economy of car reliance *Transportation Research Part D* 2005; 10: 31-53.
[608] National Obesity Taskforce, 2003. *Healthy Weight 2008 Australia's Future: The National Action Agenda for Childen and Young People and their Families.* Source: http://www.asso.org.au//freestyler /gui/files/healthy_weight_2008.pdf (accessed December 2004).
[609] News Release. Province launches plan to help students get healthier. November 23, 2004.
[610] Backgrounder. Comprehensive plan to promote student health. November 23, 2004.

An 18-month pilot project consisted of 7 intervention schools and 3 controls. At the end, intervention schools had averaged 49 more minutes per week of physical education, exceeding the target amount. As a result, aerobic fitness improvement was higher than in control schools (39 vs. 17%), as were other measures of cardiovascular health and bone mass. Several other indicators, including vegetable and fruit intake and average body fat, did not improve. The latter result was expected, as the pilot period was deemed too short to see changes in body weight (as other weight control programs do see results after 18 months, especially those which add dietary interventions to exercise)

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Key Issues

Weight Gain Prevention and Weight Loss in Children and Adolescents

The rates of overweight school-aged boys and girls in Canada increased from 15% in 1981 to 35% and 29% respectively in 1996.[611] The trend has been similar in the US and throughout the developed world.[612]

Twin studies show that there is a genetic base for some childhood obesity. But fewer than 5% of obese children have an underlying disease such as an endocrinopathy (hormone problems) to explain their condition.[613] The large majority simply have an imbalance between energy expenditure and intake. These conditions do not seem to be reversing. A study of Canadian preschool children in 2004 showed that an alarming 25% were overweight.[614]

Fewer than 5% of obese children have an underlying hormone problem to explain their condition. The large majority simply have an imbalance between energy expenditure and intake.

Children who are obese have an increased risk of becoming obese adults; the correlations in earlier studies were low,[615] but the evidence of connection is increasing.[616] Obese children have been observed to have higher levels of hypertension and other disease risk factors, and are subject to a wide range of health impacts, especially related to pulmonary function.[617,618,619] Earlier studies did not show an association between childhood weight status and adult cardiovascular disease or diabetes,[620] but again more recent research has provided evidence that specifically adolescent obesity is an independent risk factor for adverse health effects in adults. Studies have now linked severe childhood obesity to adult mortality from all causes and adolescent overweight to all-cause mortality and mortality due to coronary heart disease in adults.[621,622]

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[611] Tremblay MS, Willms JD. Secular trends in the body mass index of Canadian children *Canadian Medical Association Journal* 2000; 163(11): 1429-33.
[612] Ogden C, Flegal K, Carroll M et al. Prevalence and trends in overweight among US children and adolescents, 1999–2000 *Journal of the American Medical Association* 2002; 288 (14): 1728-32.
[613] Feldman W, Beagen BL. Screening for childhood obesity. In: *Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care.* Ottawa: Health Canada, 1994.
[614] Canning PM, Courage ML, Frizzell. Prevalence of overweight and obesity in a provincial population of Canadian preschool children *Canadian Medical Association Journal* 2004; 171(3): 240-2.
[615] Johnston FE. Health implications of childhood obesity *Annals of Internal Medicine* 1985; 103: 1068-72.
[616] Whitaker RC, Wright JA, Pepe MS et al. Predicting obesity in young adulthood from childhood and parents obesity *New England Journal of Medicine* 1997; 337: 869-73.
[617] Leung AK, Robson WLM. Childhood obesity *Postgraduate Medicine* 1990; 87: 123-33.
[618] Ball GD, McCargar LJ. Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes *Canadian Journal of Applied Physiology* 2003; 28(1): 117-40.
[619] Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease *Pediatrics* 1998; 101(Suppl 3): 518-25.
[620] Javier-Nieto F, Szklo M, Comstock GW. Childhood weight and growth rate as predictors of adult mortality *American Journal of Epidemiology* 1992; 136: 201-13.
[621] Leung AK, Robson WLM. Childhood obesity *Postgraduate Medicine* 1990; 87: 123-33.
[622] Fontaine KR, Redden DT, Wang C et al. Years of life lost due to obesity *Journal of the American Medical Association* 2003; 289: 187-93.

In addition to health risks, obese children can also suffer from significant social and psychological difficulties. Harassment and discrimination can help to create and exacerbate a negative body image and low self esteem. In some cases, eating disorders result (see relevant section below).

Prevention of Weight Gain

A 2003 Canadian report summarized the current reality with regard to obesity control:[623]

> Currently there is little work being carried out to address the prevention of either obesity or unhealthy body weight concerns and yet there is much to be gained from a concerted action simultaneously targeting both health issues. This can be achieved through the promotion of optimal growth in children and adolescents.

As children fare no better than adults in having access to effective interventions to lose weight (see below), and in fact have fewer such options, it is intuitively clear that not gaining the weight in the first place is a strong public health goal. The *Canadian Guide to Clinical Preventive Health Care* has only one recommendation for maintaining healthy body weight, that is, regular practice of moderate physical activity, [624] though no specific evidence related to children is offered (but compare the evidence for adults detailed above). As an added incentive, physical inactivity is also known to add to the risk of disease in already obese children.[625]

The relevant Cochrane review,[626] which examined evidence in the intervening decade, confirms the *Canadian Guide.* Of the 10 studies included in the review, 7 studies looked at results over at least one year; most of the interventions were school-based programs. Only two long-term studies produced slight to modest positive results with intervention, one with dietary education and physical activity, and one with physical activity alone. Another long-term study based on diet and exercise was successful only in that it *reduced the increase in obesity in the intervention group.*[627] The conclusion, which must be tentative with such limited data, is that concentrating on strategies that decrease sedentary behaviour may be effective in childhood weight maintenance. The well-known difficulties in finding effective interventions to move people of any age from sedentariness to activity are described in the previous section of this report.

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[623] Flynn MA. *Community Prevention of Obesity in Canada: the Technical Document.* March 2003.
[624] Feldman W, Beagen BL. Screening for childhood obesity. In: *Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care.* Ottawa: Health Canada, 1994.
[625] Ball GD, McCargar LJ. Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes *Canadian Journal of Applied Physiology* 2003; 28(1): 117-40.
[626] Campbell, K, Waters E, O'Meara S et al. Interventions for preventing obesity in children *Cochrane Database of Systematic Reviews,* 2004.
[627] Muller MJ, Asbek I, Mast M et al. Prevention of obesity—more than an intention. Concept and first results of the Kiel Obesity Prevention Study (KOPS) *International Journal of Obesity* 2001; 25(Suppl 1): S66-74.

A very important topic related to obesity control in children is breastfeeding. Breastfeeding has recently been proven to have a protective effect against childhood obesity.[628] In fact, one study showed that the prevalence of obesity in breastfed children was 2.8% compared to 4.5% in children who had never been breastfed.[629] Since the risk of adult obesity is twice as high in obese children when compared to non-obese children,[630] encouraging breastfeeding may be an effective measure in the prevention of future adult obesity.

A recent review found nine adequately designed, large-scale epidemiological studies confirming the significant protective effect of breastfeeding against childhood obesity.[631] Although still controversial, possible explanations for this inverse association include hormonal and behavioural mechanisms and differences in macronutrient intake.[632] Higher plasma-insulin concentrations in bottle-fed infants could lead to the early development of adipocytes (fat cells) and stimulated fat deposition.[633] Breast-fed infants may actually have inhibited adipocyte differentiation due to the bioactive factors present in breast-milk.[634] The amount of energy metabolism and protein intake is also higher in bottle-fed infants when compared to breast-fed infants.[635,636] Metabolic imprinting, a phenomenon involving a lifelong predisposition to certain diseases as a result of early nutritional experience, may be an additional explanation for the increased risk of obesity in formula-fed infants.[637]

Breastfeeding is a simple, low cost measure without potential adverse effects.[638] Although programs aimed at encouraging breastfeeding are still in the initial stages, such programs are considered promising in the prevention of obesity.[639] Pediatricians may be useful advocates for breastfeeding.[640]

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[628] Martorell R, Stein A and Schroeder D. Early nutrition and later adiposity *American Society for Nutritional Sciences* 2001; 874S-880S.
[629] Von Kries R, Koletzko B, Sauerwald T et al. Breastfeeding and obesity: cross sectional study *British Medical Journal* 1999; 319: 147-150.
[630] Balaban G, Silva G. Protective effect of breastfeeding against childhood obesity *Journal of Pediatrics* 2004; 80(1): 7-16.
[631] Arenz S, Ruckerl R, Koletzko B et al. Breast-feeding and childhood obesity – a systematic review *International Journal of Obesity* 2004; 28: 1247-56.
[632] Arenz S, Ruckerl R, Koletzko B et al. Breast-feeding and childhood obesity – a systematic review *International Journal of Obesity* 2004; 28: 1247-56.
[633] Lucas A, Sarson D, Blackburn A et al. Breast vs bottle: endocrine responses are different with formula feeding *Lancet* 1980; 1: 1267-9.
[634] Arenz S, Ruckerl R, Koletzko B et al. Breast-feeding and childhood obesity – a systematic review *International Journal of Obesity* 2004; 28: 1247-56.
[635] Whitehead R. For how long is exclusive breast-feeding adequate to satisfy the dietary energy needs of the average young baby? *Pediatric Research* 1995; 37: 239-43.
[636] Balaban G, Silva G. Protective effect of breastfeeding against childhood obesity *Journal of Pediatrics* 2004; 80(1): 7-16.
[637] Waterland R, Garza C. Potential mechanisms of metabolic imprinting that lead to chronic disease. *American Journal of Clinical Nutrition* 1999; 69: 179-97.
[638] Balaban G, Silva G. Protective effect of breastfeeding against childhood obesity *Journal of Pediatrics* 2004; 80(1): 7-16.
[639] Renders C, Seidell J, van Mechelen W et al. Overweight and obesity in children and adolescents and preventative measures *Nederlands Tijdschrift voor Geneeskunde* 2004; 148(42): 2066-70.
[640] Lightdale J, Oken E. Breastfeeding, food choices, restrictive diets, and nutritional fads Current Opinion in Pediatrics 2002; 14(3): 344-9.

As has been noted for other health promotion arenas, the environmental approaches may end up being more useful than individual therapies. As Australia's new report on childhood obesity summarized: "an approach is needed which creates living environments that support healthy eating and physical activity as well as encouraging young people and their families to adopt healthier lifestyles.[641] For example, one potentially valuable approach is to restrict junk food advertisements during peak television viewing times for children.[642] As noted earlier in this report, another approach leading to the same result is to limit children's media time (and, thus, advertisement exposure time). There is little doubt that advertising influences the eating preferences of children and, through them, the purchasing behaviour of adult caregivers. Apart from several direct studies, there is the circumstantial evidence of the amount companies pay to direct advertising to children--US$3 billion by the fast food industry alone.[643]

Finally, just as there are well-known cautions around weight loss in children (see below), even weight prevention needs to be handled carefully. As one Canadian report summarized, any focus on weight maintenance should recognize that

> …there will always be a 'variety of body shapes and sizes' and that there are normal surges in body fatness during certain stages of growth, e.g. during female adolescence…. The importance of promoting regular physical activity so that energy balance is achieved through a realistic food intake cannot be over-emphasized.[644]

Treatment for Weight Loss

The more drastic methods of weight loss used with adults, including surgery and pharmacotherapy, are usually not appropriate for children. Very low-calorie diets are also generally avoided so as to not impair growth or development. The only case where the preceding treatments are employed involve severely obese adolescents; even then, gastric banding surgery has been the only promising approach.[645]

The relevant Cochrane review of standard treatments with obese children included 18 studies.[646] The present state of research is not encouraging. Most of the studies were very small and limited to specialist obesity clinics. They examined interventions to increase physical activity, various types of counselling, dieting, and different degrees of family involvement. The Cochrane review concluded that "there was limited

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[641] National Obesity Taskforce, 2003. *Healthy Weight 2008 Australia's Future: The National Action Agenda for Childen and Young People and their Families.* Source: http://www.asso.org.au//freestyler /gui/files/healthy_weight_2008.pdf (accessed December 2004).

[642] Nestle M, Jacobson MF. Halting the obesity epidemic: a public health policy approach *Public Health Reports* 2000; 115: 12-24.

[643] The Henry J. Kaiser Family Foundation. The role of media in childhood obesity. *Issue Brief.* February 2004. Available at http://www.kff.org/entmedia/loader.cfm?url=/commonspot/security/ getfile.cfm&PageID=32022 (accessed February 2005).

[644] Flynn MA. *Community Prevention of Obesity in Canada: the Technical Document.* March 2003.

[645] Widhalm K, Dietrich S, Prager G. Adjustable gastric banding surgery in morbidly obese adolescents: experiences with eight patients *International Journal of Obesity* 2004; 28: S42-5.

[646] Summerbell CD, Ashton V, Campbell KJ et al. Interventions for treating obesity in children *Cochrane Database of Systematic Reviews*, 2004.

amount of quality data on the components of programs to treat childhood obesity that favour one program over another."[647]

Various treatments do show declines in weight over the short-term, though the improvement typically wanes with longer-term follow-up. Some examples of results follow:

- A team headed by Epstein compared decreasing sedentary behaviours with increasing physical activity among obese children. Both treatments, in low and high dose formats, produced a decrease in excess weight ranging from 22% to 27% at 6 months, though these results were cut roughly in half by 24 months.[648] A focus on reducing sedentary behaviour had a slight edge over the approach involving increased physical activity.

- Golan and colleagues found that behaviour modification which focused mainly on parents produced a significantly greater drop in excess weight compared with the group where children were the agents of change (15% versus 8%).[649] The positive effect of involving parents directly in behavioural treatment has been confirmed over several studies.[650]

The involvement of parents significantly increases the chance of weight loss.

As research is pursued in the area of childhood obesity, one of the challenges will be the ongoing debate over how to define these categories. Current opinion still lands on BMI as the most useful measure, though the cut-off points for unhealthy categories remain unclear.[651]

Another important area of caution is the potential connection between weight consciousness, dieting, and disordered eating among adolescents (see the related subsection of this report). Recent data showed that nearly 50% of Ontario teenagers feel unhappy about their weight.[652] As seen in BC and other provinces, such attitudes are increasingly penetrating into preadolescent populations.[653] Research should assess the dangers that treatments might pose for exacerbating poor body image and rates of eating disorders, though it must be noted that interventions for childhood overweight do not always involve dieting.

Whatever the resolution on this and other significant matters, there is no doubt that ongoing intervention research is vital given the rising tide of obesity in children. The

[647] Summerbell CD, Ashton V, Campbell KJ et al. Interventions for treating obesity in children *Cochrane Database of Systematic Reviews*, 2004.
[648] Epstein LH, Paluch RA, Gordy CC et al. Decreasing sedentary behaviors in treating pediatric obesity *Archives of Pediatrics & Adolescent Medicine* 2000; 154(3): 220-6.
[649] Golan M, Weizman A, Apter A et al. Parents as the excusive agents of change in the treatment of childhood obesity *American Journal of Clinical Nutrition* 1998; 67: 1130-5.
[650] Summerbell CD, Ashton V, Campbell KJ et al. Interventions for treating obesity in children *Cochrane Database of Systematic Reviews, 2004*.
[651] Bellizi MC, Dietz WH. Workshop on childhood obesity *American Journal of Clinical Nutrition* 1999; 70(1): S173-5.
[652] Jones JM, Bennett S, Olmstead MP et al. Disordered eating attitudes and behaviours in teenaged girls *Canadian Medical Association Journal* 2001; 165: 547-52.
[653] McCreary Centre Study. Mirror Images: Weight Issues among BC Youth. 1998. Available at http://www.mcs.bc.ca/pdf/weight.pdf (accessed November 2004).

Cochrane conclusion is sobering: "the mismatch between the prevalence and significance of the condition and the knowledge base from which to inform treatment strategies is a remarkable and outstanding feature of this review."[654]

Body Image and Eating Disorders

One of the contemporary realities in the developed world which is integral to the topic of weight loss is the role of body image as promoted in popular culture and reinforced by friends and family. The contribution that such messages make to the prevalence of unhealthy eating, extreme dieting behaviour[655] and full-fledged eating disorders, especially in younger women, cannot be clearly calculated, but the circumstantial evidence of an association is strong.

Eating disorders are illnesses associated with severe body image distortion and resulting obsession with weight.[656] These conditions represent an increasing public health problem.[657] Peer pressure, teasing, family dynamics and the media have all been found to contribute to a negative body image and the possibility of subsequent eating disorders.[658,659,660] Results of the many studies on this topic reveal that young, dieting females are at the highest risk of developing an eating disorder.[661]

Anorexia nervosa and bulimia nervosa are currently considered the predominant eating disorders.[662] Anorexia nervosa is marked by a severely calorie-restricted diet, at times resulting in a body weight 85% below expected levels.[663] Bulimia nervosa is characterized by recurrent periods of binge-eating followed by compensatory behaviours such as purging.[664] Binge-eating disorder has recently been identified as a separate condition, affecting perhaps 2% of obese people (though as many as 25% of those severely obese).[665]

Integral to the topic of weight loss is the role of body image as promoted in popular culture and reinforced by friends and family.

[654] Summerbell CD, Ashton V, Campbell KJ et al. Interventions for treating obesity in children *Cochrane Database of Systematic Reviews, 2004*.
[655] Sometimes called disordered eating.
[656] National Eating Disorders Screening Program. Available at: http://www.mentalhealthscreening.org/eat/eat-faq.htm (accessed November 2004).
[657] Gucciardi E, Celasun N, Ahmad F, Stewart DE. Eating Disorders. *Women's Health Surveillance Report.* Health Canada, 2001.
[658] Hoskins ML, Dellebuur K. *Consuming Identities: Young Women, Eating Disorders and the Media.* British Columbia Centre of Excellence for Women's Health, 2000.
[659] Polivy J, Herman CP. Causes of eating disorders *Annual Review of Psychology* 2002; 53: 187-213.
[660] Lieberman M, Gauvin L, Bukowski WM et al. Interpersonal influence and disordered eating behaviours in adolescent girls: the role of peer modeling, social reinforcement, and body-related teasing *Eating Behavior* 2001; 2(3): 215-36.
[661] Pratt BM, Woolfenden SR. Interventions for preventing eating disorders in children and adolescents *Cochrane Database of Systematic Reviews*, 2003.
[662] Polivy J, Herman CP. Causes of eating disorders *Annual Review of Psychology* 2002; 53: 187-213.
[663] Gucciardi E, Celasun N, Ahmad F et al. Eating Disorders. *Women's Health Surveillance Report.* Health Canada, 2001.
[664] National Eating Disorders Screening Program. Available at http://www.mentalhealthscreening.org/eat/eat-faq.htm (accessed November 2004).
[665] Yanovski SZ. Binge eating disorder and obesity in 2003: could treating an eating disorder have a positive effect on the obesity epidemic? *International Journal of Eating Disorders* 2003; 34(Suppl): S117-20.

The consequences of the various eating disorders can be severe, with as many as 1 in 10 to 20 cases leading to death from starvation, cardiac arrest, alcoholism, or suicide.[666] Some suggest that eating disorders have the highest mortality rate of any mental illness.

The consequences of the various eating disorders can be severe, with as many as 1 in 10 to 20 cases leading to death from starvation, cardiac arrest, alcoholism, or suicide.

Prevalence of eating disorders is difficult to determine, since many people are either unaware of their condition or unwilling to report it. Canadian studies have put the one-year prevalence of anorexia at 0.7% for women and 0.2% for men, and of bulimia at 1.5% for women and 0.1% for men.[667,668] In Ontario, the lifetime prevalence of bulimia among women aged 15 to 65 was estimated at 1.1% in a 1990 survey.[669] In the US, it is estimated that 1 to 4% of young women are affected by eating disorders.[670]

Treatments for eating disorders include psychotherapy, medication and / or nutritional counselling.[671] Patients are extremely difficult to treat, requiring intensive mental health resources that often are not very effective.[672] Drug trials, especially with anorexia, have generally been disappointing.[673] One small study found that at 10-year follow-up with a comprehensive inpatient program, only 24 % of severe anorexia patients were fully recovered; the crude mortality rate in the group was 7%.[674]

Treatment costs are also high, perhaps $1000 to $1500 per day for inpatient care.[675] These factors suggest that developing more effective prevention strategies should be a priority. Efforts to prevent eating disorders could benefit many more people than those with diagnosed condition. Females in western cultures exhibit a "normative discontent"[676] with their bodies, with large numbers "unhappy with the way they look and preoccupied with weight and shape."[677]

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[666] Keel PK, Dorer DJ, Eddy KT et al. Predictors of mortality in eating disorders *Archives of General Psychiatry* 2003; 60(2): 179-83.
[667] Offord DR, Boyle MH, Campbell D et al. One-year prevalence of psychiatric disorder in Ontarians 15 to 64 years of age *Canadian Journal of Psychiatry* 1996; 41: 559-563
[668] Bland RC, Newman SC, Orn H. Period prevalence of psychiatric disorders in Edmonton *Acta Psychiatrica Scandinavica* 1988; 77(Suppl 338): 33-42.
[669] Gucciardi E, Celasun N, Ahmad F et al. Eating Disorders. *Women's Health Surveillance Report.* Health Canada, 2001.
[670] Eating Disorders. *Office on Women's Health: US Department of Health and Human Services*, 2000.
[671] National Eating Disorders Screening Program. Available at http://www.mentalhealthscreening.org/eat/eat-faq.htm (accessed November 2004).
[672] Pratt BM, Woolfenden SR. Interventions for preventing eating disorders in children and adolescents *Cochrane Database of Systematic Reviews*, 2003.
[673] Zhu AJ, Walsh BT. Pharmacologic treatment of eating disorders *Canadian Journal of Psychiatry* 2002; 47(3): 227-34.
[674] Eckert ED, Halmi KA. Marchi P et al. Ten-year follow-up of anorexia nervosa: clinical course and outcome *Psychological Medicine* 1995; 25(1): 143-56.
[675] Hoskins ML, Dellebuur K. *Consuming Identities: Young Women, Eating Disorders and the Media.* British Columbia Centre of Excellence for Women's Health, 2000.
[676] Rodin, J. Cultural and psychosocial determinants of weight concerns *Annals of Internal Medicine* 1993; 119, 643-645.
[677] Battle EK, Brownell KD. Confronting a rising tide of eating disorders and obesity: treatment vs. prevention and policy *Addictive Behaviors* 1996; 21(6): 755-65.

Current prevention strategies for eating disorders include presentations and discussion groups in schools, media literacy instruction, individual counselling for those displaying disordered eating behaviour, and programs to promote a positive body image.[678]

Few of these interventions have been evaluated in-depth. The relevant Cochrane review suggests that there is insufficient evidence of help or harm from the various interventions that have been tried.[679] Studies have found that approaches which focus on symptoms instead of the underlying psychological issues produce disappointing results, whereas programs that help participants to deconstruct media messages and those that involve gender-specific, peer-led promotion of healthy lifestyles have shown some promise.[680] Interventions with entire families have also been used to reduce the risk of eating disorders.[681,682]

Ecological and policy strategies are increasing in significance. For example, the Health Canada lifestyle program called VITALITY looks beyond the individual in an effort to create social environments that reinforce positive self / body image and healthy lifestyle choices.[683] Advocacy groups are beginning to augment the work of official agencies in this regard. For example, the Council on Size & Weight Discrimination in the US supports the following vision: "Weight diversity is a positive goal. Our dream is a world in which a person's life, health, well-being, and happiness is (sic) unrelated to that person's weight."[684] Related major organizations include the International Size Acceptance Association and the National Association to Advance Fat Acceptance. "Fat friendly" advocacy and policy initiatives from government agencies may become more important as obesity takes over from smoking as "public (health) enemy no. 1." Some studies have shown that the stigmatization experienced by obese people can increase psychological stress and actually lead to more severe obesity.[685]

The public health / preventive approach to eating disorders is in its early stage; further research "must be aggressively pursued."[686] In particular, "longer-term effects of the intervention approaches will need to be monitored across development in order to demonstrate a decline in incidence of eating disorders and associated risk

[678] Hoskins ML, Dellebuur K. *Consuming Identities: Young Women, Eating Disorders and the Media.* British Columbia Centre of Excellence for Women's Health, 2000.
[679] Pratt BM, Woolfenden SR. Interventions for preventing eating disorders in children and adolescents *Cochrane Database of Systematic Reviews*, 2003.
[680] Elliot DL, Goldberg L, Moe EL et al. Preventing substance use and disordered eating: initial outcomes of the ATHENA program *Archives of Pediatrics & Adolescent Medicine* 2004; 158: 1043-9.
[681] Neumark-Sztainer D, Wall M, Story M et al. Are family meal patterns associated with disordered eating behaviours among adolescents? *Journal of Adolescent Health* 2004; 35(5): 350-9.
[682] Hoskins ML, Dellebuur K. *Consuming Identities: Young Women, Eating Disorders and the Media.* British Columbia Centre of Excellence for Women's Health, 2000.
[683] The VITALITY Approach. Available at www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/vitality_approach_e.html (accessed November 2004).
[684] Available at http://www.cswd.org/mainwhatwe.html (accessed November 2004).
[685] Myers A, Rosen JC. Obesity stigmatization and coping: relation to mental health symptoms, body image, and self-esteem *International Journal of Obesity & Related Metabolic Disorders* 1999; 23(3): 221-30.
[686] Battle EK, Brownell KD. Confronting a rising tide of eating disorders and obesity: treatment vs. prevention and policy *Addictive Behaviors* 1996; 21(6): 755-65.

factors."[687] At the same time, caution needs to be incorporated into both individual and community-wide programs for weight control, and especially weight loss. Clinicians and project leaders must work against reinforcing personal beliefs / feelings or environmental messages that promote the development of eating disorders. In particular, there should be vigilance surrounding anyone setting unhealthy or unrealistic weight loss goals or covering up a disorder under the guise of "normal" dieting.[688]

As they are better understood, surveillance for the risk factors of eating disorders needs to be integrated into any weight control program. On the other hand, there must be balance in any concern about thinness obsession and eating disorders. As one study concluded: "Given the substantial health risk associated with overweight and the fact that during the past 2 decades the prevalence of overweight has increased sharply among children and adolescents, it is not prudent to suggest that overweight girls should accept their body shape and not be encouraged to lose weight."[689]

[687] Pratt BM, Woolfenden SR. Interventions for preventing eating disorders in children and adolescents *Cochrane Database of Systematic Reviews*, 2003.
[688] Foster GD, Wadden TA, Vogt RA et al. What is a reasonable weight loss? Patients' expectations and evaluations of obesity treatment outcomes *Journal of Consulting & Clinical Psychology* 1997; 65(1): 79-85.
[689] Field AE, Cheung L, Wolf AM et al. Exposure to the mass media and weight concerns among girls *Pediatrics* 1999; 103(3): E36.

Weight Gain and Smoking Cessation

One of the phenomena which underlines the complex association between risk factors, and the challenge faced in risk factor management in both the clinical and public health settings, is the inverse relationship between smoking and weight gain. Over 75% of adult cigarette smokers experience weight gain following smoking cessation,[690] with the average increase in weight being 2.4 to 5.0 kg.[691] In one study, the mean weight gain, after being adjusted for numerous cohort factors, was 2.8 kg in men and 3.8 kg in women; 9.8 % of the men and 13.4 % of the women faced a weight gain greater than 13 kg. [692] The risk for weight gain following smoking cessation increases in people under 55 and in people who smoke more than 15 cigarettes per day.[693] Cessation related weight gain appears to decline over time[694,695], although not all studies have found this to be so.[696]

The inverse relationship between smoking and weight gain underlines the complex association between risk factors, and the challenge faced in risk factor management in both the clinical and public health settings.

Suggested causes of the gain in weight upon smoking cessation include increased appetite and food reward, increased daily calories consumed, decreased metabolic rate and energy expenditure, an imbalance in lipid intake and fat oxidation, and changes in adipose tissue metabolism. [697,698] In particular, increased energy intake is frequently reported following smoking cessation.[699] It can be a major cause of weight gain, accounting for 69% of the weight gain in women in one study.[700] The suggestion that nicotine has an acute anorectic effect was called into question by one study.[701]

Cessation related weight gain appears to decline over time.

[690] Lerman C, Berrettini W, Pinto A et al. Changes in good reward following smoking cessation: a pharmacogenetic investigation *Psychopharmacology* 2004; 174: 571-7.
[691] Froom P, Melamed S, Benbassat J. Smoking cessation and weight gain *Journal of Family Practice* 1998; 46(6): 460-5.
[692] Williamson DF, Madans J, Anda RF et al. Smoking cessation and severity of weight gain in a national cohort *New England Journal of Medicine* 1991; 324(11): 739-45.
[693] Williamson DF, Madans J, Anda RF et al. Smoking cessation and severity of weight gain in a national cohort *New England Journal of Medicine* 1991; 324(11): 739-45.
[694] Chen Y, Horne SL, Dosman JA. The influence of smoking cessation on body weight may be temporary. American Journal of Public Health 1993; 83: 1330-32.
[695] Mizoue T, Ueda R, Tokui N et al. Body mass decrease after initial gain following smoking cessation. *International Journal of Epidemiology* 1998; 27(6): 984-8.
[696] Williamson DJ, Madans J, Anda RF et al. Smoking cessation and severity of weight gain in a national cohort *New England Journal of Medicine* 1991; 324(11): 739-45.
[697] Lerman C, Berrettini W, Pinto A et al. Changes in good reward following smoking cessation: a pharmacogenetic investigation *Psychopharmacology* 2004; 174: 571-7.
[698] Filozof C, Fernandex Pinilla MC, Fernandez-Cruz A. Smoking cessation and weight gain *Obesity Reviews* 2004; 5: 95-103.
[699] Hatsukami D, LaBounty L, Hughes J et al. Effects of tobacco abstinence on food intake among cigarette smokers *Health Psychology* 1993; 12(6): 499-502.
[700] Filozof C, Fernandex Pinilla MC, Fernandez-Cruz A. Smoking cessation and weight gain *Obesity Reviews* 2004; 5: 95-103.
[701] Perkins KA, Sexton JE, DiMarco A et al. Acute effects of tobacco smoking on hunger and eating in male and female smokers *Appetite* 1994; 22(2): 149-58.

Although weight gain is not likely to negate the health benefits of smoking cessation, it is often a source of concern for prospective quitters.[702] Many studies suggest that the prospect of weight gain may limit a smoker's will to quit, and hinder their long term success.[703] One project found that female smokers were more likely to be weight concerned.[704] Other researchers found that weight gain was not always classified as negative by quitters,[705] and that the majority of previous smokers would not necessarily relapse even after a 9 kg weight gain.[706] Programs that promote self-esteem, physical activity and healthy eating among prospective quitters are recommended to control the weight gain associated with smoking cessation and to increase the odds for success in smoking cessation.[707]

[702] Froom P, Melamed S, Benbassat J. Smoking cessation and weight gain *Journal of Family Practice* 1998; 46(6): 460-5.
[703] Botella-Carretero JI, Escobar-Morreale HF, Martin I et al. Weight gain and cardiovascular risk factors during smoking cessation with bupropion or nicotine *Hormone & Metabolic Research* 2004; 36(3): 178-82.
[704] Meyers AW, Klesges RC, Winders SE et al. Are weight concerns predictive of smoking cessation? A prospective analysis *Journal of Consulting & Clinical Psychology* 1997; 65(3): 448-52.
[705] Ortiz A, Martinez M, Torres A et al. Predictors of smoking cessation success *Puerto Rico Health Sciences Journal* 2003; 22(2): 173-7.
[706] Meyers AW, Klesges RC, Winders SE et al. Are weight concerns predictive of smoking cessation? A prospective analysis *Journal of Consulting & Clinical Psychology* 1997; 65(3): 448-52.
[707] You Can Control Your Weight as You Quit Smoking, 2003. Available at http://win.niddk.nih.gov/publications/smoking.htm (accessed November 2004).

Alcohol Consumption

Excessive alcohol consumption can be considered separately as a risk factor or as a species of unhealthy diet or substance abuse / addiction. It is a complex topic to tackle, both for socio-political reasons and because the health status associated with the consumption of alcohol is ambivalent. Regular, moderate alcohol consumption has recently been identified as having health benefits. This does not take away from the need to monitor and moderate the impact of excessive drinking, as dietary guidelines routinely acknowledge.

Alcohol is one of the most common psychoactive substances consumed in Canada.[708] About 80% of British Columbian adults consume alcohol in a given year. Of this population, 56% identify themselves as regular drinkers, [709] with men more likely than women to be in that category. [710,711] This rate of regular drinking is among the highest in Canada, second only to Quebec.[712] BC also has the highest alcohol-related mortality rate in Canada, with 27 deaths per 100,000. By comparison, Newfoundland has the lowest alcohol-related mortality rate in Canada (23 deaths per 100,000).[713] Although the rate of per capita alcohol consumption in British Columbia has been declining, the rate of regular, heavy drinking is increasing.[714]

Of great concern is the fact that alcohol consumption is not just confined to the adult population. One study estimated that 47% of boys and 41% of girls in BC have tried alcohol by age 13, and 80% of both genders have tried alcohol by age 17.[715]

Moderate alcohol consumption[716] (no more than 2 standard drinks on any one day, with no more than 9 drinks a week for women and 14 a week for men) has recently been demonstrated to have a beneficial impact on people over the age of 45.[717] Health benefits can include reduced risk of coronary heart disease,[718] ischemic stroke,[719] type II diabetes,[720] peripheral vascular disease,[721] dementia, and osteoporosis.[722] This risk

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[708] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[709] Advisory Committee on Public Health. Statistical report on the health of Canadians 1999.
[710] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[711] Nolen-Hoeksema S. Gender differences in risk factors and consequences for alcohol use and problems *Clinical Psychology Review* 2004; 24(8): 981-1010.
[712] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[713] Prevention Source BC: Statistical Summaries. Available at http://www.preventionsource.bc.ca /statsheets/alcohol _injury.html (accessed November 2004).
[714] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[715] The McCreary Centre Society. Healthy Connections: Listening to BC Youth. Highlights from the Adolescent Health Survey II. The McCreary Centre Society, 1999.
[716] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[717] Ellison RC. Balancing the risks and benefits of moderate drinking *Annals of the New York Academy of Sciences* 2002; 957: 1-6.
[718] Meister KA, Whelan EM, Kava R. The health effects of moderate alcohol intake in humans: an epidemiologic review *Critical Reviews in Clinical Laboratory Sciences* 2000; 37(3): 261-96.
[719] Hillborn M. Alcohol consumption and stroke: benefits and risks *Alcoholism-Clinical and Experimental Research* 1998; 22(7 Suppl): S352-8.
[720] Wannamethee SG, Shaper AG, Perry IJ et al. Alcohol consumption and the incidence of type II diabetes *Journal of Epidemiology and Community Health* 2002; 56(7): 542-8.

reduction has been attributed to increased concentrations of HDL-cholesterol and inhibition of blood coagulation caused by the presence of alcohol. Contrary to popular perceptions, moderate drinkers can exhibit improved mental health status characterized by decreased depression and stress, as well as lower absenteeism from work.[723]

Although most people drink moderately, excessive alcohol use can contribute to several chronic physical, psychological and behavioural problems.[724,725] The health risks of alcohol abuse are well known and include cirrhosis, alcoholism, a variety of cancers, injuries, and death.[726] Excessive alcohol use can result in family violence, verbal or physical abuse, property damage, traffic collisions, child neglect and death, and foetal alcohol syndrome.[727,728]

In 1999, British Columbia's annual healthcare costs related to excessive alcohol consumption were an estimated $179 million. When law enforcement, fire damage, traffic accidents, loss of productivity and other indirect costs are factored in, alcohol-related costs balloon to almost $1 billion annually.[729]

Excessive alcohol use is of considerable concern to public health. Intervention programs include counselling,[730] emergency department screening, brief on-site advice and referral,[731] pharmacological treatments, and other psychosocial approaches. Successful programs individualize alcohol intervention and prevention to accommodate the needs of the targeted person or population.[732] Community action programs and educational strategies have the potential to be beneficial in the long-run.[733] Legislative and regulatory controls on alcohol prices and marketing also have a large role to play in reducing excessive alcohol consumption.

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[721] Goldberg DM, Soleas GJ, Levesque M. Moderate alcohol consumption: the gentle face of Janus *Clinical Biochemistry* 1999; 32(7): 505-18.
[722] Standridge JB, Zylstra RG, Adams SM. Alcohol consumption: an overview of benefits and risks *Southern Medical Journal* 2004; 97(7): 664-72.
[723] Goldberg DM, Soleas GJ, Levesque M. Moderate alcohol consumption: the gentle face of Janus *Clinical Biochemistry* 1999; 32(7): 505-18.
[724] Chronic diseased and associated risk factors in Australia, 2001. Available at http://www.aihw.gov.au/publications/phe/cdarfa01/cdarfa01-c02a.pdf (accessed November 2004).
[725] Kendall PRW. Public health approach to alcohol policy: a report of the provincial health officer *Ministry of Health Planning* 2002.
[726] Thun MJ, Peto R, Lopez AD et al. Alcohol consumption and mortality among middle-aged and elderly US adults *The New England Journal of Medicine* 1997; 337(24): 1705-14.
[727] Chronic diseased and associated risk factors in Australia, 2001. Available at http://www.aihw.gov.au/publications/phe/cdarfa01/cdarfa01-c02a.pdf (accessed November 2004).
[728] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[729] Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.
[730] Helmkamp JC, Swisher-McClure S, Manley WC et al. A brief summary of alcohol intervention research at West Virginia University from 1998-2003 *West Virginia Medical Journal* 2004; 100(4): 143-6.
[731] Hungerford DW, Pollock DA, Todd KH. Acceptability of emergency-based screening and brief intervention for alcohol problems *Academic Emergency Medicine* 2000; 7(12): 1383-92.
[732] Marlatt GA, Witkiewitz K. Harm reduction approaches to alcohol use: health promotion, prevention, and treatment *Addictive Behaviour* 2002; 27(6): 867-86.
[733]Kendall PRW. *Public Health Approach to Alcohol Policy: A Report of the Provincial Health Officer.* BC Ministry of Health Planning, 2002.

Summary

Interventions to Reduce Energy Intake

1. Interventions of proven effectiveness with strong evidence

- Counselling for reduced energy intake by primary healthcare providers.
- Behaviour therapy combined with healthy eating for weight loss.
- Sustained, community-initiated programs for reduced energy intake.
- Weight Watchers program.
- Encouragements to breastfeed for weight maintenance in children..
- Comprehensive school programs, especially with parental involvement.
- Family / parental involvement for weight maintenance in children.
- Reduced vending machine prices for healthy foods.
- Drug treatment with orlistat or sibutramine, where indicated.
- All forms of surgery for morbid obesity, and especially gastric bypass.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Workplace interventions that include cafeteria changes.
- Family support programs.
- Counselling for increased consumption of fruit, vegetables and fibre.
- Low fat and low calorie diets alone for short-term weight loss.
- Single product promotions for short-term change in sales.
- Labelling healthy foods on restaurant menus.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Mass media campaigns for increased vegetable and fruit consumption (but these do raise awareness levels, a precursor to action).
- Increased access to vegetables and fruit in low-income areas.

Interventions to Increase Energy Expenditure

1. Interventions of proven effectiveness with strong evidence

- Exercise alone for weight maintenance.

- Signs encouraging stairway usage.
- Behavioural/social approaches focusing on moderate-intensity physical activity such as walking.
- Behavioural/social approaches based at home and reinforced by frequent telephone contact.
- Community social support (e.g., walking groups).
- School-based physical education.
- Enhanced access to places for physical activity.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Community-wide campaigns with multiple components.
- School-based physical activity for prevention of childhood obesity.
- Reducing sedentary activities for weight maintenance in children.
- Counselling by primary care physicians.
- Physician training, reminders and incentives.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Classroom-based health education.
- Mass media campaigns in isolation.
- Health education to reduce TV viewing and video game playing.
- Family-based social support.
- College-based physical and / or health education.
- Exercise alone for weight loss.
- Workplace programs geared to individuals.
- Workplace "environmental" interventions.
- Transportation policy (various studies pending).
- Other urban planning (various studies pending).

Combined Interventions

1. Interventions of proven effectiveness with strong evidence

- Exercise combined with healthy eating for weight loss.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Programs to encourage reduced television watching
- Combining healthy eating, exercise and counselling.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Environmental approaches to weight gain prevention (research pending; see the next section).

Regulatory and Economic Interventions

A review of the above summary indicates few interventions at the regulatory and economic level. Indeed, current efforts in this area, such as the move by the Canadian government to eliminate trans fats in processed foods, are at the forefront in this field and thus have not been tested or evaluated for effectiveness. In Australia, the approach taken involves the implementation of promising strategies even in the absence of this evidence. They suggest using the best available evidence while not excluding untried but promising interventions that are "deemed worthy of systematic implementation and evaluation".[734]

Using such an approach, a European review suggested several regulatory and economic interventions, including:[735]

- Taxes on foods with a low content of a range of nutrients, e.g. soft drinks.
- Restrictions on advertising, promotion, and sponsorship of energy-dense foods and beverages (especially when directed at young people).
- Nutrition signposting based on an agreed standard for fat, fibre, vegetable and fruit content which the consumer can recognize as appropriate in a healthy diet.
- Enhanced nutrition messages that foster an understanding of the relationship between food and health.

This list can be compared with the inventory of ideas in a Canadian report on obesity from August, 2004:[736]

- Legislation to regulate portions to a "reasonable" size and enforce disclosure of nutritional content of fast food at point-of-purchase.
- Using taxes and subsidies, change price structures to favour healthy food.
- Remove sales tax on exercise equipment.
- Offer tax incentives to employers providing exercise facilities.
- Taxation to encourage densification and active commuting, e.g., traffic congestion and gasoline taxes, rush hour tolls, subdivision fees.
- Urban design to promote walking and bicycling.
- Polices to support adequate income for individuals and families.

It is noteworthy that many of the preceding approaches are based on taxation, confirming the point made in a recent OECD report, namely, that some commentators believe *fiscal or legislative* changes should have a higher priority that other types of health promotion strategies.[737]

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[734] New South Wales Centre for Public Health Nutrition. *Best Options for Promoting Healthy Weight and Preventing Weight Gain in NSW*. June 2004.
[735] International Union Against Cancer. *Evidence-based Cancer Prevention: Strategies for NGOs*, 2004.
[736] Raine KD. *Overweight and Obesity in Canada: A Population Health Perspective.* Centre for Health Promotion Studies, University of Alberta, 2004.
[737] Bennett J. *Investment in Population Health in Five OECD Countries.* OECD Health Working Papers. 2003.

Reassessing and Applying the Lessons Learned from Tobacco Control

It is true that successful anti-tobacco campaigns have been comprehensive, involving multiple types of interventions, but it also must be recognized that the vanguard in the war was clearly *ecological* in nature, addressing a range of social contexts. The "back was broken" with respect to tobacco through large-scale socioeconomic interventions along with regulatory and and educative efforts.

In particular, macro-systemic changes to taxation and advertising regulations around tobacco represent policy levers without parallel in effectiveness, though they are almost matched by the socio-cultural shifts in attitude brought about by counter-marketing and well-executed school and workplace interventions. The "de-norming" that has stigmatized smoking and tobacco companies, and, to a lesser extent, teen smoking uptake, smoking while pregnant, and environmental tobacco smoke, has been a an important public health success. When the public is mostly convinced and on board, the momentum for change can both build and be sustained.

Alongside these public policies and changes in social norms was the wide range of community programs in neighbourhoods, workplaces and schools aimed at smoking prevention, smoking cessation or reducing the harm of environmental tobacco smoke. Finally, supported by both the policy and program pillars, was the platform of face-to-face clinical interventions.

Tobacco and obesity are not identical public health issues. Unlike tobacco use, obesity involves two major determinants that are essential to life, namely food and physical activity. This means that interventions may need to be more subtle as they deal with a more complex situation. Obesity control advocates could well be "envious" of tobacco control colleagues and their simple message: don't smoke.

Nevertheless, much of the tobacco control story can inform our approach to obesity. The first question is where to begin redressing the intervention imbalance between smoking and obesity, and start seeing the type of success obtained with tobacco.

Begin with the Environment

Based on successes in the tobacco control battle, there is a compelling rationale to start with environmental interventions and programs that affect the widest audience. The intent is to create the kind of supportive socioeconomic world that reinforces other interventions and helps them to be more effective. Even before trying less proven or more complex environmental "engineering," a good place to begin is with the same means that have worked most successfully with tobacco.

Economic Levers

The struggle with tobacco has shown that people are price sensitive, especially younger people, even when the product is addicting. One option then is to use special taxation on unhealthy, energy-dense foods and/or subsidies on healthy foods. Though these interventions have not been fully tested, the results of price interventions in micro-environments such as school cafeterias and vending machines are both suggestive and promising. A comparable example related to physical activity is the waiving of recreation centre entrance fees, which recently offered to grade 5 students in Delta, B.C.

A comprehensive and effective policy will take into consideration and address the challenge of food security. How can individuals and families make healthy eating choices if they do not have access to such food in their neighbourhoods, nor the resources to make appropriate purchases? This is equivalent to the sensitivity required in tobacco control to the unexpected impacts of taxation and health education on those of lower socioeconomic status.

Regulatory Levers

One of the best options in this area might be to ban targeted marketing of unhealthy foods to "captive" audiences of children. Other options include enhanced nutrition labelling and the use of nutrition signposting. More complex regulations would include restrictions on demonstrably unhealthy food ingredients such as trans fats.

Healthcare Policy Levers

The current primary care reform in Canada provides a good opportunity to invest in new approaches that would adequately educate and compensate providers for dietary and exercise counselling, as well as fully cover the out-of-pocket costs of any therapies required by patients. The parallel in the tobacco control sphere is ensuring that nicotine replacement therapy or other drugs are made freely available to smokers seeking to quit.

Counter-marketing Campaigns

Experience with most marketing campaigns has been that, on their own, they increase awareness but do not necessarily result in behaviour change. They are, however, as seen in the anti-tobacco campaign, an important component of comprehensive programs. Media advocacy, given the right environment, can be very influential. An example is the popular 2003 documentary *Super Size Me* which reportedly helped to change the corporate practices of one of the largest fast food corporations in the world.[738]

Provide Simultaneous Messages for Interdependent Determinants

The "triple threat" of reducing uptake, increasing cessation and controlling ETS has been important, with one battlefront often reinforcing another. The parallel with obesity control is to ensure that dietary interventions are matched by exercise prescriptions. There is some evidence that a double-barrelled approach will see the best weight management results. Even better than parallel and concurrent messages about diet and exercise would be *integrated* approaches that tackled them both simultaneously at environmental and program levels.

Engage in a Comprehensive Long-term Approach

Behavioural risk factors can largely be addressed in two different spheres, at the broader environmental level or through interventions focusing on individuals. The former seeks to make changes that influence entire populations whereas the latter addresses the needs of individual patients.

[738] News report at http://edition.cnn.com/2004/US/03/02/mcdonalds.supersize.ap/ (accessed December 2004).

A comprehensive campaign needs to appropriately address both spheres. In tobacco control additional focus needs to be placed on interventions for the individual. If this is not done, the result can be to create general bad feelings among smokers without offering them enough high-intensity aids for cessation. The same mistake cannot be made with obesity control. It needs to be comprehensive and multi-channel from the start, including community-wide programs involving social support and follow-up, workplace programs, and specialized training in schools that fully integrates the partnership role of parents.

At the same time, the micro-environmental measures need to be introduced and integrated, e.g., cafeteria pricing and promotion, signs directing people to stairways in buildings, providing exercise facilities in the workplace and so on.

A final aspect of any comprehensive approach to obesity control is targeting special-needs or high-leverage populations. Some authorities have argued for special attention towards the physical activity and obesity rates among older people. Perhaps an even higher priority is the absolute need to prevent excess weight gain among young people in the first place; this so-called *primordial prevention*[739] is a precise parallel to reducing teen smoking uptake.

Reducing overweight and obesity rates will require a full press from every player in healthcare, community agencies and advocacy organizations, not to mention political leaders, parents, educators and role models. Indeed, the unequivocal emphasis from all quarters is an essential part of the "social-normative momentum." The campaign against smoking has taught us that this will likely take decades and will only be successful with full support from all those involved.

[739] In 1978, Strasser coined the term 'primordial prevention' to mean "activities that prevented the penetration of risk factors into populations. The basic idea is to intervene to stop the appearance of the risk factor in the population. In some sense, this is not dissimilar to traditional public health immunization efforts for infectious conditions, which aim to prevent the appearance of the risk factor or condition before it takes hold in the population". Quoted in Schneiderman N, Gentry J, da Silva JM, Speers M, Tomes H. (eds.) *Integrating Behavioural and Social Sciences with Public Health.* 1999 Washington, DC.: American Psychological Association.

Exposure to Ultraviolet Radiation

Skin cancer is one of the most common cancers in the world, with the rates increasing in some jurisdictions, e.g., Australia, the US.[740,741] In particular, there were dramatic increases in the prevalence of malignant melanoma in recent decades. The lifetime risk of developing a malignant melanoma in North America is currently about 1 in 100. This compares with the year 1935, when the rate was 1 in 1,500.[742] The difference may be accounted for by an increase in outdoor leisure activities, though this presumably has been partially offset by more indoor work.[743] Concerns continue over changes in the atmosphere, and especially ozone depletion, which may result in increased ultraviolet (UV) exposure and more skin cancer.[744]

UV radiation is known to damage skin; acute exposure causes sunburn and chronic exposure results in loss of elasticity and increased aging (sometimes called photoaging). Absorption of UV triggers a thickening of the superficial skin layers and an increase in skin pigmentation, which serve to protect the skin against future sunburns. Unfortunately, this protective mechanism, as well as direct DNA damage and immunosuppression, makes the skin more vulnerable to cancer.[745] In particular, strong evidence exists of a dose-response relationship between non-melanoma skin cancer (see below) and cumulative exposure to UV radiation.[746,747]

It is important to distinguish skin cancers. In addition to malignant melanoma, which accounts for the largest proportion of mortality from skin cancers, there are two other main types, basal cell carcinoma and squamous cell carcinoma. These carcinomas occur frequently but are difficult to track epidemiologically as they are usually treated successfully without requiring hospitalization or a review of a pathologic specimen. Because of the heterogeneity of reporting, the data tables of the Canadian Cancer Statistics reports actually exclude the estimated 76,000 cases of non-melanoma skin cancer.[748]

There is some evidence that skin cancer rates are levelling off and the mortality rate even declining for women in Canada, though still increasing for men.[749] This matches an overall decline in mortality rates for all cancer as reported in the latest

[740] Stanton WR, Janda M, Baade PD et al. Primary prevention of skin cancer: a review of sun protection in Australia and internationally *Health Promotion International* 2004; 19(3): 369-78.
[741] Jemal A, Devesa SS, Hartge P et al. Recent trends in cutaneous melanoma incidence among whites in the United States *Journal of the National Cancer Institute* 2001; 93(9): 678-83.
[742] BC Cancer Agency. Available at http://www.bccancer.bc.ca/HPI/CME/SkinCancer/CMESkinCancer/Readings/Prevention/Epidemiology.htm (accessed November 2004).
[743] de Gruijl FR. Skin cancer and solar UV radiation *European Journal of Cancer* 1999; 35(14): 2003-9.
[744] Yamaguchi N, Kinjo Y, Akiba S et al. Ultraviolet radiation and health: from hazard identification to effective prevention *Journal of Epidemiology* 1999; 9(6 Suppl): S1-4.
[745] Ichihashi M, Ueda M, Budiyanto A et al. UV-induced skin damage *Toxicology* 2003; 189(1-2): 21-39.
[746] Suzuki T, Ueda M, Ogata K et al. Doses of solar ultraviolet radiation correlate with skin cancer rates in Japan *Kobe Journal of Medical Science* 1996; 42(6): 375-88.
[747] Woodhead AD, Setlow RB, Tanaka M. Environmental factors in nonmelanoma skin cancer *Journal of Epidemiology* 1999; 9(6 Suppl): S102-14.
[748] Canadian Cancer Statistics 2004. Available at http://www.cancer.ca/vgn/images/portal/cit_86751114/14/33/195986411niw_stats2004_en.pdf (accessed November 2004).
[749] BC Cancer Agency. Available at http://www.bccancer.bc.ca/HPI/CME/SkinCancer/CMESkinCancer/Readings/Prevention/Epidemiology.htm (accessed November 2004).

Canadian statistics.[750] This does not lessen the need to respond preventively. For example, though the acceleration stopped in the late 1980s in Ontario, reported skin cancer prevalence is still much higher now than in the 1970s.[751] BC's skin cancer rates also have doubled in 20 years. The province has the highest melanoma prevalence in the country, accounting for 100 annual deaths.[752] This compares with about 700 melanoma-related deaths every year in Canada as a whole.[753]

The story about UV radiation has been complicated in recent years by a number of factors, in addition to the atmospheric ozone changes already noted.

- There are significant health benefits from appropriate doses of UV. Production of vitamin D through such exposure is the most important source of the vitamin for most people in the world. Vitamin D serves many significant functions, and has been shown to have a protective effect against osteoporosis, arthritis, hypertension, diabetes and many types of cancer.[754]

- Some subgroups of melanoma and basal cell carcinoma do not seem to be caused by UV exposure (e.g., some skin cancers have a genetic base).[755]

- The persistent notion that suntans are healthy, or at least healthy-looking.[756]

- The fact of the growing popularity, especially among adolescents and young people, of artificial tanning devices that emit UV radiation.[757,758,759] The evidence which shows that such practices increase skin cancer is strongest for the non-malignant forms of the disease.[760] The concerns about these devices have prompted new regulations requiring warning labels describing the UV exposure that they entail.[761]

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[750] Canadian Cancer Statistics 2004. Available at http://www.cancer.ca/vgn/images/portal/cit_86751114/14/33/195986411niw_stats2004_en.pdf (accessed November 2004).
[751] Cancer Care Ontario. Available at http://www.cancercare.on.ca/pdf/CF-May2001-melanoma.pdf (accessed November 2004).
[752] BC Ministry of Health Services, Preventive Health Programs. Available at http://www.healthservices.gov.bc.ca/prevent/sunsmart.html (accessed November 2004).
[753] Canadian Cancer Statistics 2004. Available at http://www.cancer.ca/vgn/images/portal/cit_86751114/14/33/195986411niw_stats2004_en.pdf (accessed November 2004).
[754] Grant WB. Health benefits of solar UV-B radiation through the production of vitamin D *Photochemical & Photobiological Sciences* 2003; 2(12): 1307-8.
[755] Green A, Whiteman D, Frost C et al. Sun exposure, skin cancers and related skin conditions *Journal of Epidemiology* 1999; 9(6 Suppl): S7-13.
[756] Robinson JK, Rigel DS, Amonette RA. Summertime sun protection used by adults for their children *Journal of the American Academy of Dermatology* 2000; 42(5 Pt 1): 746-53.
[757] Rhainds M, De Guire L, Claveau J. A population-based survey on the use of artificial tanning devices in the Province of Quebec, Canada *Journal of the American Academy of Dermatology* 1999;40(4):572-6.
[758] Demko CA, Borawski EA, Debanne SM et al. Use of indoor tanning facilities by white adolescents in the United States *Archives of Pediatrics & Adolescent Medicine* 2003; 157(9): 854-60.
[759] Cokkinides VE, Weinstock MA, O'Connell MC et al. Use of indoor tanning sunlamps by US youth, ages 11-18 years, and by their parent or guardian caregivers: prevalence and correlates *Pediatrics* 2002; 109(6): 1124-30.
[760] Karagas MR, Stannard VA, Mott LA et al. Use of tanning devices and risk of basal cell and squamous cell skin cancers *Journal of the National Cancer Institute* 2002; 94(3): 224-6.
[761] Health Canada, Tanning Lamps. Available at http://www.hc-sc.gc.ca/english/iyh/lifestyles/tanning.html (accessed November 2004).

- The complexities of defining and testing an appropriate measure of sun protective behaviour.[762]

- Serious questions have been asked about the efficacy of one of the most popular and "self-evident" interventions, namely, topical sunscreens. The concern has focused on whether sunscreens afford enough protection against all forms of potentially harmful radiation. Several meta-analyses over the last few years have been unable to confirm any clear relationship between sunscreen use and melanoma incidence. Sunscreens may reduce burning, but, according to some data, actually promote melanoma incidence.[763]

- There is a significant lag time of 10-30 years for the clinical appearance of skin cancer to occur. This can be both a spur to early preventive measures but also an obstacle. The value placed on long-term health protection, especially by children and teens, can be "diminished by the large discount rate assigned to benefits occurring in the distant future."[764]

There is clearly "room for improvement" when dealing with UV radiation at a population level. For example, an environmental scan conducted in Alberta in 2001 admitted that skin cancer prevention activities were somewhat sporadic and given a much lower priority than other public health issues. In terms of current risky behaviour, results from the US are telling: approximately 32% of adults reported having a sunburn in 2002 and less than a third of adolescents practiced any form of sun protection; the only positive result was the relatively high rate of sunscreen use among children (62%).[765]

Prevention Strategies

The most significant preventable risk factor for developing skin cancer is exposure to the sun's UV radiation. Most significantly, about 90% of malignant melanomas can be attributed to UV exposure.[766] UV radiation has been called the most prominent and ubiquitous physical carcinogen in the natural environment.[767] This creates an obvious target for preventive healthcare, namely, reduced UV exposure.

The most significant preventable risk factor for developing skin cancer is exposure to the sun's UV radiation.

Both Canada and the US have review processes and guidelines institutionalized in public bodies whose mandate included clinical and public health responses to UV exposure reduction. In Canada, there is the Canadian Task Force on Preventive Health Care (formerly the Canadian Task Force on the Periodic Health Examination) which disseminates a guide focusing mainly on clinical

[762] Buller DB, Borland R. Skin cancer prevention for children: a critical review *Health Education & Behavior* 1999; 26(3): 317-43.
[763] Christensen D. Data still cloudy on association between sunscreen use and melanoma risk *Journal of the National Cancer Institute* 2003; 95(13): 932-3.
[764] Feldman SR, Dempsey JR, Grummer S et al. Implications of a utility model for ultraviolet exposure behavior *Journal of the American Academy of Dermatology* 2001; 45(5): 718-22.
[765] Saraiya M, Glanz K, Briss P et al. On reducing exposure to ultraviolet light. Preventing skin cancer: findings of the Task Force on Community Preventive Services *Morbidity & Mortality Weekly Report. Recommendations & Reports* 2003; 52(RR-15):1-12.
[766] BC Ministry of Health Services, Preventive Health Programs. Available at http://www.healthservices.gov.bc.ca/prevent/sunsmart.html (accessed November 2004).
[767] de Gruijl FR. Skin cancer and solar UV radiation *European Journal of Cancer* 1999; 35(14): 2003-9.

preventive health care; the counterpart in the US is the Preventive Services Task Force, on which the Canadian work is highly dependent. In terms of population health, the US also has the parallel Task Force on Community Preventive Services (TFCPS). This Task Force has conducted major reviews of smoking prevention and physical activity intervention which figured prominently in earlier sections of this report. Skin cancer prevention is another area which has been recently completed by the group.[768]

The TFCPS organized the topic of skin cancer prevention into three groups, all of which focused on the major risk factor of UV exposure: setting-specific, target-population-specific, and community-wide interventions. As most of the target groups get well handled under the settings (e.g., school-aged children under schools), only one required special treatment, i.e., the parents or other caregivers of children.[769] The organization categories used by other researchers will be adapted and standardized to follow the pattern of preceding sections of this report.

From the point of view of the TFCPS, there appears to be much more research needed.[770] The Task Force only identified two intervention categories with sufficient evidence to warrant a positive recommendation: education and policy approaches in primary schools and recreation / tourism settings. The effects in these two cases were small-to-moderate, but as they occurred in populations rather than individuals, the public health benefit could still be substantial. Summaries of the Task Force results[771] and those of Canadian and other systematic reviews follow. The relevant Cochrane review is still at the protocol stage.[772]

Community-based Interventions

Community programs involve combinations of individual-directed strategies in multiple settings, media campaigns, and sometimes environmental and policy changes. The campaign is usually conducted in a circumscribed geographical area and lasts, by definition, for at least a year.[773] The TFCPS assessed the 8 qualifying studies as having overall limitations in design and execution, and therefore could not draw a positive conclusion for this type of intervention. One randomized study that did show a positive effect involved 10 towns in New Hampshire; the proportion of children using some sun-protection increased significantly in the intervention towns

[768] Saraiya M, Glanz K, Briss P et al. On reducing exposure to ultraviolet light. Preventing skin cancer: findings of the Task Force on Community Preventive Services *Morbidity & Mortality Weekly Report. Recommendations & Reports* 2003; 52(RR-15): 1-12.

[769] Saraiya M, Glanz K, Briss P et al. On reducing exposure to ultraviolet light. Preventing skin cancer: findings of the Task Force on Community Preventive Services *Morbidity & Mortality Weekly Report. Recommendations & Reports* 2003; 52(RR-15): 1-12.

[770] More Research is Needed to Determine Effectiveness of Many Program Approaches to Improve Sun-Protective Behaviors. The Community Guide. Available at http://www.thecommunityguide.org /cancer/skin/default.htm (accessed November 2004).

[771] This report will be dependent on the results from the TFCPS provided on The Community Guide website as the full published paper was yet not available. The citation for the peer-reviewed version is Saraiya M, Glanz K, Briss PA et al. Interventions to prevent skin cancer by reducing ultraviolet radiation: a systematic review *American Journal of Preventive Medicine* 2004; 27(5): 422-66.

[772] Naldi L, Buzzetti R, Cecchi C et al. Educational programmes for skin cancer prevention Cochrane Skin Group *Cochrane Database of Systematic Reviews*, 2003.

[773] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).

(from 78 to 87%), compared with a decline in the control towns.[774] Office-based counselling by physicians was one of the components in this campaign, and parents reported that they received more information about sun protection from such professionals in the intervention towns (though the focus was again more on sunscreen use rather than other strategies).[775] An earlier US review was more positive about overall community-wide results, though, as with any large-scale intervention, it could not rule out "the possibility that improvements in sun protection reflect secular society-wide trends or response bias prompted by exposure to the program."[776] Another challenge is identifying the precise strategies in a multi-component intervention that most contributed to any positive results.

Mass Media Campaigns

Mass media campaigns typically have used public service announcements and multimedia information kiosks, sometimes supported by "small media" such as brochures, newsletters and video. A unique public intervention regarding sun protection is the UV index (UVI) reported or broadcast in the media; the UVI presents a warning about the strength of the sun's rays on a particular day, along with advice on "taking cover."

Only 3 studies qualified in the TFCPS review of mass media interventions, too few to establish a pattern of effectiveness.[777] The one assessment of the UVI demonstrated a high level of awareness of the index in the population of 58 towns where such information was broadcast; among the aware group, 38% said they had changed their sun protection practices.[778] A Swedish trial offered more equivocal evidence for interventions involving UV information from the UVI or a personal radiation indicator device; though some sun-related beliefs and behaviours changed, sunbathing and sunburn did not decrease more than in a group offered general written information.[779]

A brief review identified 2 additional UK studies, but derived the same conclusion, namely, that response to mass media campaigns alone is at best mixed.[780]

Recreation / Tourism Settings

Beaches and other outdoor recreation sites offer important platforms for sun protection initiatives.[781]

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[774] Dietrich AJ, Olson AL, Sox CH et al. Persistent increase in children's sun protection in a randomized controlled community trial *Preventive Medicine* 2000; 31(5): 569-74.
[775] Dietrich AJ, Olson AL, Sox CH et al. Persistent increase in children's sun protection in a randomized controlled community trial *Preventive Medicine* 2000; 31: 569-74.
[776] Buller DB, Borland R. Skin cancer prevention for children: a critical review *Health Education & Behavior* 1999; 26(3): 317-43.
[777] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).
[778] Geller AC, Hufford D, Miller DR et al. Evaluation of the Ultraviolet Index: media reactions and public response *Journal of the American Academy of Dermatology* 1997; 37(6): 935-41.
[779] . Branstrom R, Ullen H, Brandberg Y. A randomised population-based intervention to examine the effects of the ultraviolet index on tanning behaviour *European Journal of Cancer* 2003; 39(7): 968-74.
[780] Melia J, Pendry L, Eiser JR et al. Evaluation of primary prevention initiatives for skin cancer: a review from a UK perspective *British Journal of Dermatology* 2000; 143(4): 701-8.

Interventions, which are aimed at adults and children, have included educational brochures; sun-safety training of lifeguards, aquatic instructors and outdoor recreation staff; lessons and interactive activities; increasing shaded areas; provision of sunscreen; and / or point-of-purchase prompts. The outcome examined by the TFCPS was improvement in sun-protective "covering up"; the 11 studies (only 5 were high quality) did point to a modest 11.2% median relative increase in such behaviour by adults (but only provided equivocal evidence for children).[782]

One of the best results was obtained with a multi-component intervention involving education and tailored assessment reports; sun protection behaviours among people recruited at beaches occurred at double the rate of the control group at 24 month follow-up.[783] One reason for the general success of these programs is the fact that they tended to be more rigorously planned and intensive interventions when compared with those in other settings.[784] The potential impact of expanding such efforts in many outdoor settings (e.g., zoos, sporting events) is large.

Workplace-based Interventions

Single and multi-component interventions have been used with workers to increase sun protective intentions or behaviours among workers. As with the school settings, the multiple component approach makes it difficult to isolate the effects attributable to a specific approach. Typical interventions have included some combination of:

- surveys to assess knowledge, intentions and behaviours
- screening by dermatologists
- sun protection training of safety officers, managers or recreation staff (including at outdoor pools)
- peer leader modeling
- classroom teaching, sometimes using brochures
- interactive activities
- provision or promotion of sun-protective gear or products.

The TFCPS reviewed 8 studies which again were not considered to provide sufficient evidence to draw a conclusion about effectiveness. The main recommendation was to pursue more research, and especially to look for interventions with strong results that could be incorporated into the workplace with minimal disruption to its main functions.[785]

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[781] Weinstock MA, Rossi JS, Redding CA et al. Sun protection behaviors and stages of change for the primary prevention of skin cancers among beachgoers in southeastern New England *Annals of Behavioral Medicine* 2000; 22(4): 286-93.

[782] Saraiya M, Glanz K, Briss P et al. On reducing exposure to ultraviolet light. Preventing skin cancer: findings of the Task Force on Community Preventive Services *Morbidity & Mortality Weekly Report. Recommendations & Reports* 2003; 52(RR-15): 1-12.

[783] Weinstock MA, Rossi JS, Redding CA et al. Randomized controlled community trial of the efficacy of a multicomponent stage-matched intervention to increase sun protection among beachgoers *Preventive Medicine* 2002; 35(6): 584-92.

[784] By comparison, low intensity interventions are not recommended; e.g., merely offering leaflets on sun protection through travel agents and tour operators has had no effect. Dey P, Collins S, Will S et al. Randomised controlled trial assessing effectiveness of health education leaflets in reducing incidence of sunburn *British Medical Journal* 1995; 311: 1062-3.

[785] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).

School-based Interventions

Child Care Centres

Educational and policy approaches in child care centres are designed to decrease sunburns or increase sun-protective knowledge, attitudes, intentions and behaviours. Intervention components have included curriculum for classroom and take-home activities, brochures for parents, staff education, and a working session to develop plans and policies. The latter included some combination of increasing sunscreen use, promoting sun-protective clothing, avoidance of peak sun hours, and increasing provision of shade and / or encouraging playing in shade. Only two studies qualified in the TFCPS review, which did not provide sufficient data for the Task Force to make a recommendation.[786]

Primary Schools

The intervention aims with younger grade-school children are similar to those described for child care centres. The components include some combination of:

- provision of information to children (instruction, small media or both).
- additional activities to influence them (e.g., demonstration, role playing)
- activities intended to change the involvement of caregivers
- environment or policy approaches (e.g., providing sunscreen, shade, or play times before or after peak sun intensity).

The TFCPS identified 20 studies, but only found 6 of them to be of the highest quality. The median relative increase in sun-protective behaviour was 25%. Only one study looked at decreasing sunburns as a proxy for decreased sun exposure. There was inconsistent evidence about the impact of interventions aimed at avoiding peak sunlight times.[787] An earlier US review of skin cancer prevention for children was positive about the impact of school curricula to change sun-safety behaviours, though a multi-unit approach was required. Changes as a result of short presentations were highly variable, very small or nonexistent.[788] A study published in 2004 further reinforces the value of curricular interventions, e.g., three times more children in the intervention group used long-sleeve shirts and hats.[789]

Interventions include some combination of increasing sunscreen use, promoting sun-protective clothing, avoidance of peak sun hours, and increasing provision of shade and / or encouraging playing in shade.

[786] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).
[787] Saraiya M, Glanz K, Briss P et al. On reducing exposure to ultraviolet light. Preventing skin cancer: findings of the Task Force on Community Preventive Services *Morbidity & Mortality Weekly Report. Recommendations & Reports* 2003; 52(RR-15): 1-12.
[788] Buller DB, Borland R. Skin cancer prevention for children: a critical review *Health Education & Behavior* 1999; 26(3): 317-43.
[789] Stankeviciute V, Zaborskis A, Petrauskiene A et al. Skin cancer prevention: children's health education on protection from sun exposure and assessment of its efficiency *Medicina* 2004; 40(4): 386-93.

Secondary School / College

Educational policy and approaches have been aimed at decreasing sunburns and increasing sun-protective knowledge, attitudes and behaviours among adolescents and young adults. Interventions include classroom teaching, home activities, internet-based material, small media (e.g., brochures, fact sheets, sunscreen samples, class credit and / or cash incentives). Although the TFCPS found 13 studies, they were not considered substantial enough or of sufficient quality to warrant a conclusion on effectiveness.[790] A modest review of UK interventions included one study which did not contradict this conclusion.[791]

Home-based Interventions

Interventions oriented to parents or other caregivers are aimed at changing their behaviour, though the ultimate goal is to change the level of protection enjoyed by the children under their care. Single or multi-component approaches have included one or more of the following:

- surveys to assess current level of knowledge and practice
- educational brochures
- newsletters, tip cards and postcard reminders
- sun-safety lessons, interactive activities and incentives
- increasing shade or providing sunscreen
- point-of-purchase prompts such as discount coupons for protective gear.

Interventions oriented to parents or other caregivers are aimed at changing their behaviour, though the ultimate goal is to change the level of protection enjoyed by the children under their care.

The TFCPS did not find sufficient evidence among 9 qualifying studies to recommend this intervention category as effective in improving sun-protective attitudes or behaviours. A recent result of interest is the positive correlation between a parent's sun-safe practices and those of their adolescent children.[792,793] Efforts to improve parental modeling, as occurred in one UK study,[794] might produce downstream effects with children. Apart from their example and persuasion, parents also "often control the environment and organizational policies that promote or hinder protection for children."[795]

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[790] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).
[791] Melia J, Pendry L, Eiser JR et al. Evaluation of primary prevention initiatives for skin cancer: a review from a UK perspective *British Journal of Dermatology* 2000; 143(4): 701-8.
[792] Cokkinides VE, Weinstock MA, Cardinez CJ et al. Sun-safe practices in U.S. youth and their parents: role of caregiver on youth sunscreen use *American Journal of Preventive Medicine* 2004; 26(2): 147-51.
[793] O'Riordan DL, Geller AC, Brooks DR et al. Sunburn reduction through parental role modeling and sunscreen vigilance *Journal of Pediatrics* 2003; 142(1): 67-72.
[794] Fleming C, Newell J, Turner S et al. A study of the impact of Sun Awareness Week 1995 *British Journal of Dermatology* 1997; 136: 719-24.
[795] Buller DB, Borland R. Skin cancer prevention for children: a critical review *Health Education & Behavior* 1999; 26(3): 317-43.

Clinical Interventions and Management

There are two categories of interventions relevant to healthcare settings, namely, the counselling and other services provided to patients and the attempts to improve the effectiveness of providers such as physicians and pharmacists.

The TFCPS looked at the education of healthcare providers through teaching sessions, internet, video and role-modeling. Although 11 studies were identified, they were lacking in one significant regard, i.e., in not measuring the improvements in knowledge and sun-protective behaviour among clients rather than providers.[796] Continued attention to improving clinical effectiveness is advisable as physicians are reported to be the top desired source for sun protection information.[797] An important result from a Canadian study noted a high correlation between sun protective behaviours and having received physician advice.[798]

Counselling

As for the interventions actually used by healthcare providers, the most notable one is counselling. According to a somewhat outdated report by the Canadian Task Force on Preventive Health Care, there are few data on the effectiveness of counselling patients to protect themselves from sunlight.[799] Most studies of counselling have examined intermediate outcomes such as knowledge and attitudes rather than changes in sun-protective behaviour. An exception is a before/after study which evaluated counselling at the time of skin cancer removal; increased use of protective measures and reduced deliberate tanning were observed on 2-6 year follow-up, but it is not clear how much the effect could be attributed to the surgery itself.[800]

The conclusion of the Canadian Task Force was that there was insufficient evidence to recommend for or against counselling, but that it was still prudent to counsel, especially those patients with established risk factors for skin cancer (e.g., light-coloured skin). This recommendation, consistent with the advice of major healthcare organizations, was based on the low risk and cost of such counselling and the potentially large health benefits. The counselling should focus on sun avoidance and protective clothing.[801] The parallel US work in this area includes newer studies, but with substantially the same conclusions.[802] The latter report does offer additional data on two important and controversial topics, namely, sunscreens and tanning salons. Although it also fits under other categories, it is convenient to cover sunscreens at this point, whereas tanning devices will be briefly outlined in the section below which deals with regulations.

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[796] The Community Guide. Available at http://www.thecommunityguide.org/cancer/skin/default.htm (accessed November 2004).
[797] Weinstein JM, Yarnold PR, Hornung RL. Parental knowledge and practice of primary skin cancer prevention: gaps and solutions *Pediatric Dermatology* 2001; 18(6): 473-7.
[798] Boggild AK, From L. Barriers to sun safety in a Canadian outpatient population *Journal of Cutaneous Medicine & Surgery* 2003; 7(4): 292-9.
[799] Feightner JW. Prevention of Skin Cancer. 1994. Available at http://www.hc-sc.gc.ca/hppb/healthcare/pdf/clinical_preventive/s10c70e.pdf (accessed November 2004).
[800] Robinson JK. Compensation strategies in sun protection behaviors by a population with nonmelanoma skin cancer *Preventive Medicine* 1992; 21: 754-65.
[801] Feightner JW. Prevention of Skin Cancer. 1994. Available at http://www.hc-sc.gc.ca/hppb/healthcare/pdf/clinical_preventive/s10c70e.pdf (accessed November 2004).
[802] US Preventive Services Task Force. *Counseling to Prevent Skin Cancer*, 2003. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5215a2.htm (accessed November 2004).

Sunscreens

The evidence only supports the modest effectiveness of sunscreen for preventing squamous cell carcinoma and its precursor, solar keratoses.[803,804,805] There is insufficient evidence for a positive effect on basal cell carcinoma or melanoma, and even some evidence that relying on sunscreen could increase the risk of contracting these conditions.[806,807,808] Recently, the International Agency for Research on Cancer of the World Health Organization concurred with these cautions concerning dependence on sunscreen.[809] These results have not fully penetrated into clinical practice; one survey of paediatricians showed that 60% usually or always counsel about skin protection, but that their advice normally focuses on using sunscreen.[810] Likewise, the general public is still confident in sunscreens; a recent study showed that parents typically used sunscreen to protect their children at the beach rather than sun avoidance or protective clothing.[811]

There has been research on other topical and systemic agents to protect against solar damage. The most promising to date has been a polyphenolic extract from green tea.[812] Retinoids, synthetic derivatives of Vitamin A taken orally by prescription, have been found to be chemoprotective against skin cancer,[813] as have lipid-lowering agents for heart disease.[814]

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[803] A small lump on the skin which is caused by a lot of exposure to sun over the years.

[804] Green A, Williams G, Neale R et al. Daily sunscreen application and beta-carotene supplementation in prevention of basal-cell and squamous-cell carcinomas of the skin: a randomised controlled trial *The Lancet* 1999; 354: 723-9.

[805] Thompson SC, Jolley D, Marks R. Reduction of solar keratoses by regular sunscreen use *New England Journal of Medicine* 1993; 329: 1147-51. Note: a keratosis is a skin condition marked by an overgrowth of layers of horny skin which can manifest as pink/reddish scaly lesions; can be a pre-cancerous marker.

[806] Westerdahl J, Olsson H, Masback A et al. Is the use of sunscreens a risk factor for malignant melanoma? *Melanoma Research* 1995; 5: 59-65.

[807] Huncharek M, Kupelnick B. Use of topical sunscreens and the risk of malignant melanoma: a meta-analysis of 9067 patients from 11 case-control studies *American Journal of Public Health* 2002; 92: 1173-7.

[808] Autier P, Dore JF, Luther H. The case of sunscreens revisited *Archives of Dermatology* 1998; 134: 509-10.

[809] International Agency for Research on Cancer (IARC). *Handbooks of Cancer Prevention: Sunscreens.* Vol. 5. Lyon, France: IARC Press, 2001.

[810] Easton A, Price J, Boehm K et al. Sun protection counseling by pediatricians *Archives of Pediatrics & Adolescent Medicine* 1997; 151: 1133-8.

[811] Boyett T, Davy L, Weathers L et al. Sun protection of children at the beach *Journal of the American Board of Family Practice* 2002; 15(2): 112-7.

[812] Scarlett WL. Ultraviolet radiation: sun exposure, tanning beds, and vitamin D levels. what you need to know and how to decrease the risk of skin cancer *Journal of the American Osteopathic Association.* 2003; 103(8): 371-5.

[813] Reilly P, DiGiovanna JJ. Retinoid chemoprevention in high-risk skin cancer patients *Dermatology Nursing* 2004; 16(2): 117-20, 123-6.

[814] Dellavalle R, McNealy K, Graber M et al. Lipid-lowering agents for preventing melanoma. Cochrane Skin Group *Cochrane Database of Systematic Reviews*, 2003.

Regulatory and Economic Interventions

Artificial Tanning Devices / Beds

About a third of 19 case-control studies[815] reviewed found a positive association between the use of artificial tanning devices and melanoma risk, but most did not adjust for confounders such as recreational sun exposure. Of the 9 studies which examined duration, frequency or timing of tanning device exposure, 4 found a positive association with melanoma risk. The strongest link was with a high lamp exposure and / or an experience of burning.

The evidence for precisely how to regulate warnings (or counsel) in reference to artificial tanning devices remains somewhat equivocal. There is new data suggesting that the supposedly safer long-wavelength UV-A rays that are the staple of tanning devices can also damage the skin, and especially increase the risk of non-melanoma skin cancers.[816] This only increases the need to confirm the science and clarify the policy as soon as possible.

Potential Harms of Skin Protection

There are limited data about the potential harms of counselling or of specific sun-safety behaviours. Sunscreen use can lead to a "false sense of security."[817] One RCT with young adults found that those using a sunscreen with a high sun protection factor (SPF) stayed longer in the sun than those using sunscreen with a lower SPF.[818] A similar issue exists around "fake tan" products which some people mistakenly believe are protective against sunburns. Recent studies of this phenomenon have been conducted in Australia, the country with the highest skin cancer rates in the world.[819,820]

Other unproven concerns of sun-safety measures focus on reduced vitamin D with sunscreen use and lower levels of physical activity and mental health with sun avoidance strategies.[821]

These cautions necessitate the careful development of any policy related to sunscreens or other sun-protective strategies.

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[815] Swerdlow AJ, Weinstock MA. Do tanning lamps cause melanoma? An epidemiologic assessment *Journal of the American Academy of Dermatology* 1998; 38: 89-98.
[816] Autier P, Dore JF. Influence of sun exposures during childhood and during adulthood on melanoma risk. EPIMEL and EORTC Melanoma Cooperative Group. European Organisation for Research and Treatment of Cancer *International Journal of Cancer* 1998; 77(4): 533-7.
[817] US Preventive Services Task Force. *Counseling to Prevent Skin Cancer*. 2003. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5215a2.htm (accessed November 2004).
[818] Autier P, Dore JF, Negrier S et al. Sunscreen use and duration of sun exposure: a double-blind, randomized trial *Journal of the National Cancer Institute* 1999; 91: 1304-9.
[819] Girgis A, Tzelepis F, Paul CL et al. Australians' use of fake tanning lotions: another piece of the puzzle *Australian & New Zealand Journal of Public Health* 2003; 27(5): 529-32.
[820] Beckmann KR, Kirke BA, McCaul KA et al. Use of fake tanning lotions in the South Australia population *Medical Journal of Australia* 2001; 174: 75-8.
[821] US Preventive Services Task Force. *Counseling to Prevent Skin Cancer* 2003. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5215a2.htm (accessed November 2004).

Social Normalization

Since so many public prevention strategies to reduce solar UV exposure have been ineffective, there has been a suggestion that the best way forward is to influence social norms. The parallel is with the public stigma that is now firmly attached to smoking in more and more populations and settings. The proposal in the case of UV exposure is to decrease "the present utility of a suntan."[822] Society needs to counteract the immediate benefits associated with a tan, especially in light of how distant in the future the health costs of UV radiation will normally be felt. For children and teens, the social norm needs to become fair skin and protective clothing.

The ever-influential arena of popular movies may become the best influencer at this point; the image of pale-skinned film stars may be more effective than sunscreen in reducing harmful UV exposure. Public policies need to reinforce any momentum towards a normative shift in society, e.g., planting shade trees, planning events at times when sunlight is at low intensity, and requiring better design and ultraviolet protection factor labelling in summer clothing.[823] One of the most significant impacts could be made in school settings were the norm to become the use of sun-protective clothing and /or sunscreen at all outdoor play times.[824,825] So far, studies of such policy and environmental changes have been limited.[826]

Since so many public prevention strategies to reduce solar UV exposure have been ineffective, there has been a suggestion that the best way forward is to influence social norms by reducing the 'utility' of a suntan.

[822] Feldman SR, Dempsey JR, Grummer S et al. Implications of a utility model for ultraviolet exposure behavior *Journal of the American Academy of Dermatology* 2001; 45(5): 718-22.
[823] Gambichler T, Rotterdam S, Altmeyer P et al. Protection against ultraviolet radiation by commercial summer clothing: need for standardised testing and labelling *BMC Dermatology* 2001; 1(1): 6.
[824] Feldman SR, Dempsey JR, Grummer S et al. Implications of a utility model for ultraviolet exposure behavior *Journal of the American Academy of Dermatology* 2001; 45(5): 718-22.
[825] Guidelines for School Programs to Prevent Skin Cancer *Morbidity & Mortality Weekly Report* 2002; 51(RR-4): 1-18.
[826] Buller DB, Borland R. Skin cancer prevention for children: a critical review *Health Education & Behavior* 1999; 26(3): 317-43.

High Risk Groups

Outdoor Workers

All outdoor workers exposed to the sun are at increased risk of ultraviolet (UV) exposure. Farmers, police, athletes and construction workers are only a few of the workers who may experience up to 10% more UV than indoor workers.[827] Mountain guides have been shown to be exposed to 23 times the recommended limits for UV radiation[828] and professional cyclists have been shown to exceed the international exposure standards by more than 30 times.[829] This increased exposure has been shown to damage eyes[830] as well as amplify the risk for cancer.[831] One study estimated that 44% of outdoor workers are at increased risk for skin cancer, with the estimated lifetime skin cancer risk of this group being up to 20 times higher than other workers.[832] An Australian study found that outdoor workers with sensitive skin experienced more skin cancers and lesions, and developed them earlier, than indoor workers.[833] These studies are consistent with general reviews comparing skin cancer incidence rates by occupation.[834,835] The results show that specific sun-safety interventions targeting outdoor workers are necessary as a part of an overall strategy of occupational carcinogen control (see the next section of this report).

The risk of skin cancer in outdoor workers can be up to 20 times the risk of other workers.

There are a number of measures that can be put in place to control UV exposure in the outdoor workplace, including engineering controls, such as providing shade covers for workers, and administrative controls, such as rescheduling outdoor work programs or moving jobs to shady areas. Rotating staff between indoor and outdoor tasks would lessen each employee's total UV exposure. Other measures include the provision of personal protective equipment and training for all workers exposed to high levels of UV radiation.[836] Personal precautions include wearing approved sunglasses and protective clothing, using sunscreen on exposed skin, and regular skin cancer screenings.[837] The majority of intervention programs encourage these

[827] Parisi AV, Meldrum LR, Wong JC et al. Lifetime ultraviolet exposure estimates for selected population groups in south-east Queensland *Physics in Medicine and Biology* 1999; 44(12): 2947-53.
[828] Moehrle M, Dennenmoser B, Garbe C. Continuous long-term monitoring of UV radiation in professional mountain guides reveals extremely high exposure *International Journal of Cancer* 2003; 103(6): 775-8.
[829] Moehrle M, Heinrich L, Schmid A et al. Extreme UV exposure of professional cyclists *Dermatology* 2000; 201(1): 44-5.
[830] Sun Safety Guidelines for Outdoor Workers. *Leeds, Grenville and Lanark District Health Unit,* 2003. Available at www.healthunit.org/sunsafety/outsidework.htm (accessed November 2004).
[831] Scarlett WL. Ultraviolet radiation: sun exposure, tanning beds, and vitamin D levels. what you need to know and how to decrease the risk of skin cancer *Journal of the American Osteopathic Association* 2003; 103(8): 371-5.
[832] Azizi E, Modan M, Fushs Z et al. Skin cancer risk of Israeli workers exposed to sunlight *Harefuah* 1990; 118(9): 508-11.
[833] Woolley T, Buettner PG, Lowe J. Sun-related behaviours of outdoor working men with a history of non-melanoma skin cancer *Journal of Occupational & Environmental Medicine* 2002; 44(9): 847-54.
[834] Beral V, Robinson N. The relationship of malignant melanoma, basal and squamous skin cancers to indoor and outdoor work *British Journal of Cancer* 1981; 446: 886-91.
[835] Marks R, Jolley D, Dorevitch AP et al. The incidence of non-melanoucytic skin cancers in Australian population: results of a five-year prospective study *Medical Journal of Australia* 1989; 150: 475-8.
[836] Ultraviolet radiation as a hazard in the workplace *World Health Organization,* 2003.
[837] Skin cancer and sunlight *Canada's National Occupational Health & Safety Resource,* 1999. Available at www.ccohs.ca/oshanswers/diseases/skin_cancer.html (accessed November 2004).

individual measures through education. One effectiveness evaluation showed that in outdoor workers who were screened for skin cancer, told about the level of sun damage on their skin, and educated about sun protection, sun protection behaviour increased by 16%.[838]

As a related issue, it is notable that workers exposed to non-solar UV, from sources such as welding torches and fluorescent lights, can also be at an increased risk for cancer.[839,840] Engineering and administrative controls, as well and personal protective equipment can minimize health risk to such exposed workers.[841]

Skin Cancer Patients

Skin cancer patients are at increased risk of developing further skin cancer as a result of solar UV because of their existing genetic or behavioural susceptibility.[842,843] Previous or current skin cancer patients present an opportunity to deliver intervention programs to what amounts to a presumably motivated "captive audience."

Although some skin cancer patients have been shown to use sunscreens more regularly, without education many of the sun exposure habits of these patients show no statistically significant difference from the rest of the population.[844,845] When education is provided to previous skin cancer patients, results can be positive. In one study, 1042 people received repetitive and interactive oral and written education about sun protection after having non-melanoma skin cancer surgically removed. At one-year follow-up, 62% continued to use sunscreens and 56% changed their outdoor activity habits.[846]

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[838] Girgis A, Sanson-Fisher RW, Watson A. A workplace intervention for increasing outdoor workers' use of solar protection *American Journal of Public Health* 1994; 84(1): 77-81.
[839] Currie CL, Monk BE. Welding and non-melanoma skin cancer *Clinical Dermatology* 2000; 25: 28-9.
[840] Guenel P, Laforest L, Cyr D et al. Occupation risk factors, ultraviolet radiation, and ocular melanoma: a case-control study in France *Cancer Cause & Control* 2001; 12(5): 451-9.
[841] Ultraviolet radiation as a hazard in the workplace *World Health Organization*, 2003.
[842] *The Genetics of Skin Cancer* Stanford Cancer Centre, 2004. Available at http://cancer.stanford hospital.com/healthInfo/geneticsAndCancer/types/skin/index.html (accessed November 2004).
[843] Melia J, Pendry L, Eiser JR et al. Evaluation of primary prevention initiatives for skin cancer: a review from a U.K. perspective *British Journal of Dermatology* 2000; 143: 701-8.
[844] Harth Y, Ulman Y, Peled I et al. Sun protection and sunscreen use after surgical treatment of basal cell carcinoma *Photodermatology, Photoimmunology & Photomedicine* 1995; 11(4): 140-2.
[845] Scarlett WL. Ultraviolet radiation: sun exposure, tanning beds, and vitamin D levels. what you need to know and how to decrease the risk of skin cancer *Journal of the American Osteopathic Association* 2003; 103(8): 371-5.
[846] Robinson JK. Behaviour modification obtained by sun protection education coupled with removal of a skin cancer *Archives of Dermatology* 1990; 126(4): 477-81.

Summary

1. Interventions of proven effectiveness with strong evidence

- Educational and policy approaches to sun-safety in primary schools.
- Educational and policy initiatives with adults in recreational settings.

2. Interventions of promising effectiveness with moderate or mixed evidence

- Counselling for sun protection in healthcare settings.
- Community-wide campaigns and mass media communication such as the ultraviolet index.

3. Interventions of no or low effectiveness and / or with insufficient evidence

- Educational and policy approaches in child care centers, secondary schools and colleges.
- Single focus and multi-component programs in the workplace.
- Sunscreen products.
- Single focus or multi-component programs for parents / caregivers.

Exposure to Occupational and Environmental Carcinogens

As many as 5% of cancer deaths are due to occupational factors and 2% to environmental pollution.[847] These figures are very general approximations, as estimating the attributable mortality of carcinogens is a complex task.[848] The only occupational exposure which has been thoroughly documented is that involving asbestos, which may by itself account for half of all occupational cancer deaths.[849]

For most carcinogens, data is derived from high-dose experiments in animals; thus policy-makers must extrapolate from animals to humans and from high-dose to low-dose conditions.[850] The assumptions involved in such risk assessment involve a lot of uncertainty, but in practice regulations "err on the side of safety." The *precautionary principle* suggests that it is best to avoid exposure to a suspicious albeit useful substance, even in the absence of unequivocal evidence, as long as there are known alternatives that are safe.

The *precautionary principle* suggests that it is best to avoid exposure to a suspicious albeit useful substance, even in the absence of unequivocal evidence, as long as there are known alternatives that are safe.

Another complication both in terms of research and motivation towards prevention is the long latency period between exposure to many carcinogens and disease development—as long as 40 to 50 years. Asbestos again provides an example. Although asbestos exposure levels in Europe and other developed regions have been dramatically reduced since 1980, the expected improvement in mesothelioma[851] rates and pleural cancer deaths will not "kick in" until 2018. The highest risk is carried by men born around 1945.[852]

It will not be possible to detail the risks of and responses to each and every carcinogen. The volume of data would overwhelm this report. The World Health Organization maintains a website with over 200 monographs detailing the effects of and interventions for harmful environmental agents; the asbestos report alone includes over 40 pages of references.[853]

Even in the absence of detailed treatments, the basic pattern of intervention is clear. Once a carcinogen has been identified, primary prevention is the best strategy, i.e., eliminating sources of carcinogen exposure, or at least reducing exposure levels.

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[847] Adami H, Day N, Trichopoulos D et al. Primary and secondary prevention in the reduction of cancer morbidity and mortality *European Journal of Cancer* 2001; 37: S118-S127.
Some Canadian authorities have recently suggested that these figures are underestimates. Canadian Strategy for Cancer Control. *Report on Environmental and Occupational Exposures Meeting,* January 14, 2003. Available at http://209.217.127.72/cscc/pdf/pprev/Env&OccupMtgReport_ an142003.pdf (accessed December 2004).

[848] Levi F. Cancer prevention: epidemiology and perspectives *European Journal of Cancer* 1999; 35(7): 1046-58.

[849] Doll R, Peto R. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today *Journal of the National Cancer Institute* 1981; 66: 1191-1308.

[850] American Cancer Society. Available at http://www.cancer.org/docroot/PED/content/PED_1_3X_ Risk_Assessment.asp?sitearea=PED (accessed December 2004).

[851] A rare type of cancer in the sac lining the chest or abdomen. Exposure to airborne asbestos increases the risk of developing malignant mesothelioma.

[852] Levi F. Cancer prevention: epidemiology and perspectives *European Journal of Cancer* 1999; 35(7): 1046-58.

[853] Source: http://www.inchem.org/pages/ehc.html (accessed December 2004).

Secondary prevention depends on detecting asymptomatic illness. The newest screening tests, which involve measuring various biomarkers that are also used in molecular epidemiology, can be very expensive.[854,855]

Effectiveness Assessment

It is useful to note from the start that there will be no effectiveness evaluations provided for the prevention strategies summarized below. Data on outcomes related to interventions are scarce in the literature. While "environmental scans" listing many different programs are commonplace, comparing the relative effectiveness of interventions related to carcinogens has not yet been part of the research agenda.

The International Union Against Cancer (UICC) is the largest non-governmental association related to cancer in the world, comprising 280 cancer-fighting organisations. It published a guide to cancer prevention in 2004[856] which could only find one systematic review on the effects of interventions to control occupational carcinogen risk. That review, though limited to carcinogenic risk in the rubber industry, outlined the complexity encountered in gathering evidence of prevention effectiveness with all forms of workplace cancer:[857]

- as noted above, the long latency period between exposure and disease development, which makes it difficult to identify harmful agents, makes it equally difficult to monitor improvements in morbidity and mortality with any intervention (though the use of biological markers of exposure is helping to offset this problem).
- long-term observational studies are challenging to conduct, especially trying to control confounding influences (and RCTs with an unprotected control group of course would not be ethical).
- the quantitative relationship between exposure and disease is often poorly understood, so that an intervention involving the reduction of exposure is difficult to interpret.
- in the event a carcinogen is eliminated in an occupational setting, the health impact of any substitute product is not always certain.

The UICC report concludes: "this picture shows why it is difficult to obtain evidence of a reduction in cancer risk after the adoption of control measures and why reports of such evidence are rare."[858]

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[854] Hrelia P, Maffei F, Angelini S et al. A molecular epidemiological approach to health risk assessment of urban air pollution *Toxicology Letters* 2004; 149(1-3): 261-7.
[855] Norppa H. Cytogenetic biomarkers *IARC Scientific Publications* 2004; (157): 179-205.
[856] International Union Against Cancer. *Evidence-based Cancer Prevention: Strategies for NGOs - A UICC Handbook for Europe.* Available at http://www.uicc.org/index.php?id=976 (accessed December 2004).
[857] Kogevinas M, Sala M, Boffetta P et al. Cancer risk in the rubber industry: a review of the recent epidemiological evidence *Occupational & Environmental Medicine* 1998; 55(1): 1-12.
[858] International Union Against Cancer. *Evidence-based Cancer Prevention: Strategies for NGOs - A UICC Handbook for Europe.* Available at http://www.uicc.org/index.php?id=976 (accessed December 2004).

Occupational Exposures

Occupationally-related cancers make up a small fraction of all cancers, but the prevalence increases greatly when the population is restricted to those directly at risk. For example, an estimated 9% of men in occupations characterized by carcinogen exposure contract lung cancer.[859] One study suggested that 13 to 18% of lung cancers in European men may be attributable to occupational carcinogens.[860] Overall, it is estimated that 9% of all malignancies in men can be traced to the workplace.[861]

> *"Of all the occupationally related diseases, cancer evokes particular concern and strong emotions, because of the opportunity afforded for attribution, blame, and compensation. On the other hand, occupational cancers have unique potential for prevention."*
> Veys CA. ABC of work related disorders: occupational cancers *British Medical Journal* 1996; 313: 615-9.

Occupational exposure has always figured highly in cancer studies. Apart from final conclusions on prevalence and risk levels, there are several motivations for identifying carcinogens in the workplace:[862]

- many environmental carcinogens are first detected in the workplace.[863,864]
- the workplace is a unique setting where large numbers might be exposed to a harmful agent and where epidemiological cohorts can be conveniently assembled for research purposes.[865]
- risk assessment and control procedures can be easily applied.
- occupational cancers are mostly preventable.[866]

Categorizing Carcinogens

There are many complexities with identifying occupational carcinogens. Most occupational exposures are also found in the environment, including consumer products. For example, though asbestos, benzene and radon gas are considered occupational hazards, "it is likely that many more people are exposed to these substances outside than inside the occupational environment."[867] Most environmental agents and consumer products are found in some occupational settings. This includes, naturally, substances in air and water, but also medications, foods and others. As well, sunlight can be a cancer risk factor in outdoor work (see

[859] Morabia A, Markowitz S, Garibaldi K et al. Lung cancer and occupation: results of a multicentre case-control study *British Journal of Industrial Medicine* 1992; 49(10): 721-7.
[860] Boffetta P, Kogevinas M. Introduction: epidemiologic research and prevention of occupational cancer in Europe *Environmental Health Perspectives* 1999; 107(Suppl 2): 229-31.
[861] Miller AB. The information explosion: the role of the epidemiologist *Cancer Forum* 1984; 8: 67-75.
[862] Stellman JM, Stellman SD. Cancer and the workplace *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 70-92.
[863] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.
[864] Blair A, Rothman N, Zahm SH. Occupational cancer epidemiology in the coming decades *Scandinavian Journal of Work, Environment & Health* 1999; 25(6): 491-7.
[865] Ward EM, Schulte PA, Bayard S et al. Priorities for development of research methods in occupational cancer *Environmental Health Perspectives* 2003; 111(1): 1-12.
[866] Lamontagne AD, Christiani DC. Prevention of work-related cancers *New Solutions* 2002; 12(2): 137-56.
[867] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.

the previous section of this report). The distinction between occupational and environmental carcinogens can thus be quite arbitrary.

Occupational Carcinogens

Only about 2% of the 50,000 chemicals used in industry have been evaluated for carcinogenicity.[868] It is clear that many more hazardous agents may be discovered, though for now there has been "a shift away from occupational cancer research in the epidemiologic community."[869] One reason for the reduced emphasis is the decreased exposure to some recognized carcinogens; in other words, there have been some public and occupational health success stories, e.g., modifications in the dyestuff industry which has reduced bladder cancer rates. However, the rise of new industries with unassessed risks, and the "export" of high risk industries to developing countries, means that the prevention task is hardly complete.[870]

The International Agency for Research on Cancer (IARC)[871] classifies the evidence identifying a carcinogen as sufficient, limited or inadequate; there also may be definite evidence for a *lack* of carcinogenicity (in 1996, only 1 chemical out of 782 examined agents fit this last category).[872] Sufficient evidence means that the data points to actual causation, i.e., the substance causes cancer. The second category, limited evidence, is sometimes divided into *probably* and *possibly* carcinogenic.

The growth in the number of known carcinogens identified by the IARC can be seen in the following table:[873]

Category	*1972-1995*	*1972-2004*
Carcinogenic Substances	66	95
Probably Carcinogenic	51	66
Total	**117**	**161**

One of the most recent substances added to the list was environmental tobacco smoke (May, 2004). As a comparison, the US National Toxicity Program identified 228 carcinogens (52 definite)[874] in its biennial report of December, 2002. Of course, not all carcinogens on the list are chemicals, e.g., ultraviolet (see the previous major

[868] Stellman JM, Stellman SD. Cancer and the workplace *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 70-92.
[869] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.
[870] Boffetta P, Kogevinas M. Introduction: Epidemiologic research and prevention of occupational cancer in Europe *Environmental Health Perspectives* 1999; 107(Suppl 2): 229-31.
[871] Goldsmith DF. Linking environmental cancer with occupational epidemiology research: the role of the International Agency for Research on Cancer (IARC) *Journal of Environmental Pathology, Toxicology & Oncology* 2000; 19(1-2): 171-5.
[872] Stellman JM, Stellman SD. Cancer and the workplace *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 70-92.
[873] IARC website. Available at http://www.iarc.fr/ (accessed December 2004).
[874] Source: http://ehp.niehs.nih.gov/roc/toc10.html (accessed December 2004).

section of this report) and other types of radiation.[875] In fact, one of the prototype carcinogenic agents was x-rays, which, ironically, first came to light in healthcare settings.[876]

Narrowing the total number of hazards down to specifically *occupational* carcinogens is a difficult task, for reasons noted above. A November, 2004, report involving Canadian researchers summarized the best current understanding, based on IARC data, as follows:

- Definite occupational carcinogens: 28
- Probable occupational carcinogens: 27
- Possible occupational carcinogens: 113

Thus only a third of the entire list of definite / probable carcinogens has been associated significantly with workplaces. As a further comparison, the US National Institute for Occupational Safety and Health has 133 agents on its 2004 list of occupational carcinogens; their criteria and methods of selection are not clear.[877]

Occupational carcinogens can be further analyzed according to the precise occupations implicated and their target sites of cancer. Occupations with known exposure risks include:[878]

Known exposure risks - Aluminium production, boot and shoe manufacturing, coke production, cabinet making, iron and steel founding, painting, rubber industry.

Probable exposure risks - Art glass, hairdresser, insecticide use, petroleum refining.

Such identification of high-risk occupations needs to be qualified, as conditions can vary widely over different sites and over time. Likewise, a known carcinogen can have a variety of effects in different people under different circumstances; genetic factors, for instance, are known to play a role.[879,880]

In terms of cancer sites, there is strong evidence of occupational carcinogenesis in nasal cavities, larynx, lung, liver, skin, bladder, thyroid and blood (specifically leukemia).[881] The lung is the target organ most affected by occupational carcinogens.

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[875] Wakeford R. The cancer epidemiology of radiation *Oncogene* 2004; 23: 6404-28.
[876] Stellman JM, Stellman SD. Cancer and the workplace *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 70-92.
[877] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.
[878] Stellman JM, Stellman SD. Cancer and the workplace *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 70-92.
[879] Thier R, Golka K, Bruning T et al. Genetic susceptibility to environmental toxicants: the interface between human and experimental studies in the development of new toxicological concepts *Toxicology Letters* 2002; 127(1-3): 321-7.
[880] Ishibe N, Kelsey KT. Genetic susceptibility to environmental and occupational cancers *Cancer Causes & Control* 1997; 8(3): 504-13.
[881] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.

Prevention

This report will only examine prevention in reference to occupational carcinogens in general terms. Although a specific story could be told about each of the 50 to 150 known or probable cancer-causing hazards in workplaces (similar to the presentation on environmental tobacco smoke earlier in this report), neither time nor space allows such an approach. What is most vital for the present report is to realize that the strategic framework for response is quite similar for many different carcinogens and occupations.

This report will only examine prevention in reference to occupational carcinogens in general terms.

There are several precursors to an intervention in occupational settings, each of which represent a considerable challenge:

- identifying a substance as a carcinogen and acknowledging the degree of evidence currently available
- working out dose-response relationships and any mediating factors such as genetics or co-carcinogens
- assessing exposure levels in a particular workplace
- assembling the preceding information into an overall quantitative risk assessment[882]
- considering which interventions to pursue in light of political lobbying, public perception and feasibility considerations.[883]

Control strategies for occupational carcinogens take place at two levels: societal and individual workplaces.

Societal Interventions

The response of a whole society or community to an occupational hazard involves various regulatory controls of decreasing intensity:[884,885]

- outright bans on the manufacture and use of the material or of the particular risky industrial process
- clear standards, enforcement and penalties
- established limits for exposure, and surveillance systems to alert, monitor compliance, and evaluate interventions
- regulated limits for exposure with no mandated surveillance
- legislated guidelines on the safe use of a substance
- mandated educational efforts
- "right to know" policies.

The **surveillance** systems mentioned in this list, while technically not a preventive measure, have proven to be invaluable in researching hazards, evaluating intervention

[882] Siemiatycki J, Richardson L, Straif K et al. Listing of occupational carcinogens *Environmental Health Perspectives* 2004; 112(15): 1447-59.
[883] Verma DK, Purdham JT, Roels HA. Translating evidence about occupational conditions into strategies for prevention *Occupational & Environmental Medicine* 2002; 59(3): 205-13.
[884] Canadian Strategy for Cancer Control. *Best Practices Review: Primary Prevention of Exposures to Occupational and Environmental Carcinogens.* October, 2004.
[885] Verma DK, Purdham JT, Roels HA. Translating evidence about occupational conditions into strategies for prevention *Occupational & Environmental Medicine* 2002; 59(3): 205-13.

effectiveness, and prompting necessary improvements in regulatory controls.[886] An example of a surveillance system in Canada is the National Dose Registry, which monitors exposure to ionizing radiation in a number of occupations. The risk assessment and surveillance task can be very complex when dealing with a mixture of agents in a workplace.[887] Synthesized rating and prioritizing methods have been proposed by some researchers.[888]

The **outright ban** of an industrial substance or process is quite rare. Even in more "intervention-friendly" Europe, bans and restrictions are still imposed very cautiously.[889] In 1967, 4 substances in addition to asbestos were banned in the UK; by 2004, no materials had been added to this list anywhere in Europe.[890]

By far the most common active intervention related to occupational carcinogens is regulated exposure levels, with or without a surveillance system. The **occupational exposure limits** (also known as threshold limit values or permissible exposure limits), which should be reviewed upon the development of new evidence,[891] serve to set the standards which are intended to minimize risk to workers. The rule of thumb is to limit risk to no more than 1 case per million over a lifetime.[892]

"Right to know" and other educational policies exist in many jurisdictions. In Canada, the Workplace Hazardous Materials Information System requires disclosure to workers handling hazardous products. The main communication tool is the Material Safety Data Sheet, which lists ingredients in a product that are considered to be toxic; carcinogens are noted if they compose more than 0.1% of the product.[893] Methods to improve these means of informing workers are being investigated.[894] The ultimate aim is to equip workers to be able to care for their own welfare.

A parallel to informing workers is the **labelling** of manufactured goods to reveal whether or not they are free of hazardous chemicals. This "eco-labelling" approach, more widespread in Europe than in Canada or the US, serves to create some pressure on companies to modify their industrial processes.

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[886] Greife A, Halperin W, Groce D et al. Hazard surveillance: its role in primary prevention of occupational disease and injury *Applied Occupational and Environmental Hygiene* 1995; 10(9): 737-42.
[887] Tomatis L, Huff J, Hertz-Picciotto I et al. Avoided and avoidable risks of cancer *Carcinogenesis* 1997; 18(1): 97-105.
[888] LaMontagne AD, Youngstrom RA, Lewiton M et al. An exposure prevention rating method for intervention needs assessment and effectiveness evaluation. [Clinical Trial. Journal Article. Randomized Controlled Trial] *Applied Occupational & Environmental Hygiene* 18(7):523-34, 2003.
[889] Canadian Strategy for Cancer Control. *Best Practices Review: Primary Prevention of Exposures to Occupational and Environmental Carcinogens.* October, 2004.
[890] International Union Against Cancer. *Evidence-based Cancer Prevention: Strategies for NGOs - A UICC Handbook for Europe.* Available at http://www.uicc.org/index.php?id=976 (accessed December 2004).
[891] Which was undertaken in Ontario, for example, in 2004.
[892] American Cancer Society. Available at http://www.cancer.org/docroot/PED/content/PED_1_3X_ Risk_Assessment.asp?sitearea=PED (accessed December 2004).
[893] Canadian Strategy for Cancer Control. *Best Practices Review: Primary Prevention of Exposures to Occupational and Environmental Carcinogens.* October, 2004.
[894] Niewohner J, Cox P, Gerrard S et al. Evaluating the efficacy of a mental models approach for improving occupational chemical risk protection *Risk Analysis* 2004; 24(2): 349-61.

Although most of the preceding interventions are of a policy nature, many other community-based actions are also undertaken throughout Canada, aimed at educating the public, creating coalitions, and launching various forms of advocacy directed at government and / or industry. In the field of occupational health, some of the strongest and most influential action has come from unions.[895] When the focus is carcinogens, organizations such as the Canadian Cancer Society are playing an increasing role in developing preventive strategies.

There is undoubtedly much more work to be done in Canada and the various provinces regarding occupational carcinogens. One telling sign is the fact that the *Canadian Environmental Protection Act* (1999) does not target carcinogens. A recent scan of Canadian initiatives in this area concluded: "there is no focus on carcinogens as chemicals of high concern, as there is in Europe, and there is no articulated policy or strategy for reducing or eliminating them."[896]

There is no focus on carcinogens as chemicals of high concern in Canada and there is no articulated policy or strategy for reducing or eliminating them.

Workplace-based Interventions

Whether mandated by government or adopted voluntarily, various interventions are available in the workplace in order to eliminate or reduce carcinogen exposure. A well-accepted principle in managing occupational hazards involves a so-called "hierarchy of controls," beginning with a first line of defence, near the hazard source, and leading to the last measure to be employed, near the worker. The comprehensive US report *Preventing Illness and Injury in the Workplace* provides a convenient summary of the possible interventions:[897]

- At or near the hazard source
  - Substitution of less hazardous material
  - Process modification (e.g., automation)
  - Equipment modification
  - Isolation of the source
  - Local exhaust ventilation
  - Work practices (e.g., housekeeping)

- Workplace environment
  - General dilution ventilation
  - Local room air-cleaning
  - Work practices

- At or near the worker
  - Work practices
  - Isolation of workers
  - Personal protective equipment

[895] Canadian Strategy for Cancer Control. *Best Practices Review: Primary Prevention of Exposures to Occupational and Environmental Carcinogens.* October, 2004.
[896] Canadian Strategy for Cancer Control. *Best Practices Review: Primary Prevention of Exposures to Occupational and Environmental Carcinogens.* October, 2004.
[897] *Preventing Illness and Injury in the Workplace.* Washington, DC: U.S. Congress, Office of Technology Assessment, 1985.

Clinical Care

Clinicians treating people with cancer should take a history that reveals any occupational risks. One of the main motivations for identifying the potential involvement of a carcinogen is the possibility of alerting employers and other employees of the presence of the risk in the workplace (i.e., primary prevention). It is salient to note that "virtually all occupational carcinogens have first been recognized by astute clinicians."[898]

Secondary prevention is also a goal where a full illness has not yet manifested. In particular, it is vital to counsel the affected patient to avoid exposure to co-carcinogens that can exacerbate their condition.[899] These agents are either environmental triggers working opportunistically, e.g., viruses, or modifiable behavioural risk factors. The best known example of the latter type of synergistic risk is that of lung cancer in asbestos workers who also smoke, which is more than 50 times the risk in non-smoking asbestos workers.[900]

Environmental Exposures

As challenging as it is to track occupational carcinogens, it is even more difficult to quantify the impact of environmental pollution. The generally low level and widespread nature of the exposure causes the identification of population impacts to be elusive. Apart from environmental tobacco smoke (covered in a previous section of this report), general air pollution in and around urban centres has probably been the most harmful pollutant in the past, accounting for 1 out of 100 cancer deaths, and up to 5% of lung cancer mortality.[901]

There are several other obstacles to the aggressive pursuit of prevention in the arena of environmental carcinogens:

- the degree to which cancer and other disease can be traced to such agents remains a matter of scientific and political controversy[902]
- setting priorities within various environmental improvement goals (most of which are massive projects), and between environmental and other modifiable risk factors for chronic disease
- sorting out the plausible from the implausible sources of cancer: "no field of epidemiological research has seen so many new hypotheses as that of carcinogenesis from environmental pollution"[903]

> *"The identification of the environmental causes of human cancers has been a long and difficult process."*
> Montesano R, Hall J. Environmental causes of human cancers *European Journal of Cancer* 2001; 37(Suppl 8): S67-87

[898] Landrigan PJ. The prevention of occupational cancer *Ca: a Cancer Journal for Clinicians* 1996; 46(2): 679.
[899] Haverkos HW. Viruses, chemicals and co-carcinogenesis *Oncogene* 2004; 23: 6492-99.
[900] Stellman SD. Interactions between smoking and other exposures: occupation and diet. In: Hoffmann D, Harris C (eds). Banbury Report No. 23, *Mechanisms in Tobacco Carcinogenesis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory, 1986.
[901] Levi F. Cancer prevention: epidemiology and perspectives *European Journal of Cancer* 1999; 35(7): 1046-58.
[902] Gold LS, Slone TH, Manley NB et al. *Misconceptions About the Causes of Cancer*. Vancouver, BC: The Fraser Institute, 2002.

- choosing intervention plans in the absence of complete research data
- finding the will to redirect or complement energies and resources involved with the treatment of cancer; a letter from several environmental and occupational medicine authorities in *The Scientist* noted that the premier American Association for Cancer Research meeting in 2002 featured *no presentation on primary cancer prevention*[904]
- identifying the most critical outcome to target: reduced environmental carcinogen levels, evidence of decreased uptake in human populations, or, after several decades, proof of decreased health impacts and mortality
- the extreme difficulty of establishing the comparative effectiveness of any intervention

There are also some potential pathways on which to move forward. First, an alliance can be formed with those working to eliminate occupational carcinogens; most of the agents in the environment are the same and originate in the workplace anyway. Second, there is the very real possibility of sizeable and powerful coalitions with other organizations concerned with the environment and the ecological and more acute human harms created by pollution.

Regulatory Changes

Inevitably, with something as large as "the environment," government resources and action will be required, as well as significant partnerships with industry. The minutes of the recent meeting of the Environmental and Occupational Exposures group identified the following potential targets for elimination or reduction (not prioritized):[905]

- consumer and downstream exposure to pesticides / herbicides
- clorination byproducts exposure in drinking water
- air pollution
- consumer exposure to carcinogens in products, including food
- hazardous waste sites
- other industrial pollution.

Again, the very scope of the initiatives required in each of these situations is what has probably precluded getting the concerns off of high-level agendas and into the hands of policy-makers.

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[903] Adami H, Day N, Trichopoulos D et al. Primary and secondary prevention in the reduction of cancer morbidity and mortality *European Journal of Cancer* 2001; 37: S118-S127.
[904] Huff J, Castelman B, LaDou J et al. Primary prevention of cancer. *The Scientist* 2002; 16(18). Available at http://www.the-scientist.com/yr2002/sep/let_020916.html (accessed December 2004).
[905] Canadian Strategy for Cancer Control. *Report on Environmental and Occupational Exposures Meeting*, January 14, 2003. Available at http://209.217.127.72/cscc/pdf/pprev/Env&OccupMtgReport_an142003.pdf (accessed December 2004).

Clinical Care

Although much harder to trace than occupational exposures, physicians should look for cases where cancer may have been caused or exacerbated by environmental agents. Possibly of little help to the patient, perspectives gained in the clinical care setting can add to the priority-setting and momentum for environmental action.

Synergies between risk factors are a concern, as they were in the occupational sphere. An instance is radon gas, which forms as a result of the breakdown of subsurface uranium. When it accumulates in homes it can be carcinogenic, and this impact becomes synergistic for tobacco smokers.[906] The US Environmental Protection Agency estimates that radon gas is the second-leading cause of lung cancer in that country.[907] Concerns over radon have actually been leveraged in some cases to motivate people towards smoking cessation.[908] A synergism between smoking and other environmental pollutants also is likely; smokers are at a higher risk when exposed to air-borne carcinogens, a fact that should be underlined by healthcare providers.[909]

[906] Lee ME, Lichtenstein E, Andrews JA et al. Radon-smoking synergy: A population-based behavioral risk reduction approach *Preventive Medicine* 1999; 29(3): 222-7.
[907] See the EPA fact sheet at http://www.epa.gov/iaq/radon/myths.html (accessed December 2004).
[908] Lee ME, Lichtenstein E, Andrews JA et al. Radon-smoking synergy: A population-based behavioral risk reduction approach *Preventive Medicine* 1999; 29(3): 222-7.
[909] Levi F. Cancer prevention: epidemiology and perspectives *European Journal of Cancer* 1999; 35(7): 1046-58.

Cancer and Infectious Agents

Introduction

The fact that viral infections can cause cancer has been suspected for over a 100 years, beginning with the observed connection between cervical cancer and multiple sexual partners.[910] By 1911, the *Journal of the American Medical Association* had reported on the association between viruses and cancer in animals. Proof of causality has proven more elusive, but slowly the research support for implicating specific pathogens has emerged.[911] The International Agency for Research on Cancer has now confirmed 7 viral or bacterial agents as carcinogenic in humans.[912] Cancers of the stomach, liver and cervix rank among the most prevalent ones with a viral or bacterial origin.

The International Agency for Research on Cancer has now confirmed 7 viral or bacterial agents as carcinogenic in humans.

Several parasitical worms or flukes (known collectively as helminths) have been added to the list of proven or probable carcinogens. In fact, the blood fluke called *Schistosoma haematobium* was linked with bladder carcinoma as early as the middle of the 19th century.

The etiology and mechanisms of infection-based cancer have been important areas of study, generating several Nobel prizes in recent years.[913] Two features have spurred on the research:

- the study of viral carcinogenesis has offered a wealth of insight into the general cellular mechanisms of cancer.[914]
- an infectious origin for a particular cancer holds out the promise that such disease is actually *preventable.*

The impact of infection-associated cancer is more substantial than sometimes realized by the general public. Kuper and colleagues noted that "following tobacco use, infections as a group may be the most important preventable cause of cancer in humans."[915] Worldwide, the proportion of cancer attributable to infections with viruses, bacteria and parasites is estimated to be 15-16%, or 1.2 to 1.5 million new cases a year.[916,917,918] Some of these agents

Worldwide, the proportion of cancer attributable to infections with viruses, bacteria and parasites is estimated to be 15-16%. Some of these agents are less common in developed countries, so the proportion of cancers associated with infections may be half as much as the global rate.

[910] Moscicki AB, Palefsky J, Gonzales J et al. Human papillomavirus infection in sexually active adolescent females: prevalence and risk factors. *Pediatric Research.* 1990; 28(5): 507-13.
[911] Such agents are referred to as being carcinogenic or oncogenic.
[912] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303. See Appendix A.
[913] Kuper H, Adami HO, Trichopoulos D. Infections as a major preventable cause of human cancer. *Journal of Internal Medicine.* 2000; 248(3): 171-83.
[914] Butel JS. Viral carcinogenesis: revelation of molecular mechanisms and etiology of human disease. *Carcinogenesis.* 2000; 21(3): 405-26.
[915] Kuper H, Adami HO, Trichopoulos D. Infections as a major preventable cause of human cancer. *Journal of Internal Medicine.* 2000; 248(3): 171-83.
[916] *Evidence-based Cancer Prevention Strategies for NGOs*. International Union Against Cancer; 2004.

are less common in developed countries, so the proportion of cancers associated with infections may be half as much as the global rate.[919] For instance, in the US, about 7% of total cancer incidence has been attributed to one or more infectious agent.[920] It is important to note that improved serological techniques may eventually reveal an even greater role for infection in the phenomenon of carcinogenesis.[921]

We will provide an overview of the pathogens associated with cancer, their disease mechanism and burden, before turning to a detailed presentation on each agent. The latter material will especially focus on the prevention and other management strategies that could be used to reduce the prevalence of infection-related cancer.

Overview of Agents and Disease Burden

As noted above, several viruses, bacteria and even microscopic parasites are involved in the development of cancer in humans. A couple of features are shared by these agents. First, they are often highly prevalent in populations, whereas malignancies in infected people are much rarer. For example, half the world's population harbours *Helicobacter pylori*, but only 1% develops gastric cancer.[922] Second, there is a prolonged latency period between initial infection and cancer development, during which time the agent persists in the host. Taken together, these facts suggest that cancers linked to infections follow the general pattern of most cancers, i.e., they are *multi-factorial.* In other words, infections are usually not sufficient for carcinogenesis; co-factors are required to promote both initiation and progression. One such factor, host genetic susceptibility, represents a particularly intense area of research.

Infections are usually not sufficient for carcinogenesis; co-factors are required to promote both initiation and progression.

Many synergies between infectious agents and other "environmental" factors are also being discovered; the latter include tobacco use, alcohol consumption and specific dietary components. Different infectious agents seem to interact with each other to create an additive or even multiplicative effect in terms of disease onset and progress. Human immunodeficiency virus type 1 (HIV-1) shows this effect with a number of other pathogens; another example is hepatitis B and C, which interact synergistically in the development of liver cancer.[923]

Some of these characteristics—prevalence in the general population, long latency, the role of other interacting factors—make the identification of causal relationships

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[917] Kuper H, Adami HO, Trichopoulos D. Infections as a major preventable cause of human cancer. *Journal of Internal Medicine.* 2000; 248(3): 171-83.
[918] Pisani P, Parkin DM, Munoz N et al. Cancer and infection: estimates of the attributable fraction in 1990. *Cancer Epidemiology, Biomarkers & Prevention.* 1997; 6(6): 387-400.
[919] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[920] Mueller NE. Cancers caused by infections: unequal burdens. *Cancer Epidemiology, Biomarkers & Prevention.* 2003; 12(3): 237s.
[921] Kuper H, Adami HO, Trichopoulos D. Infections as a major preventable cause of human cancer. *Journal of Internal Medicine.* 2000; 248(3): 171-83.
[922] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[923] Donato F, Boffetta P, Puoti M. A meta-analysis of epidemiological studies on the combined effect of hepatitis B and C virus infections in causing hepatocellular carcinoma. *International Journal of Cancer.* 1998; 75(3): 347-54.

difficult. The etiology, or the causation, of disease is a notoriously complex area of medicine. When an agent is detected in tumours, there is no guarantee that it produced the cancer. Confirmation of an etiologic link requires a combination of epidemiological data, biological plausibility, and demonstrations of cellular proliferation in animal-based or *in vitro* studies. The ongoing work of confirming causation is reflected in the disparate inventories of cancer-linked infections provided in the appendices; because of political-legal implications, some government agencies are more "conservative" in adding agents to their list, as compared with the more expansive conclusions that may be drawn by academics and, especially, advocacy groups.

A final complicating factor in causation studies involves teasing apart the many subtypes of the carcinogenic viruses. For example, there are over 100 genotypes seen in human papillomavirus, but only a subset of these show a high risk for cancer development.[924]

The Cancers: Burden and Trends

The cancers with a significant infectious origin are not marginal. For example, stomach cancer, associated with the bacteria *Helicobacter pylori*, is the fourth most frequent cancer in the world, with 876,000 new cases in the year 2000. Liver cancer, with its strong association with the hepatitis viruses, is the fifth most common cancer globally and one of the leading causes of cancer death. Cervical cancer, with its well-known connection to the human papillomavirus, is the second most common type (after breast cancer) among women worldwide.[925] Augmenting the basic prevalence statistics is the fact that each of these cancers exhibit high rates of morbidity and mortality.

Although some key infection-linked cancers, such as Hodgkin's disease and gastric and cervical cancer, show continuing decline in incidence in Canada, we cannot afford to be complacent. The reality is that, often due to a growing and, mostly, ageing population,[926] the *absolute* numbers and / or mortality burdens of some relevant cancers (e.g., non-Hodgkin's lymphoma) continue to climb across the country and throughout the developed world. Disease latency also affects the trend-lines, increasing the impact over time of a disease such as cervical cancers (which tends to be diagnosed at a relatively young age); thus, even though cervical cancer rates are down, mortality attributable to this cancer is actually up in Canada.[927] In sum, the cancers associated with infections represent the loss of thousands of human

[924] Munoz N, Bosch FX, de Sanjose S et al. Epidemiologic classification of human papillomavirus types associated with cervical cancer. *New England Journal of Medicine.* 2003; 348(6): 518-27.
[925] Parkin DM. International variation. *Oncogene.* 2004; 23(38): 6329-40.
[926] For example, stomach cancer is largely a disease of older age. Age-specific incidence and mortality rates do not begin to rise until age 40, and like many cancers, rates increase steeply only after age 50 (note: in Ireland, recent statistics showed that only about 1% of stomach cancer cases were in patients below age 35). These demographic factors explain why the incidence burden (total number of cases) of stomach cancer showed no percentage change for men in Canada over 1992-2001, even though the rate of stomach cancer has steadily declined.
[927] Canadian Cancer Society. *Canadian Cancer Statistics 2005.*

lives. Thus, to quote international authorities, there is no question that "these specific oncogenic infections should be identified, monitored, and treated when indicated."[928]

Geographical Variation of Disease

A complicating feature of global public health policies related to infection-based cancers is the wide variation in prevalence of the agent and / or the cancer, especially comparing developed and developing countries. For example, almost two-thirds of stomach cancer cases occur in the developing world, and cervical cancer follows a similar pattern. Likewise, only about 20% of liver cancer cases occur in the industrialized world, and they account for only 1% of total cancer cases in, for example, North America (compared to, for instance, 50% of cancer cases in China); however, the extremely high mortality rate with liver cancer somewhat mitigates any comfort among developed nations that may be derived from such statistics. Epidemiological studies confirm that the pattern of liver cancer can be largely explained by the worldwide distribution of chronic hepatitis infection, especially hepatitis B.[929]

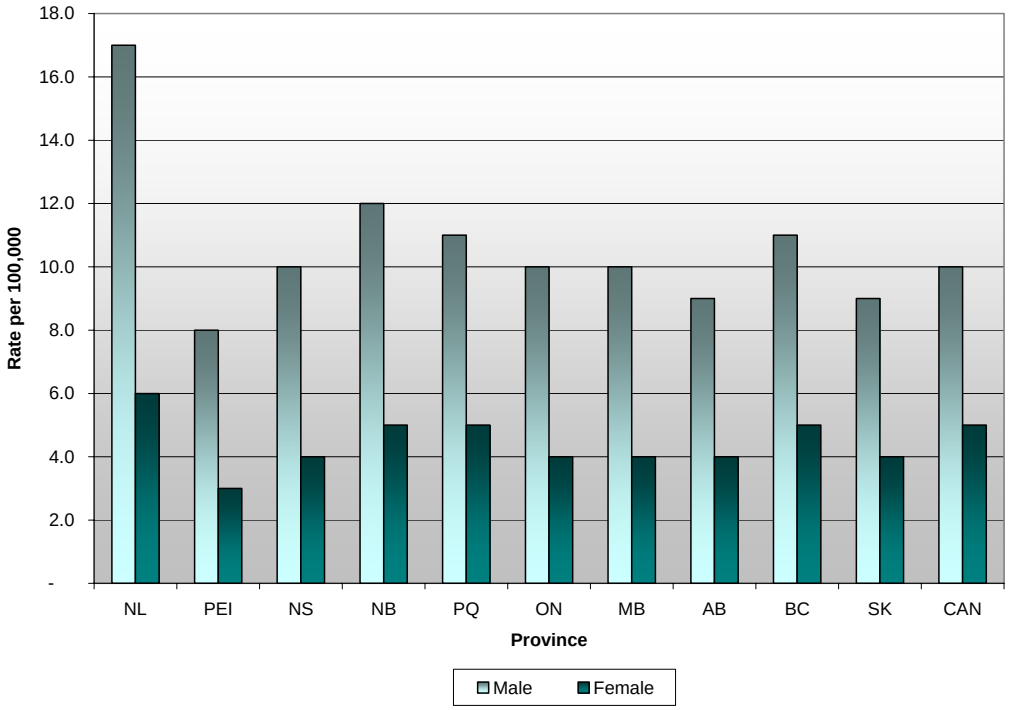
One of the most obvious geographical variations relates to the third class of infectious agent (alongside viruses and bacteria), namely, parasitic worms or flukes. These organisms are almost entirely restricted to areas outside of North America (see the fuller description in a later section).

There are more localized variations in cancer rates which are also significant; for instance, the rate of liver cancer is high in Japan compared to other developed countries. Somewhat rarer cancers also swing more towards developed countries. For reasons that are not entirely clear, the highest incidence rate for non-Hodgkin's lymphomas is observed in the developed areas of North America; the epidemiology cannot be entirely accounted for by the distribution of the major contributing agents, i.e., the Epstein-Barr and human immunodeficiency viruses.[930]Similarly, it is not yet clear if the somewhat higher leukemia rate in North America bears any connection to the pattern of infection with human T cell lymphotrophic virus type I.

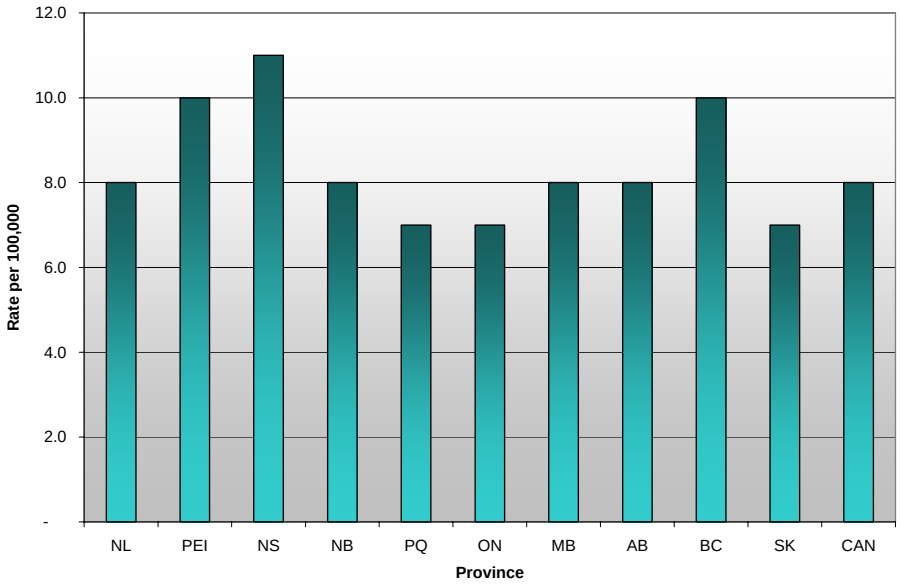
Rates also vary within countries and provinces. The following two charts show the different incidence rates across Canada for stomach and cervical cancers.[931]

[928] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[929] Bosch FX, Ribes J, Cleries R et al. Epidemiology of hepatocellular carcinoma. *Clinical Liver Diseases.* 2005; 9(2): 191-211.
[930] Parkin DM. International variation. *Oncogene.* 2004; 23(38): 6329-40.
[931] Canadian Cancer Society. *Canadian Cancer Statistics 2005.*

Stomach Cancer
Estimated Age-standardized Rates
Canadian Provinces 2005



Cervical Cancer
Estimated Age-standardized Rates
Canadian Provinces 2005



Epidemiology of the Main Infectious Agents in Developed Countries

The following table summarizes the major role of infection in carcinogenesis as seen in developed countries.

Agent	*Type*	*Prevalence of infection*	*Main associated cancer*	*Relative risk of infected person getting cancer*	*Annual incidence of cancer (developed countries)*[932]	*Proportion of specific cancer attributable to infection*
Human papillomavirus (HPV) - various types	Virus		Cervix		100,000	90 to 100%[933,934]
Hepatitis B / C virus (HBV, HCV)	Virus	• Chronic HBV 0.5 to 1.0%[935] • HCV 0.5 to 1.0%	Liver, esp. hepatocellular carcinoma (HCC)	• HBV: 13.7[936] • HCV: 11.5	106,000	80%[937] • HB: 40 to 60% • HC: 20 to 30%[938]
Helicobacter pylori	Bacter-ium	Up to 50% of population are carriers	Stomach	• Odds ratio about 2[939,940] • 1% of carriers[941]	333,000	70%[942]
Epstein-Barr virus (EBV)	Virus	90%[943]	Hodgkin's disease; non-Hodgkin's lymphoma		264,000	30-90%, depending on the disorder
Human immuno-deficiency virus type 1 (HIV-1) as co-factor	Virus		Kaposi sarcoma	• 0.1% females • 0.2% males	8,600	
Human T cell lymphotrophic v. type I (HTLV-I)	Virus		Leukemia			1%[944]
Human herpesvirus type 8 (HHV-8) - probable	Virus		Kaposi sarcoma		8,600	

[932] *Evidence-based Cancer Prevention Strategies for NGOs*. International Union Against Cancer; 2004.
[933] Pisani P, Parkin DM, Munoz N et al. Cancer and infection: estimates of the attributable fraction in 1990. *Cancer Epidemiology, Biomarkers & Prevention.* 1997; 6(6): 387-400.
[934] Walboomers JM, Jacobs MV, Manos MM et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *Journal of Pathology.* 1999; 189(1): 12-9.
[935] Zhang J, Zou S, Giulivi A. Viral hepatitis and emerging blood borne pathogens in Canada: Hepatitis B in Canada.2002. Available at http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/01vol27/27s3/27s3e_e.html. Accessed May 2005.
[936] Colditz GA, Atwood KA, Emmons K et al. Harvard report on cancer prevention volume 4: Harvard Cancer Risk Index. Risk Index Working Group, Harvard Center for Cancer Prevention. *Cancer Causes & Control.* 2000; 11(6): 477-88.
[937] Bosch FX, Ribes J, Diaz M et al. Primary liver cancer: worldwide incidence and trends. *Gastroenterology.* 2004; 127(5 Suppl 1): S5-S16.
[938] *Targeting Cancer: An Action Plan for Cancer Prevention and Detection. Cancer 2020 Background Report*. Cancer Care Ontario; 2003.
[939] Huang JQ, Sridhar S, Chen Y et al. Meta-analysis of the relationship between Helicobacter pylori seropositivity and gastric cancer. *Gastroenterology.* 1998; 114(6): 1169-79.
[940] Parkin DM. International variation. *Oncogene.* 2004; 23(38): 6329-40.
[941] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[942] McLoughlin RM, Sebastian SS, O'Connor HJ et al. Review article: test and treat or test and scope for Helicobacter pylori infection. Any change in gastric cancer prevention? *Alimentary Pharmacology & Therapeutics.* 2003; 17 Suppl 2: 82-8.
[943] Rickinson AB, Callan MF, Annels NE. T-cell memory: lessons from Epstein-Barr virus infection in man. *Philosophical Transactions of the Royal Society of London - Series B: Biological Sciences.* 2000; 355(1395): 391-400.
[944] Pisani P, Parkin DM, Munoz N et al. Cancer and infection: estimates of the attributable fraction in 1990. *Cancer Epidemiology, Biomarkers & Prevention.* 1997; 6(6): 387-400.

Other Agents Under Investigation

Before turning to our treatment of the confirmed infectious agents of interest in the developed world, it is important to note that this whole topic is a scientific "moving target." First, several additional suspect agents are under investigation from all three classes of infection. For example, people chronically infected with *Salmonella* (the bacterium that causes typhoid) are up to 8 times more likely to develop gallbladder cancer.[945,946] Various *Helicobacter* species have also garnered a lot of attention. For instance, *Helicobacter bilis* appears to play a role in biliary tract cancer.[947] Turning to the virus world, there is some evidence linking breast cancer to a human homologue of the mouse mammary tumour virus, as well as to cytomegalovirus.[948,949] As noted in the table above, human herpesvirus type 8 has been identified as a probable cause of Kaposi sarcoma.

Second, the list of cancers related to already well-known agents is being lengthened all the time. For example, mucosa-associated lymphoid tissue (MALT) and other lymphomas of the stomach have been associated with *Helicobacter pylori*.[950,951] This bacterium has also recently been connected to liver cancer[952] and biliary tract cancer.[953] As for viruses, hepatitis B and C also have been linked to biliary tract cancer,[954] and hepatitis C to non-Hodgkin's lymphoma.[955] Human papillomavirus has been connected to breast cancer, as has Epstein-Barr virus; the latter also has been associated with lung, gastric, colon and prostate cancers.[956,957] As will be described below, human papillomavirus has been detected in a spectrum of cancers as well.

The subtypes of specific viral agents being implicated in cancer development are steadily expanding as well. For example, the list of HPV subtypes demonstrated to cause cancer of the cervix gets longer and longer. Of the *known* subtypes of HPV, 15-20 have now been associated with cervical cancer.

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[945] Shukla VK, Singh H, Pandey M et al. Carcinoma of the gallbladder--is it a sequel of typhoid? *Digestive Diseases & Sciences.* 2000; 45(5): 900-3.
[946] Sheth S, Bedford A, Chopra S. Primary gallbladder cancer: recognition of risk factors and the role of prophylactic cholecystectomy. *American Journal of Gastroenterology.* 2000; 95(6): 1402-10.
[947] Murata H, Tsuji S, Tsujii M et al. Helicobacter bilis infection in biliary tract cancer. *Alimentary Pharmacology & Therapeutics.* 2004; 20 Suppl 1: 90-4.
[948] Levine PH, Pogo BG, Klouj A et al. Increasing evidence for a human breast carcinoma virus with geographic differences. *Cancer.* 2004; 101(4): 721-6.
[949] Richardson AK, Cox B, McCredie MR et al. Cytomegalovirus, Epstein-Barr virus and risk of breast cancer before age 40 years: a case-control study. *Brirish Journal of Cancer.* 2004; 90(11): 2149-52.
[950] Konturek PC, Konturek SJ, Starzyska T et al. Helicobacter pylori-gastrin link in MALT lymphoma. *Alimentary Pharmacology & Therapeutics.* 2000; 14(10): 1311-8.
[951] Parsonnet J, Hansen S, Rodriguez L et al. Helicobacter pylori infection and gastric lymphoma. *New England Journal of Medicine.* 1994; 330(18): 1267-71.
[952] Ito K, Nakamura M, Toda G et al. Potential role of Helicobacter pylori in hepatocarcinogenesis. *International Journal of Molecular Medicine.* 2004; 13(2): 221-7.
[953] Bulajic M, Maisonneuve P, Schneider-Brachert W et al. Helicobacter pylori and the risk of benign and malignant biliary tract disease. *Cancer.* 2002; 95(9): 1946-53.
[954] Shaib Y, El-Serag HB. The epidemiology of cholangiocarcinoma. *Seminars in Liver Disease.* 2004; 24(2): 115-25.
[955] Matsuo K, Kusano A, Sugumar A et al. Effect of hepatitis C virus infection on the risk of non-Hodgkin's lymphoma: a meta-analysis of epidemiological studies. *Cancer Science.* 2004; 95(9): 745-52.
[956] Liu Y, Klimberg VS, Andrews NR et al. Human papillomavirus DNA is present in a subset of unselected breast cancers. *Journal of Human Virology.* 2001; 4(6): 329-34.
[957] Grinstein S, Preciado MV, Gattuso P et al. Demonstration of Epstein-Barr virus in carcinomas of various sites. *Cancer Research.* 2002; 62(17): 4876-8.

Mechanisms of Disease

There are three main mechanisms by which infections both initiate and promote carcinogenesis:[958]

1. When an agent becomes persistent in the host, it may induce a chronic inflammatory response, which in turn creates a chemical environment damaging to the DNA and to other elements within cells (such as systems which regulate cellular growth and death); the proliferation of cells, a common precursor to malignancy, can be a by-product of these processes. Bacterial toxins can also directly damage DNA.

2. Agents may directly transform cells by inserting active genes into the host DNA; this can result in an interruption of cellular controls which normally inhibit cancerous growth. The insertion of DNA in a sperm or egg cell creates the possibility of viruses essentially being inherited by offspring.

3. Agents such as the human immunodeficiency virus (HIV) act as immunosuppressors, which create a climate conducive to aggressive cancer development.

Prevention and Management

Focusing on the main pathogens in developed countries, we will look at each one in turn from the point of view of effective health care. The agenda is to identify and evaluate the interventions available at various stages of exposure and disease development, namely:

1. Preventing exposure to the pathogen in the first place.

2. Preventing establishment of infection (e.g., through prophylactic vaccination).

3. Preventing full cancer development once infection is present (including detecting and treating the infection or precancerous cells and lesions before cancer becomes completely established, e.g., through therapeutic vaccination).

The first category is a form of early primary prevention. Category 2 measures, such as vaccinations, are classic forms of primary prevention. Finally, screening for precancer or early cancer and other approaches covered under category 3 are species of secondary prevention. The ultimate aim of all these approaches is clear, namely, preventing cancer from fully developing.

Future Developments

As already noted, there are many potentially carcinogenic agents being investigated. Likewise, tremendous research energy is going into the development of therapies for current and emerging infectious agents related to cancer. The key factor in making real progress on prevention and treatments is a full understanding of the mechanisms of transmission, infection and disease progression. As will be seen for each of the

[958] Kuper H, Adami HO, Trichopoulos D. Infections as a major preventable cause of human cancer. *Journal of Internal Medicine.* 2000; 248(3): 171-83.

main agents described in the balance of this report, there is still a long way to go in understanding the basic science. As one review summarized:

> *At present, information concerning the role of viruses in the pathogenesis of human neoplasms is fragmented and incomplete. It is clear that their role is complex, and a complete understanding of the intricacies involved in viral interaction with the human genome may still take many years. New virologic study techniques can be expected to emerge and epidemiologic studies will continue. With each new report, a bit more will be understood, new hypotheses stimulated, and additional studies undertaken.*[959]

[959] Phelan JA. Viruses and neoplastic growth. *Dental Clinics of North America.* 2003; 47(3): 533-43.

Human Papillomavirus

Human papillomavirus has been proposed as the first-ever necessary and sufficient cause of a human cancer identified by researchers.

Globally, cervical cancer is the second most common female cancer (only exceeded in prevalence by breast cancer). As indicated in the table above, there is virtually a one-to-one connection between cervical cancer cases and the detection of HPV DNA. As Walboomers et al. concluded in 1999, "the presence of HPV in virtually all cervical cancers implies the highest worldwide attributable fraction so far reported for a specific cause of any major human cancer."[960] In short, HPV has been proposed as the first-ever necessary and sufficient cause of a human cancer identified by researchers.[961,962]

The human papillomavirus represents a bewildering array of types, subtypes and variants. Over 100 HPV types have been identified so far, with approximately 40 known to infect the human genital tract. Of these, about half are oncogenic, with the majority of cancer-causing forms related genetically to two main types, HPV-16 and HPV-18.[963,964] Indeed, the latter two types together account for about 70 to 75% of cervical cancer cases (an increase from earlier estimates of 50%).[965,966,967]

For completeness, it is important to note that HPV types have been implicated in a number of other cancers, including other anogenital carcinomas, e.g., of the vulva or penis,[968] and various nongenital mucosal and cutaneous diseases, e.g., oropharyngeal and lung carcinomas and certain skin cancers.[969,970,971,972] In the latter case, UV

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[960] Walboomers JM, Jacobs MV, Manos MM et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *Journal of Pathology.* 1999; 189(1): 12-9.
[961] Bosch FX, Munoz N. The viral etiology of cervical cancer. *Virus Research.* 2002; 89(2): 183-90.
[962] Bosch FX, Lorincz A, Munoz N et al. The causal relation between human papillomavirus and cervical cancer. *Journal of Clinical Pathology.* 2002; 55(4): 244-65.
[963] Munoz N, Bosch FX, de Sanjose S et al. Epidemiologic classification of human papillomavirus types associated with cervical cancer. *New England Journal of Medicine.* 2003; 348(6): 518-27.
[964] Bosch FX, Manos MM, Munoz N et al. Prevalence of human papillomavirus in cervical cancer: a worldwide perspective. International biological study on cervical cancer (IBSCC) Study Group. *Journal of the National Cancer Institute.* 1995; 87(11): 796-802.
[965] Clifford GM, Smith JS, Plummer M et al. Human papillomavirus types in invasive cervical cancer worldwide: a meta-analysis. *British Journal of Cancer.* 2003; 88(1): 63-73.
[966] Goldie SJ, Grima D, Kohli M et al. A comprehensive natural history model of HPV infection and cervical cancer to estimate the clinical impact of a prophylactic HPV-16/18 vaccine. *International Journal of Cancer.* 2003; 106(6): 896-904.
[967] Harper DM, Franco EL, Wheeler C et al. Efficacy of a bivalent L1 virus-like particle vaccine in prevention of infection with human papillomavirus types 16 and 18 in young women: a randomised controlled trial. *The Lancet.* 2004; 364(9447): 1757-65.
[968] The attributable fraction of these cancers with respect to HPV infection is 40 to 50%. Dillner J, Meijer CJ, von Krogh G et al. Epidemiology of human papillomavirus infection. *Scandinavian Journal of Urology & Nephrology Supplement.* 2000; 34(205): 194-200.
[969] Mork J, Lie AK, Glattre E et al. Human papillomavirus infection as a risk factor for squamous-cell carcinoma of the head and neck. *New England Journal of Medicine.* 2001; 344(15): 1125-31.
[970] Gillison ML, Koch WM, Capone RB et al. Evidence for a causal association between human papillomavirus and a subset of head and neck cancers. *Journal of the National Cancer Institute.* 2000; 92(9): 709-20.
[971] Cheng YW, Chiou HL, Sheu GT et al. The association of human papillomavirus 16/18 infection with lung cancer among nonsmoking Taiwanese women. *Cancer Research.* 2001; 61(7): 2799-803.
[972] Masini C, Fuchs PG, Gabrielli F et al. Evidence for the association of human papillomavirus infection and cutaneous squamous cell carcinoma in immunocompetent individuals. *Archives of Dermatology.* 2003; 139(7): 890-4.

radiation is known to be a co-factor.[973] A particularly significant cancer related to HPV in high-risk male populations is squamous cell anal carcinoma.[974] Aside from lesions and full cancers, the other main disorders associated with HPV are different types of genital warts.

Taken as a group, anogenital HPV is the most common sexually transmitted infection.[975] The lifetime risk of contracting such an infection is about 80%.[976]

Transmission of the Agent

The primary mode of HPV transmission is sexual intercourse. Studies show that the number of recent sexual partners is significantly associated with the incidence of HPV infection.[977,978] Limited research has concluded that the virus can be passed through fomites (substances or articles that hold and convey infection, e.g., handkerchief) or skin contact, but this remains very debatable; no evidence of such transmission has been found in the case of genital lesions, the precursor to cancer.[979] A final transmission route implicated as plausible is non-penetrative sexual activity (including oral sex).[980] Although the whole area of transmission is subject to ongoing study, the basic understanding is that HPV infections are "easily transmitted."[981]

As Arena et al. have noted, "the data reported in the literature on the relationship between HPV and pregnancy are highly discordant."[982] Although earlier studies suggested the possibility of "vertical transmission" of HPV from mother to infant during delivery, more recent research has concluded that this route of viral spread is very low-risk.[983,984] Even when the virus is found in newborns, it often seems to clear

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[973] Pfister H. Chapter 8: Human papillomavirus and skin cancer. *Journal of the National Cancer Institute Monograph.* 2003; (31): 52-6.
[974] Xi LF, Critchlow CW, Wheeler CM et al. Risk of anal carcinoma in situ in relation to human papillomavirus type 16 variants. *Cancer Research.* 1998; 58(17): 3839-44.
[975] Schiffman M, Kjaer SK. Chapter 2: Natural history of anogenital human papillomavirus infection and neoplasia. *Journal of the National Cancer Institute Monograph.* 2003; (31): 14-9.
[976] Bekkers RL, Massuger LF, Bulten J et al. Epidemiological and clinical aspects of human papillomavirus detection in the prevention of cervical cancer. *Reviews in Medical Virology.* 2004; 14(2): 95-105.
[977] Sellors JW, Karwalajtys TL, Kaczorowski J et al. Incidence, clearance and predictors of human papillomavirus infection in women. *Canadian Medical Association Journal.* 2003; 168(4): 421-5.
[978] Kjaer SK, Chackerian B, van den Brule AJ et al. High-risk human papillomavirus is sexually transmitted: evidence from a follow-up study of virgins starting sexual activity (intercourse). *Cancer Epidemiology, Biomarkers & Prevention.* 2001; 10(2): 101-6.
[979] Bruck LR, Zee S, Poulos B et al. Detection of cervical human papillomavirus infection by in situ hybridization in fetuses from women with squamous intraepithelial lesions. *Journal of Lower Genital Tract Disease.* 2005; 9(2): 114-7.
[980] Winer RL, Lee SK, Hughes JP et al. Genital human papillomavirus infection: incidence and risk factors in a cohort of female university students. *American Journal of Epidemiology.* 2003; 157(3): 218-26.
[981] Schiffman M, Kjaer SK. Chapter 2: Natural history of anogenital human papillomavirus infection and neoplasia. *Journal of the National Cancer Institute Monograph.* 2003; (31): 14-9.
[982] Arena S, Marconi M, Ubertosi M et al. HPV and pregnancy: diagnostic methods, transmission and evolution. *Minerva Ginecologica.* 2002; 54(3): 225-37.
[983] Smith EM, Ritchie JM, Yankowitz J et al. Human papillomavirus prevalence and types in newborns and parents: concordance and modes of transmission. *Sexually Transmitted Diseases.* 2004; 31(1): 57-62.

after a few months.[985] The first report has recently been made of fetal cervical HPV infection through *intrauterine* exposure.[986]

Co-factors and Correlates

HPV infection is very common, but mostly transient. The fact that, even in women with persistent HPV infection, only a certain fraction will eventually develop cervical cancer indicates that the virus, though necessary, is not always a sufficient cause. Co-factors seem to be involved in at least some cervical carcinogenesis.[987] For example, risk for cervical cancer developing with HPV infection increases twofold when the woman is or has been a smoker;[988] recently, evidence for the effect of passive smoking has also been reported.[989,990] In fact, some research suggests that exposure to cigarette smoke may be *required* as a carcinogen to advance HPV-infected cells toward high-grade neoplasms.[991] The crucial biological impact appears to be the oxidant load created through smoking, though this remains a matter of investigation.[992,993]

There is evidence that the presence of other sexually transmitted agents, cervical inflammation, multiple births (known as multiparity), and long-term oral contraceptive use all correlate with progression towards cervical cancer.[994,995,996,997] Although a causal relationship is unproven, herpes simplex virus-2 may act in conjunction with HPV to create cervical cancer (perhaps multiplying the risk of

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[984] Watts DH, Koutsky LA, Holmes KK et al. Low risk of perinatal transmission of human papillomavirus: results from a prospective cohort study. *American Journal of Obstetrics & Gynecology.* 1998; 178(2): 365-73.

[985] Arena S, Marconi M, Ubertosi M et al. HPV and pregnancy: diagnostic methods, transmission and evolution. *Minerva Ginecologica.* 2002; 54(3): 225-37.

[986] Bruck LR, Zee S, Poulos B et al. Detection of cervical human papillomavirus infection by in situ hybridization in fetuses from women with squamous intraepithelial lesions. *Journal of Lower Genital Tract Disease.* 2005; 9(2): 114-7.

[987] Munoz N. Human papillomavirus and cancer: the epidemiological evidence. *Journal of Clinical Virology.* 2000; 19(1-2): 1-5.

[988] Plummer M, Herrero R, Franceschi S et al. Smoking and cervical cancer: pooled analysis of the IARC multi-centric case--control study. *Cancer Causes Control.* 2003; 14(9): 805-14.

[989] Trimble CL, Genkinger JM, Burke AE et al. Active and passive cigarette smoking and the risk of cervical neoplasia. *Obstetrics & Gynecology.* 2005; 105(1): 174-81.

[990] Tay SK, Tay KJ. Passive cigarette smoking is a risk factor in cervical neoplasia. *Gynecologic Oncology.* 2004; 93(1): 116-20.

[991] Ho GY, Kadish AS, Burk RD et al. HPV 16 and cigarette smoking as risk factors for high-grade cervical intra-epithelial neoplasia. *International Journal of Cancer.* 1998; 78(3): 281-5.

[992] Giuliano A. Cervical carcinogenesis: the role of co-factors and generation of reactive oxygen species. *Salud Publica de Mexico.* 2003; 45 Suppl 3: S354-60.

[993] Moore TO, Moore AY, Carrasco D et al. Human papillomavirus, smoking, and cancer. *Journal of Cutaneous Medicine & Surgery.* 2001; 5(4): 323-8.

[994] Castellsague X, Bosch FX, Munoz N. Environmental co-factors in HPV carcinogenesis. *Virus Research.* 2002; 89(2): 191-9.

[995] Castellsague X, Munoz N. Chapter 3: Cofactors in human papillomavirus carcinogenesis--role of parity, oral contraceptives, and tobacco smoking. *Journal of the National Cancer Institute Monograph.* 2003; (31): 20-8.

[996] Munoz N, Franceschi S, Bosetti C et al. Role of parity and human papillomavirus in cervical cancer: the IARC multicentric case-control study. *The Lancet.* 2002; 359(9312): 1093-101.

[997] Moreno V, Bosch FX, Munoz N et al. Effect of oral contraceptives on risk of cervical cancer in women with human papillomavirus infection: the IARC multicentric case-control study. *The Lancet.* 2002; 359(9312): 1085-92.

developing the main types of cervical cancer up to 2 or 3 times).[998] HIV (with its associated immune suppression) and *Chlamydia trachomatis* are also on the list of potential co-factors.[999,1000,1001,1002,1003]

The most recent research has called into question how much birth and contraception experience actually influence cervical cancer rates.[1004,1005] A 2003 systematic review further concluded that "there was no evidence for a strong positive or negative association" between HPV infection and use of oral contraceptives.[1006] In sum, it is probably best to say the connection between oral contraceptives, HPV and cervical cancer remains a fluid area of research.[1007] As for the case of multiple births, if its association with cervical cancer risk holds up, then a general decline in parity might partly explain the decrease in cervical cancer in many industrialized countries.[1008]

Finally, there is consistent evidence that higher intakes of fruit and vegetables are protective against cervical cancer, as well as weaker indications of a similar role for specific dietary ingredients (e.g., vitamins C and E, lycopene, and folate).[1009,1010,1011,1012] The main proposal for the function of dietary co-factors is an antioxidant protective mechanism.[1013]

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[998] Smith JS, Herrero R, Bosetti C et al. Herpes simplex virus-2 as a human papillomavirus cofactor in the etiology of invasive cervical cancer. *Journal of the National Cancer Institute.* 2002; 94(21): 1604-13.

[999] de Sanjose S, Palefsky J. Cervical and anal HPV infections in HIV positive women and men. *Virus Research.* 2002; 89(2): 201-11.

[1000] La Ruche G, You B, Mensah-Ado I et al. Human papillomavirus and human immunodeficiency virus infections: relation with cervical dysplasia-neoplasia in African women. *International Journal of Cancer.* 1998; 76(4): 480-6.

[1001] Weissenborn SJ, Funke AM, Hellmich M et al. Oncogenic human papillomavirus DNA loads in human immunodeficiency virus-positive women with high-grade cervical lesions are strongly elevated. *Journal of Clinical Microbiology.* 2003; 41(6): 2763-7.

[1002] Palefsky JM, Holly EA. Chapter 6: Immunosuppression and co-infection with HIV. *Journal of the National Cancer Institute Monograph.* 2003; (31): 41-6.

[1003] Smith JS, Munoz N, Herrero R et al. Evidence for Chlamydia trachomatis as a human papillomavirus cofactor in the etiology of invasive cervical cancer in Brazil and the Philippines. *Journal of Infectious Diseases.* 2002; 185(3): 324-31.

[1004] Shields TS, Brinton LA, Burk RD et al. A case-control study of risk factors for invasive cervical cancer among U.S. women exposed to oncogenic types of human papillomavirus. *Cancer Epidemiology, Biomarkers & Prevention.* 2004; 13(10): 1574-82.

[1005] Shields TS, Falk RT, Herrero R et al. A case-control study of endogenous hormones and cervical cancer. *British Journal of Cancer.* 2004; 90(1): 146-52.

[1006] Green J, Berrington de Gonzalez A, Smith JS et al. Human papillomavirus infection and use of oral contraceptives. *British Journal of Cancer.* 2003; 88(11): 1713-20.

[1007] Smith JS, Green J, Berrington de Gonzalez A et al. Cervical cancer and use of hormonal contraceptives: a systematic review. *The Lancet.* 2003; 361(9364): 1159-67.

[1008] Munoz N, Franceschi S, Bosetti C et al. Role of parity and human papillomavirus in cervical cancer: the IARC multicentric case-control study. *The Lancet.* 2002; 359(9312): 1093-101.

[1009] Castellsague X, Bosch FX, Munoz N. Environmental co-factors in HPV carcinogenesis. *Virus Research.* 2002; 89(2): 191-9.

[1010] Ho GY, Palan PR, Basu J et al. Viral characteristics of human papillomavirus infection and antioxidant levels as risk factors for cervical dysplasia. *International Journal of Cancer.* 1998; 78(5): 594-9.

[1011] Giuliano AR, Siegel EM, Roe DJ et al. Dietary intake and risk of persistent human papillomavirus (HPV) infection: the Ludwig-McGill HPV Natural History Study. *Journal of Infectious Diseases.* 2003; 188(10): 1508-16.

Natural History and Carcinogenesis

This section will focus on the main HPV-related cancer of interest to public health, namely, cervical cancer. This type of cancer arises through three carcinogenic steps. First, HPV infection of the cervix occurs, primarily as a result of sexual intercourse. The effect of infection on cervical cells is quite variable. Whatever the impact, most infections tend to resolve over a one- to two-year period.[1014] The next step, progression to a precancerous state, happens in a small percentage of cases. The crucial factor is the persistence of HPV as opposed to clearance of the virus. Persistence is due mostly to some capability of the virus to suppress or evade the body's natural immune system.[1015,1016]

The modal time between HPV infection (most often in late teens or early 20s) and the peak of precancer development is 7 to 10 years. This places the typical age of women with precancerous lesions at about 30 years. The final step is full-blown, invasive cancer, which may take another 10 years to develop; between one third and two-thirds of women with precancer will move on to this end-point. In sum, this generic, prolonged natural history confirms the basic understanding that rapidly invasive cancers among young women are rare events.[1017]

The modal time between HPV infection (most often in late teens or early 20s) and the peak of precancer development is 7 to 10 years. This places the typical age of women with precancerous lesions at about 30 years.

Preventive Interventions

As outlined above, there are three approaches to preventing cancer with an infectious origin: limiting exposure to the pathogen in the first place; interrupting the establishment of infection; and stopping full cancer development once infection is present. We will look at each of these approaches in turn.

Early Primary Prevention

The most "full-proof" way to eliminate the risk for future genital HPV infections is to refrain from genital contact with another person. The next most certain approach is to only be sexually active within a long-term, mutually monogamous relationship with an uninfected partner.[1018] Indeed, reducing the number of potentially risky sexual partners by any means is clearly a preventive measure. These sort of proactive

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[1012] Sedjo RL, Papenfuss MR, Craft NE et al. Effect of plasma micronutrients on clearance of oncogenic human papillomavirus (HPV) infection (United States). *Cancer Causes Control.* 2003; 14(4): 319-26.
[1013] Castle PE, Giuliano AR. Chapter 4: Genital tract infections, cervical inflammation, and antioxidant nutrients--assessing their roles as human papillomavirus cofactors. *Journal of the National Cancer Institute Monograph.* 2003; (31): 29-34.
[1014] Schiffman MH, Castle P. Epidemiologic studies of a necessary causal risk factor: human papillomavirus infection and cervical neoplasia. *Journal of the National Cancer Institute.* 2003; 95(6): E2.
[1015] Frazer IH, Thomas R, Zhou J et al. Potential strategies utilised by papillomavirus to evade host immunity. *Immunological Reviews.* 1999; 168: 131-42.
[1016] Padilla-Paz LA. Human papillomavirus vaccine: history, immunology, current status, and future prospects. *Clinical Obstetrics & Gynecology.* 2005; 48(1): 226-40.
[1017] Schiffman M, Kjaer SK. Chapter 2: Natural history of anogenital human papillomavirus infection and neoplasia. *Journal of the National Cancer Institute Monograph.* 2003; (31): 14-9.
[1018] *Report to Congress: Prevention of Genital Human Papillomavirus Infection.* Centers for Disease Control and Prevention; 2004. Available at http://www.cdc.gov/std/HPV/2004HPV%20Report.pdf. Accessed May 2005.

"partner management" interventions become important in light of the fact that preventing transmission through condom use has not been demonstrated (though condoms may protect against the development of genital warts and lesions).[1019,1020]

The literature related to the prevention of sexually transmitted infections (STIs) is extensive. To avoid an overly lengthy document, we will confine our description of this sort of early primary prevention to a few notable programs.

Population-Based Interventions to Reduce Sexually Transmitted Infection (STI). The relevant review by the Cochrane group restricted itself to randomized controlled trials where, by definition, the unit of randomization was either a community or treatment facility (not individuals). These stringent criteria yielded only 5 qualifying studies, *all based in developing countries* and none focusing on HPV per se. The interventions in population-based programs include: education and media campaigns aimed at promoting safer sexual behaviour; improved STI treatment services; integration of case-finding into routine health care; and mass treatment of persons in at-risk communities, even if they are asymptomatic. The programs reviewed, which may have limited applicability in developed countries anyway, were for the most part unsuccessful in reducing STI incidence rates. Only one study showed a significant decrease in gonorrhoea and syphilis (which, for our purposes, will be taken as proxies for HPV infection) and an increase in condom use (with the latter being of limited application to HPV prevention anyway, given current information).[1021] A 2005 systematic review of interventions to prevent STIs examined three of the same community-based studies identified by Cochrane, including the one trial that showed some success. All the included population-level studies were based in the same African communities covered by Cochrane.[1022] There apparently has been no population-level experimental research in developed countries, even though it is acknowledged that, to have maximum impact, STI interventions will likely need to be applied to whole populations.[1023]

Individual and Group Approaches to STI Control. The bulk of the 41 studies identified in the 2005 review noted above dealt with individual approaches; a smaller number looked at group-based programs. A large percentage of the projects showed significant success. [1024] For instance, a third of the 9 group-based programs in the review involved counselling and skills building that led to significant decreases in STI transmission. One study showed counselling focused on skills training (8.6%

[1019] Giles S. Transmission of HPV. *Canadian Medical Association Journal.* 2003; 168(11): 1391; author reply.
[1020] Manhart LE, Koutsky LA. Do condoms prevent genital HPV infection, external genital warts, or cervical neoplasia? A meta-analysis. *Sexually Transmitted Diseases.* 2002; 29(11): 725-35.
[1021] Sangani P, Rutherford G, Wilkinson D. Population-based interventions for reducing sexually transmitted infections, including HIV infection. *Cochrane Database of Systematic Reviews.* 2004; (2): CD001220.
[1022] Manhart LE, Holmes KK. Randomized controlled trials of individual-level, population-level, and multilevel interventions for preventing sexually transmitted infections: what has worked? *Journal of Infectious Diseases.* 2005; 191 Suppl 1: S7-24.
[1023] Sangani P, Rutherford G, Wilkinson D. Population-based interventions for reducing sexually transmitted infections, including HIV infection. *Cochrane Database of Systematic Reviews.* 2004; (2): CD001220.
[1024] Kamb ML, Fishbein M, Douglas JM, Jr. et al. Efficacy of risk-reduction counseling to prevent human immunodeficiency virus and sexually transmitted diseases: a randomized controlled trial. Project RESPECT Study Group. *Journal of the American Medical Association.* 1998; 280(13): 1161-7.

incidence over 12 months) was superior to a health education model (15.4%).[1025] The most recent literature has supported the efficacy of cognitive-behavioural group interventions for STI control.[1026]

Another review from 2002 found 8 interventions designed to reduce STI incidence; 5 of them showed significant success, including individual counselling, mass communications regarding risk reduction, and multiple-component motivation and skills education.[1027]

A Cochrane review originally completed in 2000 confirmed that health promotion directed at women can reduce sexual risk behaviours, especially with respect to increased use of condoms for vaginal intercourse.[1028] However, we have already noted the limited protection of condoms against HPV. In fact, none of the studies included in the review focused on the control of cervical cancer as an end-point.

Summing up STI prevention, it was acknowledged in 2002 that "the evidence based for many interventions is sparse and randomised trials of interventions are in their early days."[1029]

Despite the fact that not contacting and subsequently contracting HPV would be 100% effective in preventing cervical cancer, it is possible that the advent of an HPV vaccine will create some complacency around such behavioural interventions, as well as other approaches to controlling cervical cancer. This would possibly be a backwards step, especially given the Centers for Disease Control's 2004 position statement; they maintained that an effective HPV vaccine should not replace other prevention strategies.[1030]

Primary Prevention

The one-to-one association of cervical cancer and HPV infection has two practical implications: the development of a vaccine and enhanced screening programs based on HPV testing.[1031] The development of a vaccine has had a clearer rationale and, in fact, has progressed further at this point. The vaccine story, though chronologically a later

The one-to-one association of cervical cancer and HPV infection has two practical implications: the development of a vaccine and enhanced screening programs based on HPV testing.

[1025] Baker SA, Beadnell B, Stoner S et al. Skills training versus health education to prevent STDs/HIV in heterosexual women: a randomized controlled trial utilizing biological outcomes. *AIDS Education & Prevention.* 2003; 15(1): 1-14.
[1026] Boyer CB, Shafer MA, Shaffer RA et al. Evaluation of a cognitive-behavioral, group, randomized controlled intervention trial to prevent sexually transmitted infections and unintended pregnancies in young women. *Preventive Medicine.* 2005; 40(4): 420-31.
[1027] Elwy AR, Hart GJ, Hawkes S et al. Effectiveness of interventions to prevent sexually transmitted infections and human immunodeficiency virus in heterosexual men: a systematic review. *Archives of Internal Medicine.* 2002; 162(16): 1818-30.
[1028] Shepherd J, Weston R, Peersman G et al. Interventions for encouraging sexual lifestyles and behaviours intended to prevent cervical cancer. *Cochrane Database of Systematic Reviews.* 2000.
[1029] Johnson AM, Fenton KA, Mercer C. Phase specific strategies for the prevention, control, and elimination of sexually transmitted diseases: background country profile, England and Wales. *Sexually Transmitted Infections.* 2002; 78 Suppl 1: i125-32.
[1030] *Report to Congress: Prevention of Genital Human Papillomavirus Infection.* Centers for Disease Control and Prevention; 2004. Available at http://www.cdc.gov/std/HPV/2004HPV%20Report.pdf. Accessed May 2005.
[1031] Bosch FX, Munoz N. The viral etiology of cervical cancer. *Virus Research.* 2002; 89(2): 183-90.

development than conventional cervical cancer screening, must logically come first; it represents a primary approach to prevention, whereas detecting the presence of cancer is already part of a secondary strategy.

HPV Vaccine. Vaccination can either be prophylactic (preventing contact with a virus from becoming an active infection) or therapeutic (clearing an existing infection). There has been a great deal of excitement and energy around creating and testing a vaccine targeting HPV. This has been a special focus in the context of developing countries, for two reasons: the bulk of the annual 200,000 deaths related to cervical cancer occur there (making it the most prevalent cause of female cancer mortality), and less than 5% of these women currently participate in the other major public health strategy, namely, screening.[1032]

Many challenges exist in the development of a vaccine. Because of the multiplicity of HPV types which are oncogenic, there is motivation to make any vaccine polyvalent. However, this adds development and manufacturing expense, so the balancing act becomes one of targeting those viral types which cause the greatest proportion of cancer. Once a strategy has been set, there still must be vigilance against the "potential epidemiological shift of HPV disease to currently less frequent types and variants."[1033]

There have been several studies exploring either preventive or therapeutic HPV vaccines in humans. The trial by Koutsky et al. has provided the most conclusive evidence to date that HPV vaccination will be both safe and effective.[1034] The main objectives of this double-blind, placebo-controlled, randomized trial were:[1035]

- determine whether an HPV-16 vaccine would prevent persistent infection.
- estimate the impact of the vaccine on the incidence of cervical neoplasia.[1036]
- assess the immunogenicity (i.e., ability to create an immune response) and tolerability of the vaccine.

The observed efficacy rate against cancer development was 100%. These encouraging results were matched by a very low rate of adverse events with the vaccine (less than 1%). As well, the vaccine not only prevented the development of disease, but also seems to prevent "its causative agent from residing in the genital tract where it can infect new sexual partners."[1037] The main caveat emerging from this study was evidence that vaccination against one type of HPV will not protect against infection by another. Another limitation is that the vaccine does not appear to reverse infection or cervical neoplasia once it is present.

[1032] Goldie SJ, Grima D, Kohli M et al. A comprehensive natural history model of HPV infection and cervical cancer to estimate the clinical impact of a prophylactic HPV-16/18 vaccine. *International Journal of Cancer.* 2003; 106(6): 896-904.
[1033] Padilla-Paz LA. Human papillomavirus vaccine: history, immunology, current status, and future prospects. *Clinical Obstetrics & Gynecology.* 2005; 48(1): 226-40.
[1034] Koutsky LA, Ault KA, Wheeler CM et al. A controlled trial of a human papillomavirus type 16 vaccine. *New England Journal of Medicine.* 2002; 347(21): 1645-51.
[1035] Padilla-Paz LA. Human papillomavirus vaccine: history, immunology, current status, and future prospects. *Clinical Obstetrics & Gynecology.* 2005; 48(1): 226-40.
[1036] An abnormal cell growth that may progress to cancer.
[1037] Crum CP. The beginning of the end for cervical cancer? *New England Journal of Medicine.* 2002; 347(21): 1703-5.

The results of the only other phase III trial were reported in November, 2004. It studied the effect of a bivalent vaccine protecting against HPV-16 and HPV-18; adding HPV-18 has the potential for eliminating another 10% of total cervical cancer cases.[1038] On an intention-to-treat basis, the vaccine was 95% efficacious against persistent infection and 93% against cytological abnormalities and lesions. In addition to these results, the vaccine was shown to be safe, well-tolerated and highly immunogenic.

Several other studies have reported on earlier stages of vaccine testing. The phase II data from a quadrivalent vaccine published in May, 2005, were very promising.[1039] Over two and a half years of follow-up, the vaccine reduced the combined incidence of persistent infection from HPV-6, HPV-11, HPV-16, or HPV-18—as well as related genital disease including new cervical pre-cancers and genital warts—by 90%. The phase III trial of this vaccine is now under way. Several other vaccines are in the pipeline that will be targeting even higher numbers of HPV subtypes.

As one or more of these vaccines move towards licensing in the next few years, several questions remain open:

- Who should be vaccinated, and when? Some argue that the key population should be girls before they are sexually active, but since HPV causes a variety of cancers in men and women, a case can be made to vaccinate everyone.[1040,1041]
- How long does the protection last?
- How polyvalent should a widely-used public health vaccine be? For example, if women were vaccinated against five HPV types (16, 18, 31, 33, and 45), it would reduce cervical cancer risk by 85%.[1042] Another consideration is mortality; one study showed that cervical cancer patients with HPV-18 or -45 are more likely to die from their disease.[1043]
- How effective and cost-effective would a vaccination program be over the long-term, especially compared to current screening strategies?

There are two routes to answering the last question. The first is to compare the results from highly successful hepatitis B vaccination programs (see the next major section of this report). The second is mathematical modeling of disease progression and the impact of a vaccine. An example of the latter is offered by Taira et al.[1044] Their model

[1038] Harper DM, Franco EL, Wheeler C et al. Efficacy of a bivalent L1 virus-like particle vaccine in prevention of infection with human papillomavirus types 16 and 18 in young women: a randomised controlled trial. *The Lancet.* 2004; 364(9447): 1757-65.
[1039] Villa LL, Costa RL, Petta CA et al. Prophylactic quadrivalent human papillomavirus (types 6, 11, 16, and 18) L1 virus-like particle vaccine in young women: a randomised double-blind placebo-controlled multicentre phase II efficacy trial. *Lancet Oncology.* 2005; 6(5): 271-8.
[1040] Winer RL, Koutsky LA. Human papillomavirus through the ages. *Journal of Infectious Diseases.* 2005; 191(11): 1787-9.
[1041] Crum CP. The beginning of the end for cervical cancer? *New England Journal of Medicine.* 2002; 347(21): 1703-5.
[1042] Crum CP. The beginning of the end for cervical cancer? *New England Journal of Medicine.* 2002; 347(21): 1703-5.
[1043] Wright JD, Li J, Gerhard DS et al. Human papillomavirus type and tobacco use as predictors of survival in early stage cervical carcinoma. *Gynecologic Oncology.* 2005; in press: 8 pp.
[1044] Taira AV. Evaluating human papillomavirus vaccination programs. *Emerging Infectious Diseases.* 2004; 10(11): 1915-23.

estimated HPV prevalence and infection rates for the population overall, by age group, by level of sexual activity and by gender. The conclusion was that administering an HPV-16/18 vaccine to 12 year old girls would reduce cervical cancer cases by almost 62%, with a cost-effectiveness ratio of $14,583 per QALY.[1045]

HPV Testing. There is a lot of debate concerning the potential usefulness of augmenting (or even replacing) conventional cytological screening (see under secondary prevention below) for cervical cancer with an HPV DNA test. As one study noted, "the extreme rarity of HPV-negative cancers reinforces the rationale for HPV testing in addition to, or even instead of, cervical cytology in routine cervical screening."[1046] Additional pressure to consider alternatives comes from the challenges and deficiencies of current routine screening methods (see below). However, the extra cost of HPV testing is viewed by some as being prohibitive.

In April, 2005, the American College of Obstetricians and Gynecologists released a practice bulletin that acknowledges the high sensitivity of detecting HPV DNA in terms of ruling out cervical cancer.[1047] If HPV is not present, women can be reassured with a high level of certainty that they are cancer-free. Using the test in the opposite direction is where the problems begin, i.e., deciding whether a detected HPV infection (even high risk types) but *without* cervical abnormality should be followed and treated (and, if so, when and how).[1048] The cost of any additional surveillance (in about 4 to 6% of the screened population) adds to the already higher expense of HPV testing.[1049] On the other hand, women with normal cytology and negative for high-risk HPV types can be screened less frequently; cost-effectiveness and modeling studies suggest that this fact could offset increased costs with HPV testing and thus make the procedure attractive from a public health perspective.[1050] A comprehensive review of the literature up to 2005 confirmed that adding HPV testing to conventional screening would "likely" be cost-effective, though it also acknowledged that "further research is needed into the practicalities of implementing such a policy."[1051]

Another potential area of usefulness for HPV testing is rapid intermediate evaluation of precancer treatments (see under secondary prevention below).[1052,1053,1054] An

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[1045] Quality-adjusted life-year, a standard measure of improved health which takes into consideration delayed mortality as well as reduced morbidity.

[1046] Walboomers JM, Jacobs MV, Manos MM et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *Journal of Pathology.* 1999; 189(1): 12-9.

[1047] Summary available at http://investor.digene.com/phoenix.zhtml?c=82439&p=irol-newsArticle_Print&ID=695453&highlight=. Accessed June 2005.

[1048] Franceschi S, Mahe C. Human papillomavirus testing in cervical cancer screening. *British Journal of Cancer.* 2005; 92(9): 1591-2.

[1049] Cuzick J, Szarewski A, Cubie H et al. Management of women who test positive for high-risk types of human papillomavirus: the HART study. *The Lancet.* 2003; 362(9399): 1871-6.

[1050] Brink AA, Zielinski GD, Steenbergen RD et al. Clinical relevance of human papillomavirus testing in cytopathology. *Cytopathology.* 2005; 16(1): 7-12.

[1051] Holmes J, Hemmett L, Garfield S. The cost-effectiveness of human papillomavirus screening for cervical cancer. A review of recent modelling studies. *European Journal of Health Economics.* 2005; 6(1): 30-7.

[1052] Elfgren K, Jacobs M, Walboomers JM et al. Rate of human papillomavirus clearance after treatment of cervical intraepithelial neoplasia. *Obstetrics & Gynecology.* 2002; 100(5 Pt 1): 965-71.

[1053] Paraskevaidis E, Arbyn M, Sotiriadis A et al. The role of HPV DNA testing in the follow-up period after treatment for CIN: a systematic review of the literature. *Cancer Treatment Reviews.* 2004; 30(2): 205-11.

alternate approach to tracking the development of disease and the effectiveness of therapy is surveillance of molecular biomarkers associated with the natural history of HPV-related carcinogenesis.[1055]

Avoiding Co-factors. Women who smoke do not seem to clear an HPV infection as quickly as non-smokers. Smoking is a risk co-factor for cervical cancer (as well as many other cancers, of course); but, in the case if cervical cancer, it is possible that this relationship is not necessarily a causative one (e.g., smokers perhaps having more sexual partners, on average). For this reason, it cannot be assumed that not smoking (or cessation) will automatically reduce the risk of HPV infection developing into cancer. While no specific studies were found which evaluated that particular issue, it is of significance in terms of secondary prevention that smoking does seem to decrease the effectiveness of precancer treatments.[1056]

Women who smoke do not seem to clear an HPV infection as quickly as non-smokers.

Exposure to other sexually transmitted infections should also be avoided to reduce cervical cancer risk, but the same behavioural changes already "prescribed" for preventing HPV infection would automatically be protective against some of the other agents anyway.

Conservative Treatment. The therapeutic approaches to a detected HPV infection are limited, though some new directions are being explored. In fact, in the absence of coexistent cellular changes, treatment is generally not recommended for subclinical genital HPV infection diagnosed by colposcopy,[1057] biopsy, acetic acid application, or the detection of HPV by laboratory tests. The diagnosis of subclinical genital HPV infection is often not definitive, and no therapy has yet been identified that can eliminate infection.[1058,1059] This was confirmed in the only systematic review located, which dates back to 2000 and was not published in a top-tier journal.[1060] Nonetheless, the results there (which mainly looked at laser therapy) can be added to earlier conclusions that effective antiviral therapies for subclinical HPV infection are not yet available.[1061]

[1054] Bodner K, Bodner-Adler B, Wierrani F et al. Is therapeutic conization sufficient to eliminate a high-risk HPV infection of the uterine cervix? A clinicopathological analysis. *Anticancer Research.* 2002; 22(6B): 3733-6.

[1055] Padilla-Paz LA. Emerging technology in cervical cancer screening: status of molecular markers. *Clinical Obstetrics & Gynecology.* 2005; 48(1): 218-25.

[1056] Acladious NN, Sutton C, Mandal D et al. Persistent human papillomavirus infection and smoking increase risk of failure of treatment of cervical intraepithelial neoplasia (CIN). *International Journal of Cancer.* 2002; 98(3): 435-9.

[1057] Visual examination of the cervix and vagina using a lighted magnifying instrument.

[1058] See the CDC website at http://www.cdc.gov/STD/treatment/6-2002TG.htm#SubclinicalGenitalHPVInfection. Accessed June 2005.

[1059] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.

[1060] Russomano F, Reis A, de Camargo MJ et al. Efficacy in treatment of subclinical cervical HPV infection without intraepithelial neoplasia: systematic review. *Sao Paulo Medical Journal.* 2000; 118(4): 109-15.

[1061] Phelps WC, Alexander KA. Antiviral therapy for human papillomaviruses: rational and prospects. *Annals of Internal Medicine.* 1995; 123(5): 368-82.

Research continues in this area. Reversing the assessment of earlier studies,[1062] recombinant human interferon gamma has shown good results in effecting regression of precancer cells and sometimes complete remission of HPV infection.[1063] As well, one study suggested that the highly active antiretroviral therapy used with human immunodeficiency viral infection and AIDS can have a positive effect on cervical precancer regression (the impact on HPV clearance was not reported).[1064] The quest is for a targeted antiviral, rather than simply the induction of non-specific inflammation which in turn generates a "bystander immune response."[1065] Antivirals for HPV are especially important for the large population of immunosuppressed individuals who will mostly likely not benefit from immunotherapies.

A new approach is the potential use of therapeutic vaccines to control HPV infection or associated lesions. The main targets shaping vaccine development have been the key oncoproteins responsible for malignant transformation.[1066] Mostly, results from small phase I trials have been variable.[1067] If the promise seen in some early results is eventually fulfilled, then these therapeutic agents may play a role in both primary and secondary prevention of cervical cancer.

The last statement underlines the fact that therapies for HPV often overlap with those for the various precancer and early cancer stages which may lead to full invasive cervical cancer. The object of therapy is a "moving target" throughout the natural history of HPV disease. Somewhere we pass from primary prevention related to controlling HPV infection per se, through intermediate stages of precancerous development, and finally to a point where advanced precancer or early cancer is clearly in place. For our purposes, we will treat the latter stages as cases requiring secondary prevention; once detected through screening, the transformed cells and lesions become candidates for treatment, which usually is some form of ablation[1068] through surgery or other means (see below).

Rounding out the conservative approaches to HPV infection, both dietary nutrients (e.g., retinoids, related to vitamin A, and beta-carotenes) and a topical medication called cidofovir have been investigated, with mixed-to-promising results.[1069,1070] Nonsteroidal anti-inflammatories and gene therapies are also in an early stage of

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[1062] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1063] Sikorski M, Zrubek H. Recombinant human interferon gamma in the treatment of cervical intraepithelial neoplasia (CIN) associated with human papillomavirus (HPV) infection. *European Journal of Gynaecology & Oncology.* 2003; 24(2): 147-50.
[1064] Heard I, Tassie JM, Kazatchkine MD et al. Highly active antiretroviral therapy enhances regression of cervical intraepithelial neoplasia in HIV-seropositive women. *Aids.* 2002; 16(13): 1799-802.
[1065] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1066] Peng S, Ji H, Trimble C et al. Development of a DNA vaccine targeting human papillomavirus type 16 oncoprotein E6. *Journal of Virology.* 2004; 78(16): 8468-76.
[1067] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1068] The removal or destruction of a body part or tissue or its function. Ablation may be performed by surgery, hormones, drugs, lasers, radiofrequency, heat, freezing, or other methods.
[1069] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1070] Manetta A, Schubbert T, Chapman J et al. beta-Carotene treatment of cervical intraepithelial neoplasia: a phase II study. *Cancer Epidemiology, Biomarkers & Prevention.* 1996; 5(11): 929-32.

investigation.[1071,1072] Finally, an experimental treatment of HPV infection, photodynamic therapy, has shown variable efficacy.[1073]

Secondary Prevention

Screening. Chronologically, conventional cervical cancer screening (the backdrop for future decisions about HPV tests) has a longer history than the development of vaccines or HPV DNA testing, but *logically* it belongs at this point in the discussion. Cancer screening is designed to detect the presence of precancerous cells or lesions and then prompt preventive measures. By identifying the precursor lesions associated with HPV infection, screening programs based on cytology[1074] have reduced the incidence of invasive cervical cancer. One case study, a report in the UK, concluded that cervical cancer screening has prevented an epidemic that would have killed about 1 in 65 British women born since 1950, or about 6,000 deaths per year. In sum, at least 100,000 women born between 1951 and 1970 have been spared premature death in that country.[1075] Even with such dramatic statistics, cost-effectiveness analyses of such programs have produced variable results. In countries where an abnormal test result can lead to substantial resources being invested in management, the cost per life year saved may run into many thousands of dollars.[1076]

The most common screening test that goes beyond a regular gynecologic examination is the so-called Pap smear, the name being a shortened form of its originator, GN Papanicolaou.[1077] He published results concerning the correlation between abnormalities in scraped cells and cervical cancer in a cornerstone paper in 1941. The aim, and the eventual result, of a simple screening test was to save "millions of women who would otherwise discover their cancer of the cervix uteri at a non-curable stage."[1078] As described earlier, precursor lesions usually appear a considerable length of time before a carcinoma; thus early detection and prompt management can lead to effective prevention of the disease.

> The aim of a simple screening test (the Pap smear) was to save millions of women who would otherwise discover their cancer of the cervix at a non-curable stage.

The Pap smear is a screening rather than a diagnostic test. This means that any abnormal cells (so-called cervical intraepithelial neoplasia, or CIN) need to be

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[1071] Helm CW, Meyer NJ. Anti-inflammatory agents for preventing the progression of cervical intraepithelial neoplasia. Cochrane Gynaecological Cancer Group *Cochrane Database of Systematic Reviews.* 2005.

[1072] Sethi N, Palefsky J. Treatment of human papillomavirus (HPV) type 16-infected cells using herpes simplex virus type 1 thymidine kinase-mediated gene therapy transcriptionally regulated by the HPV E2 protein. *Human Gene Therapy.* 2003; 14(1): 45-57.

[1073] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.

[1074] The examination of cellular structure.

[1075] Peto J, Gilham C, Fletcher O et al. The cervical cancer epidemic that screening has prevented in the UK. *The Lancet.* 2004; 364(9430): 249-56.

[1076] Crum CP. The beginning of the end for cervical cancer? *New England Journal of Medicine.* 2002; 347(21): 1703-5.

[1077] Alternate terminology includes PAP Test, Papanicolaou smear, cervical smear, cervical/vaginal cytology.

[1078] Michalas SP. The Pap test: George N. Papanicolaou (1883-1962). A screening test for the prevention of cancer of uterine cervix. *European Journal of Obstetrics & Gynecology & Reproductive Biology.* 2000; 90(2): 135-8.

followed up, starting with further examinations or tests (e.g., via colposcopy) to evaluate whether cancer itself is present or threatening.

An abnormal Pap smear can be treated in a variety of ways, from conservative monitoring over a period of months to see if it returns to normal, to cryosurgery that freezes and destroys infected cells, to other procedures that excise problem tissue (see below).

The main strategic issues with Pap smears are:

- Identifying the most efficient age cut-offs and frequency of routine testing.
- Focusing on organized or opportunistic screening.[1079]
- Introducing automatic scanning devices.[1080]
- As noted earlier, how and when to integrate HPV DNA testing. The most common proposal is a primary Pap test with an adjunctive HPV test, especially if the cytological examination provides equivocal results.[1081]
- Establishing the best protocol for monitoring tissue status after precancer intervention. A meta-analysis of the literature suggested that a double negative (i.e., no abnormality in Pap smear or HPV DNA test) at 6 months and then again at 24 months is sufficient to allow the person to return to a routine testing protocol.[1082]

Despite the amazing track record of Pap smears, the motivation to also move towards HPV testing and / or vaccinations has emerged due to the high false-negatives seen in conventional testing. The false-negative rate with Pap smears ranges from 5 to 30%.[1083] This results in, for example, about half of the cervical cancer cases in the US (representing about 7,000 women per year) occurring in those who are routinely screened. Cervical adenocarcinomas[1084] in younger women are especially hard to prevent.[1085] All of this uncertainty has prompted a large amount of litigation and huge awards. False positives are also a concern, given that the vast majority of HPV infections resolve spontaneously; of course, this challenge would also apply to the newer HPV tests.

We may be at the limit of human ability to derive appropriate and consistent information from the microscopic examination of Pap specimens. Thus efforts to

[1079] Gustafsson L, Ponten J, Zack M et al. International incidence rates of invasive cervical cancer after introduction of cytological screening. *Cancer Causes Control.* 1997; 8(5): 755-63.
[1080] Nieminen P, Vuorma S, Viikki M et al. Comparison of HPV test versus conventional and automation-assisted Pap screening as potential screening tools for preventing cervical cancer. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2004; 111(8): 842-8.
[1081] Vassilakos P, de Marval F, Munoz M et al. Human papillomavirus (HPV) DNA assay as an adjunct to liquid-based Pap test in the diagnostic triage of women with an abnormal Pap smear. *International Journal of Gynecology & Obstetrics.* 1998; 61(1): 45-50.
[1082] Zielinski GD, Bais AG, Helmerhorst TJ et al. HPV testing and monitoring of women after treatment of CIN 3: review of the literature and meta-analysis. *Obstetrical & Gynecological Survey.* 2004; 59(7): 543-53.
[1083] Foulks MJ. The Papanicolaou smear: its impact on the promotion of women's health. *Journal of Obstetric, Gynecologic & Neonatal Nursing.* 1998; 27(4): 367-73.
[1084] A cancer that develops in the lining or inner surface of an organ. As opposed to, for instance, cancer in squamous epithelial cells.
[1085] Crum CP. The beginning of the end for cervical cancer? *New England Journal of Medicine.* 2002; 347(21): 1703-5.

increase the sensitivity of the test have focused more on the collection, handling and processing of specimens. So called thin layer (or liquid-based) technology involves collecting material with a soft brush and then rinsing it into a special fluid preservative; from there, a thin-layer slide can be prepared which offers several improvements in terms of the quality of the cytological examination. This method has the advantage of providing material for any subsequent HPV DNA test as well.[1086]

Resisting Critics / Increasing the Use of Screening. Whatever the risk, inconvenience and cost of false negatives, there is a tragic irony developing around looking for a "perfect" Pap smear: it may become too good to be affordable. The cost of more specialized specimen collection and preparation, computerized rescreening and malpractice insurance could mean the loss of an inexpensive, widely available Pap smear, which "will undoubtedly lead to increased cervical carcinoma."[1087] The fact is that more women experience the development of cancer because of the failure to have a regular Pap smear than because of errors in cytodiagnosis.[1088]

The Cochrane review of interventions to encourage cervical screening identified the following approaches:[1089]

- invitations to women who are not overdue (letters, telephone calls, etc.)
- reminders to those overdue
- education (materials, home visits, etc.)
- counselling
- risk factor assessment
- improvements in screening methods
- economic incentives.

In all, 35 studies were identified in the review (27 being randomized controlled trials). The only extensive and strong evidence was for invitation letters; there was limited support for educational interventions.

Surgery and Other Forms of Ablation. It becomes a matter of judgment as to when to categorize surgery and other means of dealing with precancerous situations as interventions which truly have left behind the "world of prevention" and entered the arena of full cancer management. One way to enable a categorization of required interventions is the grading system that has been adopted to describe a Pap smear diagnosis. In the US, two levels of CIN (more generally known as squamous intraepithelial lesions, or SILs) are recognized: low-grade and high-grade; in contrast, the Europeans distinguish 3 levels of precancerous development.[1090] High-grade SILs of the cervix require treatment because of their potential to progress to invasive

[1086] Michalas SP. The Pap test: George N. Papanicolaou (1883-1962). A screening test for the prevention of cancer of uterine cervix. *European Journal of Obstetrics & Gynecology & Reproductive Biology.* 2000; 90(2): 135-8.
[1087] DeMay RM. Common problems in Papanicolaou smear interpretation. *Archives of Pathology & Laboratory Medicine.* 1997; 121(3): 229-38.
[1088] Boronow RC. Death of the Papanicolaou smear? A tale of three reasons. *American Journal of Obstetrics & Gynecology.* 1998; 179(2): 391-6.
[1089] Forbes C, Jepson R, Martin-Hirsch P. Interventions targeted at women to encourage the uptake of cervical screening. *Cochrane Database of Systematic Reviews.* 2002.
[1090] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.

cancer. One of the "advantages" of such cervical lesions is that they are localized, allowing for excision or other ablative therapies to be highly effective. Once we have entered this level of response, we are no longer treating HPV infection per se, though effective treatment of SIL usually means that HPV is also cleared from the site.[1091] Targeted antiviral therapies need to be developed in order to reduce the risk of recurrence after ablation.

Types of local destruction or excision used with high-grade SILs include:[1092]

- cryotherapy
- cold coagulation
- electrodiathermy
- CO_2 laser
- cone biopsy (laser or knife)
- loop diathermy, or loop electrosurgical excision procedure (LEEP).

The Cochrane review of these approaches noted that there is "no obviously superior surgical technique" for treating SIL. The LEEP did seem to offer the least morbidity and the most reliable specimens for evaluating success of the treatment.[1093] A very recent study of the cold-knife section technique showed it was very effective, with low morbidity and little adverse consequences for childbearing.[1094] This is in stark contrast to the most invasive treatment for high-grade SIL or full cancer, namely, hysterectomy.

Much like subclinical infection (discussed above under primary prevention), the treatment of low-grade SILs is a complex matter, and varies widely across jurisdictions.[1095] The approaches fall into three categories: surveillance (but this misses the small number of women who are at risk for disease progression); routine ablation (this tends to overtreat, for most infections and associated lesions are self-limiting); and selective ablation (this depends on triage through something like the new HPV DNA test). In the near term, the best improvement in any management protocol would be the clinical adoption of proven immunotherapies, such as a vaccine.[1096] As noted earlier, interferon has shown some effectiveness against low-grades SILs, though it still offers inferior results compared to surgery.[1097]

[1091] Elfgren K, Jacobs M, Walboomers JM et al. Rate of human papillomavirus clearance after treatment of cervical intraepithelial neoplasia. *Obstetrics & Gynecology.* 2002; 100(5 Pt 1): 965-71.
[1092] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1093] Martin-Hirsch PL, Paraskevaidis E, Kitchener, H. Surgery for cervical intraepithelial neoplasia. Cochrane Gynaecological Cancer Group. *Cochrane Database of Systematic Reviews.* 2005.
[1094] Mazouni C, Porcu G, Haddad O et al. Conservative treatment of cervical intraepithelial neoplasia using a cold-knife section technique. *European Journal of Obstetrics & Gynecology & Reproductive Biology.* 2005:
[1095] Scheungraber C, Kleekamp N, Schneider A. Management of low-grade squamous intraepithelial lesions of the uterine cervix. *British Journal of Cancer.* 2004; 90(5): 975-8.
[1096] Stanley M. Chapter 17: Genital human papillomavirus infections--current and prospective therapies. *Journal of the National Cancer Institute Monograph.* 2003; (31): 117-24.
[1097] Sikorski M, Zrubek H. Long-term follow-up of patients treated with recombinant human interferon gamma for cervical intraepithelial neoplasia. *International Journal of Gynaecology & Obstetrics.* 2003; 82(2): 179-85.

Hepatitis Viruses

The term "hepatitis virus" has traditionally been reserved for viruses that are hepatotropic, i.e., having a special affinity for or exerting a specific effect on the liver. Hepatitis B and C qualify, as they are strongly associated with liver infection, as well as liver cancer. The history of grouping such viruses together according to disease rather than virological properties means that at least four different virus families are represented by hepatitis viruses. Thus hepatitis B virus (HBV) belongs to the *Hepadnaviridae* family, and hepatitis C virus (HCV) to the *Flaviviridae*.[1098] Neither of these viruses are singular agents; they each exhibit multiple genotypes, which may in turn represent variation in natural history and response to treatment (though the current evidence for variable disease expression with HCV subtypes is mixed).[1099,1100,1101,1102] A further complication is the fact that several viruses can be implicated in a particular case of liver disease, including hepatitis B and C interacting together, as well as Epstein Barr virus and HIV.[1103,1104,1105,1106,1107]

Hepatitis B and C are strongly associated with liver infection, as well as liver cancer.

Transmission of the Agent

As summarized in the epidemiological overview table above, there is a high risk of chronic HBV and / or HCV infection leading to liver cancer. Naturally, this is especially a concern in areas with an elevated infection rate in the first place. For example, more than 8% of the population in Africa and Asia are chronic carriers of HBV. This contrasts with the less than 2% prevalence in Western Europe, North America and Australia.[1108] The prevalence of hepatitis C is also under 2% in developed countries, though in this case the mean worldwide rate is not much higher (i.e., the average global prevalence of HCV is 3%—about half that of chronic HBV).[1109] This means that HCV is a widespread problem, not isolated

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[1098] Howard CR. Hepatitis viruses: a pandora's box? *Journal of Gastroenterology & Hepatology.* 2002; 17 Suppl: S464-7.

[1099] Schaefer S. Hepatitis B virus: significance of genotypes. *Journal of Viral Hepatology.* 2005; 12(2): 111-24.

[1100] Chen DS. Viral hepatitis: from A to E, and beyond? *Journal of the Formosa Medical Association.* 2003; 102(10): 671-9.

[1101] Howard CR. Hepatitis C virus: clades and properties. *Journal of Gastroenterology & Hepatology.* 2002; 17 Suppl: S468-70.

[1102] Alexopoulou A, Dourakis SP. Genetic heterogeneity of hepatitis viruses and its clinical significance. *Current Drug Targets--Inflammation & Allergy.* 2005; 4(1): 47-55.

[1103] Shi J, Zhu L, Liu S et al. A meta-analysis of case-control studies on the combined effect of hepatitis B and C virus infections in causing hepatocellular carcinoma in China. *British Journal of Cancer.* 2005; 92(3): 607-12.

[1104] Santolamazza M, Marinelli RM, Bacosi M et al. What kind of hepatitis? *Journal of International Medical Research.* 2001; 29(5): 441-4.

[1105] McCarron B, Main J, Thomas HC. HIV and hepatotropic viruses: interactions and treatments. *International Journal of STD & AIDS.* 1997; 8(12): 739-45; quiz 45-6.

[1106] Alberti A, Pontisso P, Chemello L et al. The interaction between hepatitis B virus and hepatitis C virus in acute and chronic liver disease. *Journal of Hepatology.* 1995; 22(1 Suppl): 38-41.

[1107] Kottilil S, Jackson JO, Polis MA. Hepatitis B & hepatitis C in HIV-infection. *Indian Journal of Medical Research.* 2005; 121(4): 424-50.

[1108] Maddrey WC. Hepatitis B--an important public health issue. *Clinical Laboratory.* 2001; 47(1-2): 51-5.

[1109] Yen T, Keeffe EB, Ahmed A. The epidemiology of hepatitis C virus infection. *Journal of Clinical Gastroenterology.* 2003; 36(1): 47-53.

geographically. It is, for instance, the most common bloodborne infection in the US.[1110]

Hepatitis B is transmitted primarily by contact with contaminated blood or blood products—though saliva, semen, vaginal fluids, tears, breast milk and urine also can contain the virus.[1111] Infection occurs in several ways:

- direct injection of infected blood or serums through transfusions, treatment with blood products, or accidental needlesticks
- haemodialysis
- transmission through skin openings such as burns or scratches
- direct introduction of saliva or blood into inner body surfaces (i.e., mucosa)
- breathing microscopic blood droplets or aerosols
- indirect transfer of blood or other secretions from obviously soiled surfaces or objects.

In endemic areas such as Asia, perinatal (or so-called vertical) transmission from mother to child during or soon after delivery is the most common means of spreading HBV. A related topic is the risk of infection through normal breastfeeding; the evidence to date strongly suggests "that any risk of transmission associated with breast milk is negligible compared to the high risk of exposure to maternal blood and body fluids at birth."[1112] Any risks that do exist can be virtually eliminated through routine vaccination of infants.

In regions like North America where endemicity is low, the predominant means of hepatitis B transmission is horizontal, especially sexual activity and intravenous drug use.[1113] The risk of HBV infection is notably high in homosexual men with multiple partners. For health care workers, being stuck with contaminated needles and syringes or being splattered with blood are also important ways of becoming infected with HBV.

Prior to the implementation of new policies surrounding therapeutic blood supplies in the early 1990s, receiving a transfusion during an operation was a risk factor for contracting hepatitis B and C; organ transplantation also fell into this category before new precautions were instituted. Today, the risk of new infection by these means in developed countries is approaching zero for several viruses,[1114,1115] though further

[1110] Rose VL. CDC issues new recommendations for the prevention and control of hepatitis C virus infection. *American Family Physician.* 1999; 59(5): 1321-3.
[1111] Atkins M, Nolan M. Sexual transmission of hepatitis B. *Current Opinions in Infectious Diseases.* 2005; 18(1): 67-72.
[1112] Hepatitis B and breastfeeding. World Health Organization Update. 1996. Available at http://www.who.int/child-adolescent-health/New_Publications/NUTRITION/updt-22.htm. Accessed May 2005.
[1113] Maddrey WC. Hepatitis B--an important public health issue. *Clinical Laboratory.* 2001; 47(1-2): 51-5.
[1114] Dodd RY. Current safety of the blood supply in the United States. *International Journal of Hematology.* 2004; 80(4): 301-5.
[1115] Soldan K, Barbara JA, Ramsay ME et al. Estimation of the risk of hepatitis B virus, hepatitis C virus and human immunodeficiency virus infectious donations entering the blood supply in England, 1993-2001. *Vox Sanguinis.* 2003; 84(4): 274-86.

progress needs to be made with HBV detection specifically,[1116] as well as screening tissue grafts.[1117] Unfortunately, with its long latency period, chronic hepatitis originally derived through transfusions and transplants will continue to manifest itself for some decades.

Hepatitis C is transmitted by blood to blood contact only. This means that blood infected with hepatitis C must come into direct contact with the bloodstream of another person. Even the smallest amounts of blood can transmit hepatitis C. Transmission occurs through:

- sharing of equipment used to inject drugs
- unsterile tattooing, body piercing and skin penetration procedures
- household practices (such as sharing razor blades and toothbrushes)
- occupational procedures (e.g., needlestick and sharps injuries)
- haemodialysis
- certain sexual activities
- mother to baby.

In the setting of developed countries, intravenous drug use stands out as the predominant behavioural risk factor, accounting for over 40% of HCV cases (or 3 times the proportion due to sexual activities).[1118,1119] Almost 80% of injecting-drug users in the US are known to be infected with HCV.[1120]

By contrast, the risk of either sexual or perinatal transmission of HCV is estimated to be only about 5%.[1121,1122] A 2005 study revealed that one third to one half of children infected with HCV acquired the virus in utero.[1123] Again, breastfeeding is a matter of some interest; as with hepatitis B, the current conclusion is that it is safe for mothers with hepatitis C to breastfeed.[1124]

Co-factors and Correlates

Other than hepatitis infection, the main modifiable risk factors for liver cancer in developed countries are excessive alcohol consumption and cirrhosis. In fact, these

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[1116] Chiavetta JA, Escobar M, Newman A et al. Incidence and estimated rates of residual risk for HIV, hepatitis C, hepatitis B and human T-cell lymphotropic viruses in blood donors in Canada, 1990-2000. *Canadian Medical Association Journal.* 2003; 169(8): 767-73.

[1117] Zou S, Dodd RY, Stramer SL et al. Probability of viremia with HBV, HCV, HIV, and HTLV among tissue donors in the United States. *New England Journal of Medicine.* 2004; 351(8): 751-9.

[1118] Alter MJ. Epidemiology of hepatitis C. *Hepatology.* 1997; 26(3 Suppl 1): 62S-5S.

[1119] Perez CM, Suarez E, Torres EA et al. Seroprevalence of hepatitis C virus and associated risk behaviours: a population-based study in San Juan, Puerto Rico. *International Journal of Epidemiology.* 2005; 34(3): 593-9.

[1120] Data available at http://www.cdc.gov/ncidod/diseases/hepatitis/c_training/edu/1/default.htm. Accessed May 2005.

[1121] Dienstag JL. Sexual and perinatal transmission of hepatitis C. *Hepatology.* 1997; 26(3 Suppl 1): 66S-70S.

[1122] Newell ML, Pembrey L. Mother-to-child transmission of hepatitis C virus infection. *Drugs Today.* 2002; 38(5): 321-37.

[1123] Mok J, Pembrey L, Tovo PA et al. When does mother to child transmission of hepatitis C virus occur? *Archives of Disease in Childhood Fetal & Neonatal Edition.* 2005; 90(2): F156-60.

[1124] Mast EE. Mother-to-infant hepatitis C virus transmission and breastfeeding. *Advances in Experimental Medicine & Biology.* 2004; 554: 211-6.

factors, as well as diabetes (and perhaps obesity), interact synergistically with viral infection to increase the rate of cancer development.[1125] The same multiplicative effect applies with exposure to aflatoxin in poorly stored grains, though this mainly affects populations in sub-Saharan Africa and Asia.[1126]

Co-infections are an especially difficult problem. Combined hepatitis virus infections account for 5 to 10% of all HCV cases; such patients, infected with HCV and HBV (and sometimes hepatitis D), are often associated with more severe forms of liver disease and less responsiveness to interferon (see below). HCV is a common co-infection with HIV; a unique challenge is the fact that HIV drug treatments can themselves be hepatotoxic.[1127]

Natural History and Carcinogenesis

Understanding the disease course in hepatitis B and C is a complex task, partly impeded by incomplete epidemiological data.

The course of hepatitis B from a clinical perspective can be categorized into four stages of varying duration: [1128]

I. Active viral replication / immune system tolerance.
II. Initial immune response, inflammation and hepatic tissue injury.
III. Clearance of virus-infected cells.
IV. Full immunity.

If a person does not proceed beyond stage II, they become by definition chronic carriers of HBV. Cirrhosis and hepatocellular carcinoma (HCC) are common sequelae of a (usually) prolonged experience of chronic HBV; these diseases occur in 25-30% of carriers.[1129]

This general progression needs to be modified according to the age when the infection occurs. In the perinatal type of transmission experienced in endemic areas, a large percentage of the infected infants become carriers; in contrast, a smaller proportion of those infected as children or adults develop chronic forms of the disease. Of HBV carriers, 1 to 2% develop cirrhosis each year (some studies put the rate as high as 10 to 12%). The presence of cirrhosis is a major risk factor for hepatocellular carcinoma. Cancer develops in 1.5 to 4% of cirrhotic hepatitis B patients each year, usually decades after they had first become infected.[1130] As indicated in the table above, this progression to HCC eventually accounts for 40 to 60% of liver cancers worldwide.

[1125] Yuan JM, Govindarajan S, Arakawa K et al. Synergism of alcohol, diabetes, and viral hepatitis on the risk of hepatocellular carcinoma in blacks and whites in the U.S. *Cancer.* 2004; 101(5): 1009-17.
[1126] Yu MC, Yuan JM. Environmental factors and risk for hepatocellular carcinoma. *Gastroenterology.* 2004; 127(5 Suppl 1): S72-8.
[1127] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.
[1128] Custer B, Sullivan SD, Hazlet TK et al. Global epidemiology of hepatitis B virus. *Journal of Clinical Gastroenterology.* 2004; 38(10 Suppl): S158-68.
[1129] Maddrey WC. Hepatitis B--an important public health issue. *Clinical Laboratory.* 2001; 47(1-2): 51-5.
[1130] See the summary at http://www.hepnet.com/update6.html. Accessed May 2005.

The natural history and epidemiology of hepatitis C infection is still being elucidated, which is not surprising given that the virus was only identified 15 years ago.[1131] Some facts have become clearer; for instance, research has shown that fully 75% of persons with HCV will develop chronic infection.[1132] Beyond that, it seems that HCV progresses less intensely than HBV. A systematic review of the literature in 2001 suggested that for persons infected with HCV in young adulthood, less than 10% will develop cirrhosis within 20 years.[1133] A Markov modelling exercise from 2002 pegged the rate more precisely at 7% after 20 years, and only 20% after 40 years of infection.[1134] However, the risks more than double for people infected after age 40.[1135] The annual incidence of hepatocellular carcinoma among cirrhotic HCV patients is similar to that with HBC, 1.5 to 2.5%.[1136] Putting it differently, the total risk for developing liver cancer among viral cirrhosis patients is approximately 7%.[1137]

As indicated earlier, this end-point for HCV infection accounts for 20 to 30% of the global burden of liver cancer. Although creating less cancer than HBV, the sobering fact remains that liver carcinoma derived from any source is deadly; the annual death rate is about 80% in industrialized countries.[1138]

Preventive Interventions

The urgency for preventive measures around the hepatitis viruses arises not just from current rate of liver cancer and its high mortality, but from the impact of other serious diseases such as cirrhosis and the risks related to the vast "reservoirs" of viral carriers around the world. Exacerbating this scenario is that fact that HBV, HCV and HIV have similar transmission routes, leading to high co-infection rates; the conditions caused by these viruses interact synergistically, with the potential for "a major health care catastrophe in the coming years."[1139] This "perfect storm" of conditions and circumstances ought to motivate a concerted effort to control if not eradicate these viral threats.

We will now examine each of the categories of prevention in reference to HBV and HCV, and, where possible, review their effectiveness in reducing the burden of cancer.

[1131] Freeman AJ, Marinos G, Ffrench RA et al. Immunopathogenesis of hepatitis C virus infection. *Immunology & Cell Biology.* 2001; 79(6): 515-36.
[1132] Global burden of disease (GBD) for hepatitis C. *Journal of Clinical Pharmacology.* 2004; 44(1): 20-9.
[1133] Freeman AJ, Dore GJ, Law MG et al. Estimating progression to cirrhosis in chronic hepatitis C virus infection. *Hepatology.* 2001; 34(4 Pt 1): 809-16.
[1134] Dore GJ, Freeman AJ, Law M et al. Is severe liver disease a common outcome for people with chronic hepatitis C? *Journal of Gastroenterology & Hepatology.* 2002; 17(4): 423-30.
[1135] Global burden of disease (GBD) for hepatitis C. *Journal of Clinical Pharmacology.* 2004; 44(1): 20-9.
[1136] Global burden of disease (GBD) for hepatitis C. *Journal of Clinical Pharmacology.* 2004; 44(1): 20-9.
[1137] Moriwaki H. Prevention of liver cancer: basic and clinical aspects. *Experimental & Molecular Medicine.* 2002; 34(5): 319-25.
[1138] El-Serag HB, Mason AC, Key C. Trends in survival of patients with hepatocellular carcinoma between 1977 and 1996 in the United States. *Hepatology.* 2001; 33(1): 62-5.
[1139] Kottilil S, Jackson JO, Polis MA. Hepatitis B & hepatitis C in HIV-infection. *Indian Journal of Medical Research.* 2005; 121(4): 424-50.

Early Primary Prevention

Because the relative importance of various modes of transmission differs from country to country, the most relevant control strategies for each setting need to be carefully selected.[1140] Another consideration in setting priorities is that while HCV has a lower global prevalence than HBV, HCV causes the most hepatocellular carcinoma in economically developed regions.[1141] A final factor to note is that the ranking of interventions is a moving target. For example, now that the blood supply has been made almost completely risk-free, this is no longer a preventive area where substantial new gains can be made (though the robust maintenance of safety programs remains an issue).

As for HBV in a context like Canada, the first focus for preventing exposure to the virus should be public health education and other interventions around high-risk sexual practices and intravenous drug use. These measures to prevent transmission are also important for HCV (and HIV—see below); this is especially true for the area of drug injection. Assuming that Canada parallels the US, we can conclude that "prevention of illegal drug injecting will eliminate the greatest risk factor for HCV infection."[1142]

Obstacles. The control of hepatitis infection can be seen as a paradigm for the challenges encountered with regard to many of the agents in this report. The obstacles to developing preventive strategies include: asymptomatic carriers; limitations in testing procedures; long latency before cancer development; the fact that addictions are difficult to overcome; surveillance difficulties; socioeconomic forces influencing prosecution; the complication of psychological problems and full mental illness; lack of trust of authorities; concerns about privacy and discrimination (regarding test results and participation in public programs); insufficient political capital for more controversial "harm reduction" or legal measures; and (as always) limited resources.

Effectiveness of Programs. It is outside the scope of this chapter to systematically describe and evaluate the multitude of drug and sexually-transmitted infection (STI) programs in use around the world. Aside from the sheer volume of information to consider, there is the fact that it is rare for the interventions, if they have been evaluated at all, to be tied to the specific end-point of reduced hepatitis prevalence and / or lower cancer rates. With regard to STI programs, in particular, we would need to depend on evaluations related to other viruses to serve as a proxy for hepatitis control. Whatever the obstacles, based on the assumption of favourable impacts on disease when risky behaviours are eliminated or mitigated, a few notable drug use prevention programs will be described, as well as studies related to individual- or group-based approaches. With respect to STI prevention, we refer the reader to the description of approaches under the human papillomavirus section above.

[1140] Mast EE, Alter MJ, Margolis HS. Strategies to prevent and control hepatitis B and C virus infections: a global perspective. *Vaccine.* 1999; 17(13-14): 1730-3.

[1141] Monto A, Wright TL. The epidemiology and prevention of hepatocellular carcinoma. *Seminars in Oncology.* 2001; 28(5): 441-9.

[1142] Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. Centers for Disease Control and Prevention. *MMWR Recommendations & Reports.* 1998; 47(RR-19): 1-39.

Syringe and Needle Exchange Programs. The centrepiece of many harm reduction initiatives for injection drug users (IDUs) is the prescription or distribution of sterile injection equipment to prevent re-use by a single person and (more pertinent to our topic) sharing between users. The Centers for Disease Control and Prevention (CDC) in the US officially recommended community-based syringe and needle-exchange programs in 1998, though the calls for such an approach and the first pilot projects go back to the 1980s.[1143,1144] As of 2002, 180 needle-exchange programs were operating in the US.[1145] The CDC report noted that several studies up to 1998 had produced two crucial conclusions: such measures can be effective in reducing the incidence of bloodborne virus transmission; and they do not lead to the negative side effect of increased drug use. An example of a study from that era was conducted in Tacoma; non-use of the exchange program was associated with a sixfold greater risk of hepatitis B and a sevenfold greater risk of hepatitis C.[1146] Subsequent research has confirmed that equipment exchange programs can reduce syringe sharing among IDUs[1147] and decrease HCV prevalence in this at-risk population.[1148] However, other results suggest that an exchange program alone may not be enough to produce positive results; the same lead researcher from the Tacoma study found contrary results in a Seattle-based syringe exchange program.[1149] Likewise, after almost a decade of operation, the needle exchange initiative in Vancouver (the largest in North America) had failed to have much impact on needle-sharing behaviour or HCV rates.[1150] Other studies confirm that, while prevention efforts among IDUs have managed to control HBV and HIV rates, the transmission of HCV has continued at very high levels.[1151] One fact put forward to explain this is the high efficiency of bloodborne transmission with HCV.[1152] As well, the special vulnerability of and

[1143] Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. Centers for Disease Control and Prevention. *MMWR Recommendations & Reports.* 1998; 47(RR-19): 1-39.

[1144] Vlahov D, Des Jarlais DC, Goosby E et al. Needle exchange programs for the prevention of human immunodeficiency virus infection: epidemiology and policy. *American Journal of Epidemiology.* 2001; 154(12 Suppl): S70-7.

[1145] Data available from AIDS Alert at http://www.ahcpub.com/ahc_root_html/hot/archive/aa062002.html. Accessed May 2005.

[1146] Hagan H, Jarlais DC, Friedman SR et al. Reduced risk of hepatitis B and hepatitis C among injection drug users in the Tacoma syringe exchange program. *American Journal of Public Health.* 1995; 85(11): 1531-7.

[1147] Bluthenthal RN, Kral AH, Gee L et al. The effect of syringe exchange use on high-risk injection drug users: a cohort study. *AIDS.* 2000; 14(5): 605-11.

[1148] MacDonald MA, Wodak AD, Dolan KA et al. Hepatitis C virus antibody prevalence among injecting drug users at selected needle and syringe programs in Australia, 1995-1997. Collaboration of Australian NSPs. *Medical Journal of Australia.* 2000; 172(2): 57-61.

[1149] Hagan H, McGough JP, Thiede H et al. Syringe exchange and risk of infection with hepatitis B and C viruses. *American Journal of Epidemiology.* 1999; 149(3): 203-13.

[1150] Strathdee SA, Patrick DM, Currie SL et al. Needle exchange is not enough: lessons from the Vancouver injecting drug use study. *AIDS.* 1997; 11(8): F59-65.

[1151] van Beek I, Dwyer R, Dore GJ et al. Infection with HIV and hepatitis C virus among injecting drug users in a prevention setting: retrospective cohort study. *British Medical Journal.* 1998; 317(7156): 433-7.

[1152] Coutinho RA. HIV and hepatitis C among injecting drug users. *British Medical Journal.* 1998; 317(7156): 424-5.

expanding cohort of newer (usually younger) IDUs has suggested the need to target them with prevention messages and measures.[1153]

The most comprehensive analysis of equipment exchange programs was carried out by Australian researchers in 2002, though some of the methodology has been questioned.[1154] They evaluated their own country's 16-year old exchange effort very positively; an estimated 21,000 HCV infections and 90 deaths had been averted. The cost of the various programs, at $122 million, was more than made up by $2.4 billion in avoided government costs related to treatment of HCV and HIV.[1155] Nonetheless, the study acknowledged that overall HCV rates in Australia had continued to rise over the 1990s, reinforcing the fact that an integrated approach using several interventions is probably going to be more effective than a needle exchange program alone (see below).

At the same time, the exchange programs themselves may need enhancement. Different authorities have advocated offering a variety of options for syringe access by relevant populations, including prescriptions and syringe deregulation.[1156,1157] In addition, given the efficiency of HCV transmission by blood, it may be important to focus on modifying more than needle-sharing behaviours in IDUs.[1158,1159,1160] As one review concluded, "control of HCV may necessitate the use of practices that guarantee elimination of exposure to equipment contaminated with even small amounts of blood."[1161]

Integrated Approaches with Injecting Drug Users. Although there has been circumstantial evidence that comprehensive harm reduction approaches may have a positive impact on HCV rates, notably in the UK, more recent data has called this conclusion into question.[1162,1163] Nonetheless, there is a sound face-value rationale for multi-intervention strategies, such as The City of Vancouver's well-known Four Pillars program, as well as its pilot project involving a safer injection site.

[1153] Thorpe LE, Ouellet LJ, Levy JR et al. Hepatitis C virus infection: prevalence, risk factors, and prevention opportunities among young injection drug users in Chicago, 1997-1999. *Journal of Infectious Diseases.* 2000; 182(6): 1588-94.

[1154] Copeman M. Injecting drug use in Australia: needle/syringe programs prove their worth, but hepatitis C still on the increase. *Medical Journal of Australia.* 2003; 179(2): 119; author reply.

[1155] Law MG, Batey RG. Injecting drug use in Australia: needle/syringe programs prove their worth, but hepatitis C still on the increase. *Medical Journal of Australia.* 2003; 178(5): 197-8.

[1156] Rich JD, Wolf FA, Macalino G. Strategies to improve access to sterile syringes for injection drug users. *AIDS Reader.* 2002; 12(12): 527-35.

[1157] Stancliff S, Agins B, Rich JD et al. Syringe access for the prevention of blood borne infections among injection drug users. *BMC Public Health.* 2003; 3(1): 37.

[1158] Hagan H, Thiede H. Changes in injection risk behavior associated with participation in the Seattle needle-exchange program. *Journal of Urban Health.* 2000; 77(3): 369-82.

[1159] Thorpe L, Ouellet L, Hershow R et al. The multiperson use of non-syringe injection equipment and risk of hepatitis c infection in a cohort of young adult injection drug users, chicago 1997-1999. *Annals of Epidemiology.* 2000; 10(7): 472-3.

[1160] Crofts N, Caruana S, Bowden S et al. Minimising harm from hepatitis C virus needs better strategies. *British Medical Journal.* 2000; 321(7265): 899.

[1161] Hagan H, Des Jarlais DC. HIV and HCV infection among injecting drug users. *Mount Sinai Journal of Medicine.* 2000; 67(5-6): 423-8.

[1162] Hope VD, Judd A, Hickman M et al. Prevalence of hepatitis C among injection drug users in England and Wales: is harm reduction working? *American Journal of Public Health.* 2001; 91(1): 38-42.

[1163] Judd A, Hickman M, Jones S et al. Incidence of hepatitis C virus and HIV among new injecting drug users in London: prospective cohort study. *British Medical Journal.* 2005; 330(7481): 24-5.

Other Interventions. Having identified the priority "front-line" approaches to controlling exposure, it is also important to maintain vigilance around well-established areas. This includes continuing high standards around screening for HCV in donated blood supplies. The latency period means that improvements in screening introduced in the 1990s should result in a decreased incidence of HCV-positive liver cancer in 2010 to 2015.[1164]

Primary Prevention

Vaccination. Both adults and children can be protected by an HBV vaccine developed over 20 years ago. It is considered to be one of the great public health achievements.[1165] A special instance is vertical (from mother to newborn) transmission; this can be avoided by vaccinating infants born to HBV-positive women. The case for universal vaccination of children is more controversial, though such a policy is in place in many countries.[1166] For example, in Taiwan, where HBV-related childhood liver cancer was once endemic, the effect of universal HBV vaccination has almost eradicated this form of paediatric cancer.[1167]

HCV vaccine development remains at an early stage, and progress is characterized as being "agonisingly slow"[1168,1169]

Co-factors. Any of the many programs to reduce excessive drinking would theoretically reduce the rate of liver cancer, even in people with existing hepatitis infections.[1170] However, the health effects of reduced drinking in infected patients have not yet been quantified; the same gap exists in research around obesity, though one study of weight reduction did show a reversal of hepatic fibrosis.[1171]

Testing & Treatment. Information on the effect of virus eradication from *asymptomatic* carriers on the subsequent risk of liver cancer is not available. This makes the benefit of routine testing for hepatitis virus infection rather questionable, at least from the perspective of cancer control. The usual indication for antiviral treatment (at least that which will be covered by government or third party payers) is the presence of symptoms, i.e., detection of a certain stage of fibrosis development,

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[1164] Moriwaki H. Prevention of liver cancer: basic and clinical aspects. *Experimental & Molecular Medicine.* 2002; 34(5): 319-25.
[1165] Achievements in public health: hepatitis B vaccination—United States, 1982-2002. *M & Meekly Report.* 2002; 51(25): 549-52.
[1166] Boxall EH, Jefferson TO, Pratt M et al. Vaccines for preventing hepatitis B in high risk newborn infants. Cochrane Hepato-Biliary Group. *Cochrane Database of Systematic Reviews.* 1997.
[1167] Chang MH, Chen CJ, Lai MS et al. Universal hepatitis B vaccination in Taiwan and the incidence of hepatocellular carcinoma in children. Taiwan Childhood Hepatoma Study Group. *New England Journal of Medicine.* 1997; 336(26): 1855-9.
[1168] Krahn MD, John-Baptiste A, Yi Q et al. Potential cost-effectiveness of a preventive hepatitis C vaccine in high risk and average risk populations in Canada. *Vaccine.* 2005; 23(13): 1549-58.
[1169] Koff RS. Hepatitis vaccines: recent advances. *International Journal for Parasitology.* 2003; 33(5-6): 517-23.
[1170] See the information from the *Alcohol and Cancer Working Group* of the Toronto Cancer Prevention Coalition at http://www.apolnet.org/resources/apu0003.pdf. Accessed June 2005.
[1171] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.

as diagnosed by a liver biopsy. Developing *non-invasive* methods to predict disease severity is an active area of research.[1172]

There is good evidence that removing HCV from chronic hepatitis patients significantly reduces the risk of liver cancer.[1173,1174,1175] A sustained HCV response after antiviral therapy for hepatitis can lead to more than a 90% reduction in the risk of primary liver cancer, though some studies demonstrate a more modest 50% reduction.[1176,1177] The same type of effect is seen in patients with full cirrhosis, though the reduction in risk is less dramatic. The main issue at hand is: exactly how much of a sustained viral response can be achieved?

The traditional drug of choice to clear hepatitis viruses has been interferon, a protein that modulates biological responses. As demonstrated in a Cochrane review, interferon is effective in clearing acute HCV infections in about a third of patients.[1178] The results with chronic infection with hepatitis viruses are more modest.

In addition to interferon, lamivudine is approved for HBV. Neither have been particularly effective in clearing a chronic infection, and few studies support the use of such chemotherapy for actually preventing HBV-associated liver cancer.[1179,1180,1181]

Combination therapy with ribavirin improves the HCV response rate to interferon (as much as doubling it), as does altering the interferon molecule in a process called pegylation.[1182] The latter technology is more expensive than conventional interferon combined with ribavirin, but the improved response rates (i.e., 40 to 85% for HCV, depending on the genotype) probably make it cost-effective.[1183] The improvement rates using interferon are much lower for relapsing and cirrhotic patients (i.e., those

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[1172] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.
[1173] Moriwaki H. Prevention of liver cancer: basic and clinical aspects. *Experimental & Molecular Medicine.* 2002; 34(5): 319-25.
[1174] Moriwaki H. Prevention of liver cancer: current strategies and future perspectives. *International Journal of Clinical Oncology.* 2002; 7(1): 27-31.
[1175] Tabor E. Interferon for preventing and treating hepatocellular carcinoma associated with the hepatitis B and C viruses. *Digestive & Liver Diseases.* 2003; 35(5): 297-305.
[1176] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.
[1177] Yoshida H, Shiratori Y, Moriyama M et al. Interferon therapy reduces the risk for hepatocellular carcinoma: national surveillance program of cirrhotic and noncirrhotic patients with chronic hepatitis C in Japan. IHIT Study Group. Inhibition of Hepatocarcinogenesis by Interferon Therapy. *Annals of Internal Medicine.* 1999; 131(3): 174-81.
[1178] Myers RP, Regimbeau C, Thevenot T et al. Interferon for acute hepatitis C. Cochrane Hepato-Biliary Group. *Cochrane Database of Systematic Reviews.* 2001.
[1179] Tabor E. Interferon for preventing and treating hepatocellular carcinoma associated with the hepatitis B and C viruses. *Digestive & Liver Diseases.* 2003; 35(5): 297-305.
[1180] Rasi G, Pierimarchi P, Sinibaldi Vallebona P et al. Combination therapy in the treatment of chronic viral hepatitis and prevention of hepatocellular carcinoma. *International Immunopharmacology.* 2003; 3(8): 1169-76.
[1181] Wong JB, Koff RS, Tine F et al. Cost-effectiveness of interferon-alpha 2b treatment for hepatitis B e antigen-positive chronic hepatitis B. *Annals of Internal Medicine.* 1995; 122(9): 664-75.
[1182] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.
[1183] Siebert U, Sroczynski G, Rossol S et al. Cost effectiveness of peginterferon alpha-2b plus ribavirin versus interferon alpha-2b plus ribavirin for initial treatment of chronic hepatitis C. *Gut.* 2003; 52(3): 425-32.

with severe liver disease, most in need of treatment—many of whom are infected with HCV of genotype 1).[1184]

Several novel therapies for hepatitis virus infections have entered phase I trials in the last two years.[1185] The relatively poor response to current HBV therapies is motivating adoption of combination treatments that make use of nucleoside analogues and immunomodulators alongside interferon. This approach is also proving useful for the significant proportion of the HCV-infected population that does not respond to interferon therapy.[1186]

In addition to the universal use in children and adolescents, HBV vaccination is recommended for those with chronic liver disease. The increased risk with co-infection also suggests the routine use of hepatitis A vaccine with such patients.[1187]

Secondary Prevention

Screening. Patients who do not respond to antiviral treatment may progress to full cirrhosis. They may be screened for the emergence of early cancer lesions, though the efficacy and the cost-effectiveness of such protocols have not been proven.[1188] Lesions that are detected can prompt treatments that may cure the cancer, from surgical resection and other ablative procedures to full liver transplantation.[1189] The use of interferon as a conservative measure to treat liver cancer has shown enough promise to warrant further research.[1190]

Treatment. A specialized form of prevention with liver cancer involves protecting against recurrence or a new primary cancer after a patient has received surgery, ablation or other therapies for their initial liver cancer. Successful interventions in this regard have included the use of retinoids (compounds related to vitamin A) and interferon.[1191,1192,1193]

[1184] Rasi G, Pierimarchi P, Sinibaldi Vallebona P et al. Combination therapy in the treatment of chronic viral hepatitis and prevention of hepatocellular carcinoma. *International Immunopharmacology.* 2003; 3(8): 1169-76.

[1185] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.

[1186] Rasi G, Pierimarchi P, Sinibaldi Vallebona P et al. Combination therapy in the treatment of chronic viral hepatitis and prevention of hepatocellular carcinoma. *International Immunopharmacology.* 2003; 3(8): 1169-76.

[1187] Reiss G, Keeffe EB. Review article: hepatitis vaccination in patients with chronic liver disease. *Alimentary Pharmacology & Therapeutics.* 2004; 19(7): 715-27.

[1188] McHutchison JG, Manns M, Patel K et al. Adherence to combination therapy enhances sustained response in genotype-1-infected patients with chronic hepatitis C. *Gastroenterology.* 2002; 123(4): 1061-9.

[1189] Teoh NC, Farrell GC. Management of chronic hepatitis C virus infection: a new era of disease control. *Internal Medicine Journal.* 2004; 34(6): 324-37.

[1190] Tabor E. Interferon for preventing and treating hepatocellular carcinoma associated with the hepatitis B and C viruses. *Digestive & Liver Diseases.* 2003; 35(5): 297-305.

[1191] Muto Y, Moriwaki H, Saito A. Prevention of second primary tumors by an acyclic retinoid in patients with hepatocellular carcinoma. *New England Journal of Medicine.* 1999; 340(13): 1046-7.

[1192] Ikeda K, Arase Y, Saitoh S et al. Interferon beta prevents recurrence of hepatocellular carcinoma after complete resection or ablation of the primary tumor-A prospective randomized study of hepatitis C virus-related liver cancer. *Hepatology.* 2000; 32(2): 228-32.

Helicobacter pylori

The bacterium *Helicobacter pylori* is able to invade and colonize the human stomach. There it can interact with gastric epithelial cells, leading to a number of tissue changes and disease conditions, including: inflammation, loss of mucosa (i.e., an ulcer), and development of masses from benign polyps to full cancers.[1194] The latter include gastric adenocarcinoma and mucosa-associated lymphoid tissue (MALT) lymphoma. Generally, the association between *H. pylori* and gastric cancer is well-accepted, though the debate is not completely concluded. As an example of supporting data, infected individuals appear to have a 6-fold increased risk of developing an adenocarcinoma compared to the uninfected population. Overall, it is proposed that about 70% of gastric cancers can be attributed to *H. pylori*.[1195]

About 70% of gastric cancers can be attributed to infection with *Helicobacter pylori*.

H. pylori was first cultured in 1982, and classified as a carcinogen over 10 years ago; an entire scientific journal devoted to the biology of this one bacterium accounts for some of the thousands of articles published on *H. pylori* and related conditions each year.

As noted in the table in the introduction of this report, *H. pylori* exists in up to 50% of the global population, making it the most common chronic bacterial infection in humans. In developing countries, the dominant means of transmission is consumption of sewage-contaminated water or food. Oral-to-oral transmission is also possible (e.g., by kissing), as well as via contaminated secretions (such as vomit). Generally, the bacterium is harder to contract in developed countries, but there, as in other parts of the world, transmission typically occurs in early childhood within a family context.[1196,1197] Studies show, however, that mother-to-child transmission is rare, though it may occur through breastfeeding.[1198]

It is known that only certain strains are highly pathogenic, so only a subset of the population carrying the bacteria actually experience disease. A larger proportion develops some sort of pre-neoplasias, but ultimately only 2% of infected people will get a malignancy. The infected pool is large, however, resulting in stomach cancer being the second most common cancer in the world. Of related significance is the survival rate, i.e., less than 20% after 5 years. In sum, this represents an enormous disease burden.

[1193] Kubo S, Nishiguchi S, Hirohashi K et al. Effects of long-term postoperative interferon-alpha therapy on intrahepatic recurrence after resection of hepatitis C virus-related hepatocellular carcinoma. A randomized, controlled trial. *Annals of Internal Medicine.* 2001; 134(10): 963-7.

[1194] de Luca A, Iaquinto G. Helicobacter pylori and gastric diseases: a dangerous association. *Cancer Letters.* 2004; 213(1): 1-10.

[1195] McLoughlin RM, Sebastian SS, O'Connor HJ et al. Review article: test and treat or test and scope for Helicobacter pylori infection. Any change in gastric cancer prevention? *Alimentary Pharmacology & Therapeutics.* 2003; 17 Suppl 2: 82-8.

[1196] Herrera AG. Helicobacter pylori and food products: a public health problem. *Methods in Molecular Biology.* 2004; 268: 297-301.

[1197] Moss SF, Sood S. Helicobacter pylori. *Current Opinions in Infectious Diseases.* 2003; 16(5): 445-51.

[1198] Kitagawa M, Natori M, Katoh M et al. Maternal transmission of Helicobacter pylori in the perinatal period. *Journal of Obstetrics & Gynaecology Research.* 2001; 27(4): 225-30.

Smoking is an important co-factor; among patients carrying the most dangerous strain of bacteria, the risk of developing some form of cancer is almost three times higher in those who smoke.[1199] Diet can hurt or help; excessive salt and (perhaps) alcohol are risk factors, whereas the antioxidants in regularly consumed vegetables and fruit are thought to decrease the risk of gastric cancer by up to a third.[1200,1201,1202]

Two primary pathways are thought to be involved with gastric carcinogenesis: proliferation of epithelial cells in the gut and oxidative stress of stomach mucosa.[1203] The precise molecular mechanisms at work in these processes are still being worked out, including the defences which protect the bacterium in unstable, often hostile microenvironment of the stomach.[1204] Recently, a major advance occurred in our understanding of why certain patients develop serious disease; apparently, there can be a 90-fold difference in the risk of gastric cancer depending on particular mixtures of *H. pylori* virulence and host genetics.[1205,1206]

The disease induced by *H. pylori* is not limited to the stomach. Infection with the bacteria has been linked to squamous cell cancer in the larynx,[1207] and esophagus[1208] (though it is actually thought to be *protective* against esophageal adenocarcinoma).[1209]

Preventive Interventions

Given the ubiquity of the bacterium and its ease of transmission, it seems unlikely that early primary prevention will ever be the cornerstone of a public health strategy, at least not in the developed world. The measures promoted in developing countries do not really apply in North America.[1210]

[1199] Brenner H, Arndt V, Bode G et al. Risk of gastric cancer among smokers infected with *Helicobacter pylori*. *International Journal of Cancer.* 2002; 98(3): 446-9.
[1200] Tsugane S. Salt, salted food intake, and risk of gastric cancer: epidemiologic evidence. *Cancer Science.* 2005; 96(1): 1-6.
[1201] Correa P. Helicobacter pylori infection and gastric cancer. *Cancer Epidemiology, Biomarkers & Prevention.* 2003; 12(3): 238s-41s.
[1202] Lunet N, Barros H. Helicobacter pylori infection and gastric cancer: facing the enigmas. *International Journal of Cancer.* 2003; 106(6): 953-60.
[1203] Mucosa refers to the moist tissue that lines some organs and body cavities (such as the nose, mouth, lungs and stomach).
[1204] de Luca A, Iaquinto G. Helicobacter pylori and gastric diseases: a dangerous association. *Cancer Letters.* 2004; 213(1): 1-10.
[1205] Figueiredo C, Machado JC, Pharoah P et al. Helicobacter pylori and interleukin 1 genotyping: an opportunity to identify high-risk individuals for gastric carcinoma. *Journal of the National Cancer Institute.* 2002; 94(22): 1680-7.
[1206] Rad R, Prinz C, Neu B et al. Synergistic effect of Helicobacter pylori virulence factors and interleukin-1 polymorphisms for the development of severe histological changes in the gastric mucosa. *Journal of Infectious Diseases.* 2003; 188(2): 272-81.
[1207] Aygenc E, Selcuk A, Celikkanat S et al. The role of Helicobacter pylori infection in the cause of squamous cell carcinoma of the larynx. *Otolaryngology - Head & Neck Surgery.* 2001; 125(5): 520-1.
[1208] Ye W, Held M, Lagergren J et al. Helicobacter pylori infection and gastric atrophy: risk of adenocarcinoma and squamous-cell carcinoma of the esophagus and adenocarcinoma of the gastric cardia. *Journal of the National Cancer Institute.* 2004; 96(5): 388-96.
[1209] de Martel C, Llosa AE, Farr SM et al. Helicobacter pylori infection and the risk of development of esophageal adenocarcinoma. *Journal of Infectious Diseases.* 2005; 191(5): 761-7.
[1210] Plummer M, Franceschi S, Munoz N. Epidemiology of gastric cancer. *IARC Scientific Publications.* 2004; (157): 311-26.

With the synergistically added risk represented by tobacco use, the one clear primary prevention method is smoking cessation (or encouragements to not take up the habit).[1211] Controlling the intake of salted foods may also help.

Both endoscopic biopsies and non-invasive tests are used to establish whether a gastric disease process has begun, but neither of these approaches are considered cost-effective at a population level.[1212] However, the potential benefits of surveillance may propel this approach onto the high priority list in the next few years.[1213]

When disease is detected, combination therapies involving a proton-pump inhibitor[1214] and two to three antibiotics are effective in eradicating *H. pylori*, with good tolerance by the patient; a one-week regimen is curative in 80 to 90% of cases.[1215] This type of treatment has been shown to accomplish regression of precancerous lesions and low-grade MALT lymphomas.[1216,1217] Supplementation with ascorbic acid or beta-carotene also has resulted in a smaller but still significant likelihood of regression in at least one study.[1218] However, the Cochrane review of antioxidants in the prevention of gastric cancer cast grave doubts on their effectiveness.[1219] Anti-inflammatories are also being investigated as a means to slow disease progression.[1220] When disease is not detected and / or conservative therapies fail, then surgery is the best solution for any early cancer that develops. The techniques for resection increase in levels of invasiveness: endoscopic, laparocscopic and, finally, open surgery.[1221]

The Cochrane review of *H. pylori* eradication methods is still at the protocol stage. The reality is that there has been little recent advance in therapies for *H. pylori*, though many long term intervention trials (with gastric cancer as the end-point) are

[1211] Brenner H, Arndt V, Bode G et al. Risk of gastric cancer among smokers infected with *Helicobacter pylori*. *International Journal of Cancer.* 2002; 98(3): 446-9.
[1212] Correa P. Helicobacter pylori infection and gastric cancer. *Cancer Epidemiology, Biomarkers & Prevention.* 2003; 12(3): 238s-41s.
[1213] Whiting JL, Sigurdsson A, Rowlands DC et al. The long term results of endoscopic surveillance of premalignant gastric lesions. *Gut.* 2002; 50(3): 378-81.
[1214] A proton pump inhibitor is a drug that reduces the amount of gastric acid produced by stomach cells.
[1215] Axon A. Review article: gastric cancer and Helicobacter pylori. *Alimentary Pharmacology & Therapeutics.* 2002; 16 Suppl 4: 83-8.
[1216] Correa P. Helicobacter pylori infection and gastric cancer. *Cancer Epidemiology, Biomarkers & Prevention.* 2003; 12(3): 238s-41s.
[1217] Moss SF, Sood S. Helicobacter pylori. *Current Opinions in Infectious Diseases.* 2003; 16(5): 445-51.
[1218] Correa P, Fontham ET, Bravo JC et al. Chemoprevention of gastric dysplasia: randomized trial of antioxidant supplements and anti-helicobacter pylori therapy. *Journal of the National Cancer Institute.* 2000; 92(23): 1881-8.
[1219] Bjelakovic G, Nikolova D, Simonetti et al. Antioxidant supplements for preventing gastrointestinal cancers. Cochrane Hepato-Biliary Group. *Cochrane Database of Systematic Reviews.* 2004.
[1220] Juhasz M, Herszenyi L, Tulassay Z et al. Helicobacter pylori and molecular mechanisms of gastric carcinogenesis: targets for prevention and therapy. *Expert Review of Anticancer Therapy.* 2004; 4(1): 97-103.
[1221] Kitajima M. Strategies for gastric cancer treatment in the twenty-first century: minimally invasive and tailored approaches integrating basic science and clinical medicine. *Gastric Cancer.* 2005; 8(2): 55-8.

now underway in the US and Europe.[1222] Many compounds can kill the bacterium *in vitro*, but reproducing such effects in live bodies is more elusive. Animal models are helping in the development of vaccines; there has been some success, but no clear strategy has emerged.[1223,1224] One cost-effectiveness analysis suggested that resource allocation for vaccine development and implementation only made sense in developed countries.[1225]

At this point, anti-*H. pylori* therapies remain the best option, one that is recommended for all symptomatic infected individuals according to recent professional consensus statements.[1226] Using such an approach with the entire infected population would hardly seem to be feasible.[1227] Nonetheless, one modeling study demonstrated that a program of universal screening (plus treatment for those who test positive) would generate an incremental cost of only US$26 per case.[1228] Many uncertainties remain, including the effect of total eradication of *H. pylori* on gastric cancer risk, and the fact that infection actually seems to be protective against certain cancers.[1229,1230] One Canadian review has called for a major demonstration project to help answer some of the scientific and pragmatic questions.[1231]

Epstein Barr Virus

About 100 herpesviruses have been isolated, but it seems that only 8 infect humans. The best known of these are the herpes simplex viruses, types 1 and 2. The herpesviruses are widely separated in genetic make-up, but share a similar complex structure.

Epstein Barr virus (EBV) is also a human herpesvirus (HHV), specifically HHV-4. Apart from EBV, the only other type which has been significantly associated with cancer is human herpesvirus-8 (see below).

[1222] Hasham-Jiwa N, Kasakura Y, Ajani JA. Brief review of advances in the treatment of gastric carcinoma in North America and Europe, 1995-2001. *International Journal of Clinical Oncology.* 2002; 7(4): 219-24.

[1223] Moss SF, Sood S. Helicobacter pylori. *Current Opinions in Infectious Diseases.* 2003; 16(5): 445-51.

[1224] Moran AP, Svennerholm AM, Penn CW. Pathogenesis and host response of Helicobacter pylori. *Trends in Microbiology.* 2002; 10(12): 545-7.

[1225] Rupnow MF, Owens DK, Shachter R et al. Helicobacter pylori vaccine development and use: a cost-effectiveness analysis using the Institute of Medicine Methodology. *Helicobacter.* 1999; 4(4): 272-80.

[1226] Coelho LG, Leon-Barua R, Quigley EM. Latin-American Consensus Conference on Helicobacter pylori infection. Latin-American National Gastroenterological Societies affiliated with the Inter-American Association of Gastroenterology (AIGE). *American Journal of Gastroenterology.* 2000; 95(10): 2688-91.

[1227] Li H, Stoicov C, Cai X et al. Helicobacter and gastric cancer disease mechanisms: host response and disease susceptibility. *Current Gastroenterology Reports.* 2003; 5(6): 459-67.

[1228] Leivo T, Salomaa A, Kosunen TU et al. Cost-benefit analysis of Helicobacter pylori screening. *Health Policy.* 2004; 70(1): 85-96.

[1229] Roderick P, Davies R, Raftery J et al. The cost-effectiveness of screening for Helicobacter pylori to reduce mortality and morbidity from gastric cancer and peptic ulcer disease: a discrete-event simulation model. *Health Technology Assessment.* 2003; 7(6): 1-86.

[1230] Fendrick AM, Chernew ME, Hirth RA et al. Clinical and economic effects of population-based Helicobacter pylori screening to prevent gastric cancer. *Archives of Internal Medicine.* 1999; 159(2): 142-8.

[1231] Sullivan T, Ashbury FD, Fallone CA et al. Helicobacter pylori and the prevention of gastric cancer. *Canadian Journal of Gastroenterology.* 2004; 18(5): 295-302.

EBV infects more than 90% of adults in the world; two subtypes are found in humans, with EBV-1 being the most prevalent. Once infected, an individual is a lifelong carrier.[1232,1233,1234] The means of transmission is salivary contact; this is because EBV primarily infects the squamous epithelium and the lymphoid organs (specifically, the B cells) of the oropharynx. Virus can continue to be shed into the saliva for years after primary infection.[1235] Most EBV carriers are asymptomatic, though infection in adolescence frequently results in infectious mononucleosis (so-called "kissing disease"). The mechanisms which trigger a small proportion to develop a malignancy remain unclear, though, driven by the hope of discovering therapeutic strategies, they remain an intense focus of theory and research.[1236,1237]

Most Epstein Barr virus carriers are asymptomatic, though infection in adolescence frequently results in infectious mononucleosis (so-called "kissing disease").

EBV was the first human tumour virus identified. It was isolated in 1964 from a common lymphoma in African children first described by Burkitt (after whom the cancer is named). Since that time, EBV has been implicated in a wide variety of cancers, most of which can emerge years after the primary infection.[1238] However, the very functioning of EBV, which involves "strategies to minimize or eliminate its pathogenic potential, in the interest of maintaining infection and the survival of the host," means that causal connections between the virus and disease are difficult to prove.[1239] After more than 40 years of research, the picture regarding EBV and oncogenesis remains complex.[1240] An inventory of likely EBV-influenced cancers is offered in the next section.

Associated Cancers

As noted, the list of cancers linked to EBV seems to be ever expanding. As Hsu and Glaser noted: "Given that the complexity and duration of EBV-host interaction provides numerous possibilities for a malignant outcome, the heterogeneity of the cancers associated with EBV is not surprising."[1241]

[1232] Thompson MP, Kurzrock R. Epstein-Barr virus and cancer. *Clinical Cancer Research.* 2004; 10(3): 803-21.
[1233] Rickinson AB, Callan MF, Annels NE. T-cell memory: lessons from Epstein-Barr virus infection in man. *Philosophical Transactions of the Royal Society of London - Series B: Biological Sciences.* 2000; 355(1395): 391-400.
[1234] Dolcetti R, Guidoboni M, Gloghini A et al. EBV-associated tumors: pathogenetic insights for improved disease monitoring and treatment. *Current Cancer Therapy Reviews.* 2005; 1: 27-44.
[1235] Murray PG, Young LS. The Role of the Epstein-Barr virus in human disease. *Frontiers in Bioscience.* 2002; 7: d519-40.
[1236] Niller HH, Salamon D, Ilg K et al. EBV-associated neoplasms: alternative pathogenetic pathways. *Medical Hypotheses.* 2004; 62(3): 387-91.
[1237] Ambinder RF. Epstein-Barr virus-associated lymphoproliferative disorders. *Reviews in Clinical & Experimental Hematology.* 2003; 7(4): 362-74.
[1238] Thompson MP, Kurzrock R. Epstein-Barr virus and cancer. *Clinical Cancer Research.* 2004; 10(3): 803-21.
[1239] Thorley-Lawson DA, Gross A. Persistence of the Epstein-Barr virus and the origins of associated lymphomas. *New England Journal of Medicine.* 2004; 350(13): 1328-37.
[1240] Niedobitek G, Meru N, Delecluse HJ. Epstein-Barr virus infection and human malignancies. *International Journal of Experimental Pathology.* 2001; 82(3): 149-70.
[1241] Hsu JL, Glaser SL. Epstein-barr virus-associated malignancies: epidemiologic patterns and etiologic implications. *Critical Reviews of Oncology/Hematology.* 2000; 34(1): 27-53.

We begin with where the EBV story started, the disease identified by Burkitt. So-called nonendemic Burkitt's lymphoma is the version of the disorder seen most often in western countries. It has been a rare disorder, though incidence has increased recently because of its association with the immunosuppression due to AIDS. Compared to the endemic version of Burkitt's lymphoma found in Africa, the nonendemic, AIDS-related form is not as closely associated with EBV; only 15-30% of cases demonstrate the presence of the virus.[1242,1243]

EBV is involved with Hodgkin's disease, though positivity for the virus varies with the subtype of Hodgkin's (from 10% to more than 95% infection rate). About half the Hodgkin's cases in the US demonstrate the presence of EBV. However, this rate goes up to 95% in HIV- associated cases.[1244] Although not considered an AIDS-defining condition, in developed areas of the world Hodgkin's lymphoma competes with Kaposi sarcoma as the cancer most diagnosed alongside HIV infection.[1245]

Undifferentiated nasopharyngeal carcinoma is strongly associated with EBV.[1246,1247] Although mostly rare in the west (the exception being the Inuit), it is common in Canton, Hong Kong, and Taiwan.[1248,1249] The latter geographic connection may have something to do with the consumption of salted fish.[1250] However, as incidence is high in people of Chinese descent regardless of where they live, immigration may make this disease more of a concern for western countries in the future.[1251]

There are several AIDS-related lymphomas which have been linked to EBV.[1252] Other routes of becoming immunocompromised (e.g., inherited disorders, transplantation drugs) also can lead to the lymphoproliferative conditions. The AIDS-related versions are either systemic (e.g., Burkitt's) or target the central nervous system; they tend to be aggressive. The systemic lymphomas demonstrate EBV positivity in 30 to 90% of cases. Finally, there are effusion lymphomas of the visceral

[1242] Dolcetti R, Guidoboni M, Gloghini A et al. EBV-associated tumors: pathogenetic insights for improved disease monitoring and treatment. *Current Cancer Therapy Reviews.* 2005; 1: 27-44.
[1243] Subar M, Neri A, Inghirami G et al. Frequent c-myc oncogene activation and infrequent presence of Epstein-Barr virus genome in AIDS-associated lymphoma. *Blood.* 1988; 72(2): 667-71.
[1244] Gandhi MK, Tellam JT, Khanna R. Epstein-Barr virus-associated Hodgkin's lymphoma. *British Journal of Haematology.* 2004; 125(3): 267-81.
[1245] Dolcetti R, Boiocchi M, Gloghini A et al. Pathogenetic and histogenetic features of HIV-associated Hodgkin's disease. *European Journal of Cancer.* 2001; 37(10): 1276-87.
[1246] Niedobitek G, Agathanggelou A, Nicholls JM. Epstein-Barr virus infection and the pathogenesis of nasopharyngeal carcinoma: viral gene expression, tumour cell phenotype, and the role of the lymphoid stroma. *Seminars in Cancer Biology.* 1996; 7(4): 165-74.
[1247] Dolcetti R, Menezes J. Epstein-Barr virus and undifferentiated nasopharyngeal carcinoma: new immunobiological and molecular insights on a long-standing etiopathogenic association. *Advanced Cancer Research.* 2003; 87: 127-57.
[1248] Thompson MP, Kurzrock R. Epstein-Barr virus and cancer. *Clinical Cancer Research.* 2004; 10(3): 803-21.
[1249] Busson P, Keryer C, Ooka T et al. EBV-associated nasopharyngeal carcinomas: from epidemiology to virus-targeting strategies. *Trends in Microbiology.* 2004; 12(8): 356-60.
[1250] Hsu JL, Glaser SL. Epstein-barr virus-associated malignancies: epidemiologic patterns and etiologic implications. *Critical Reviews of Oncology/Hematology.* 2000; 34(1): 27-53.
[1251] Young LS, Murray PG. Epstein-Barr virus and oncogenesis: from latent genes to tumours. *Oncogene.* 2003; 22(33): 5108-21.
[1252] Cesarman E. Epstein-Barr virus (EBV) and lymphomagenesis. *Frontiers in Bioscience.* 2002; 7: e58-65.

cavity that sometimes demonstrate the presence of EBV; these conditions are also associated with human herpesvirus-8 (see below).

Although mainly infecting immune system B cells, EBV also can infect other cells.[1253] For example, certain T cell non-Hodgkin's lymphomas have been associated with the virus. One type, localized in the nasal area, demonstrates a remarkable 90% EBV-positivity.

In addition to the preceding conditions, EBV is also being investigated in the context of breast cancer, certain gastric cancers, salivary gland tumours, hepatocellular carcinomas, and smooth muscle tumours known as leiomyosarcomas (the latter only occurring in immunosuppressed patients).[1254,1255,1256,1257,1258] Whatever the theoretical interest in these investigations, it must be admitted that at present any indication of EBV-association does not have prognostic or therapeutic implications.[1259]

Preventive Interventions

With such a massive prevalance of EBV infection and its routine oral transmission, it is difficult to hold out much hope for early primary prevention, that is, eliminating exposure to and contration of the infection. As well, given the limited understanding of oncogenetic triggers and mechanisms in the many types of cancer influenced by EBV, effective primary prevention also remains elusive. Recalling the role that immunosuppression plays in the development of certain EBV-associated malignancies (see above), some of the most promising research involves therapies designed to reestablish immunocompetence.[1260,1261] This approach can theoretically be used prophylactically or to eradicate existing disease. One research focus has been infusion with cytotoxic T lymphocytes from donors, though this treatment carries its own danger of graft-versus-host disease.[1262,1263,1264] Clearly, another approach which

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[1253] Jones JF, Shurin S, Abramowsky C et al. T-cell lymphomas containing Epstein-Barr viral DNA in patients with chronic Epstein-Barr virus infections. *New England Journal of Medicine.* 1988; 318(12): 733-41.

[1254] Wu MS, Shun CT, Wu CC et al. Epstein-Barr virus-associated gastric carcinomas: relation to H. pylori infection and genetic alterations. *Gastroenterology.* 2000; 118(6): 1031-8.

[1255] Wang CP, Chang YL, Ko JY et al. Lymphoepithelial carcinoma versus large cell undifferentiated carcinoma of the major salivary glands. *Cancer.* 2004; 101(9): 2020-7.

[1256] McClain KL, Leach CT, Jenson HB et al. Association of Epstein-Barr virus with leiomyosarcomas in children with AIDS. *New England Journal of Medicine.* 1995; 332(1): 12-8.

[1257] Macsween KF, Crawford DH. Epstein-Barr virus-recent advances. *Lancet Infectious Diseases.* 2003; 3(3): 131-40.

[1258] Herrmann K, Niedobitek G. Epstein-Barr virus-associated carcinomas: facts and fiction. *Journal of Pathology.* 2003; 199(2): 140-5.

[1259] Herrmann K, Niedobitek G. Epstein-Barr virus-associated carcinomas: facts and fiction. *Journal of Pathology.* 2003; 199(2): 140-5.

[1260] Khanna R, Tellam J, Duraiswamy J et al. Immunotherapeutic strategies for EBV-associated malignancies. *Trends in Molecular Medicine.* 2001; 7(6): 270-6.

[1261] Taylor GS. T cell-based therapies for EBV-associated malignancies. *Expert Opinion in Biological Therapy.* 2004; 4(1): 11-21.

[1262] Comito MA, Sun Q, Lucas KG. Immunotherapy for Epstein-Barr virus-associated tumors. *Leukemia & Lymphoma.* 2004; 45(10): 1981-7.

[1263] Murray PG, Young LS. Epstein-Barr virus infection: basis of malignancy and potential for therapy. *Expert Reviews in Molecular Medicine.* 2001; 2001: 1-20.

[1264] Gottschalk S, Heslop HE, Roon CM. Treatment of Epstein-Barr virus-associated malignancies with specific T cells. *Advanced Cancer Research.* 2002; 84: 175-201.

can be useful in reducing the incidence of this class of tumours is prevention of HIV infection either through changes in sexual behaviour or by vaccination.[1265] Efforts are also underway to create an EBV vaccine to prevent initial infection or boost immunity in the face of EBV-associated tumours.[1266,1267,1268,1269] There are now two candidate vaccines ready for trial.[1270] Rounding out the discussion in terms of secondary prevention, broad-spectrum antiherpesvirus agents already in use clinically may have an effect on EBV diseases, though to date "reports of tumour regression remain anecdotal."[1271,1272] Novel EBV-focused treatments are also under investigation. As one study noted, "the consistent presence of…EBV in particular tumor types offers the potential for the development of highly specific, viral-targeted therapies."[1273]

Summing up the progress to date, it must be acknowledged that, whatever the promise of immunotherapies and antivirals, the prevention and management of EBV-related morbidity remains in the "nascent stages."[1274]

[1265] Mueller N. Overview: viral agents and cancer. *Environmental Health Perspectives.* 1995; 103 Suppl 8: 259-61.
[1266] Moss DJ, Khanna R, Bharadwaj M. Will a vaccine to nasopharyngeal carcinoma retain orphan status? *Developments in Biologicals.* 2002; 110: 67-71.
[1267] Lopes V, Young LS, Murray PG. Epstein-Barr virus-associated cancers: aetiology and treatment. *Herpes.* 2003; 10(3): 78-82.
[1268] Bharadwaj M, Moss DJ. Epstein-Barr virus vaccine: a cytotoxic T-cell-based approach. *Expert Reviews of Vaccines.* 2002; 1(4): 467-76.
[1269] Taylor GS. T cell-based therapies for EBV-associated malignancies. *Expert Opinion in Biological Therapy.* 2004; 4(1): 11-21.
[1270] Macsween KF, Crawford DH. Epstein-Barr virus-recent advances. *Lancet Infectious Diseases.* 2003; 3(3): 131-40.
[1271] Thompson MP, Kurzrock R. Epstein-Barr virus and cancer. *Clinical Cancer Research.* 2004; 10(3): 803-21.
[1272] Abdulkarim B, Bourhis J. Antiviral approaches for cancers related to Epstein-Barr virus and human papillomavirus. *Lancet Oncology.* 2001; 2(10): 622-30.
[1273] Israel BF, Kenney SC. Virally targeted therapies for EBV-associated malignancies. *Oncogene.* 2003; 22(33): 5122-30.
[1274] Thompson MP, Kurzrock R. Epstein-Barr virus and cancer. *Clinical Cancer Research.* 2004; 10(3): 803-21.

Human Immunodeficiency Virus

The human immunodeficiency virus (HIV) infects cells of the immune system. One of the sequelae of HIV infection is the well-known acquired immune deficiency syndrome (AIDS). Although not the greatest direct or even indirect cause of human cancers, the medical and sociopolitical realities around HIV infection (as well as associated AIDS) means that it has been a major driver of advances in the area of sexually transmitted infections such as HPV and blood-borne diseases such as HCV (the latter also related to injecting drug use).

HIV transmission can occur when blood, semen and pre-seminal fluid, vaginal fluid, or breast milk from an infected person enters the body of an uninfected person. Access can be gained through a vein (e.g., through an injection), the lining of the anus or rectum, the lining of the vagina or cervix, the opening to the penis, the mouth, other mucous membranes (e.g., eyes or inside of the nose), or cuts and sores. Contact with saliva, tears, or sweat has never been shown to result in transmission of HIV. Health care workers could come into contact with the virus through fluids surrounding the brain, spinal chord, and joints, as well as amniotic fluid.

Although spreading in heterosexual populations, men who have sex with men still account for over 50% of HIV transmission in the US.[1275] Drug users also play a significant role in HIV incidence. Although opioid users represent a small proportion of the population, the predominant means of delivery of such drugs is by injection; thus there is a disproportionate contribution of this risky behaviour to HIV transmission, accounting for perhaps 5 to 10% of HIV infections. More precisely the risk arises through sharing injection equipment, which promotes blood-to-blood contact. The most efficient transmission of HIV occurs in blood transfusions and vertically from mother to child in pregnancy and delivery. Transmission through sexual encounters and drug injecting is not particularly efficient, but multiple exposures increase the risk to the point where these routes of HIV infection end up dominating the landscape.

Associated Cancers

As has already been noted in this report, HIV co-infection alongside other carcinogens such as HPV increases the risk of the associated cancers (e.g., in the case of HPV, it is true for certain types of cervical cancer). This relationship is also true for nonviral carcinogens such as tobacco smoke. For example, one study showed that lung cancer occurred at twice the rate in HIV-infected women as in non-infected women.[1276]

Cancer development in HIV infection is promoted through a combination of immunosuppression and activation of inflammation.[1277] The cancers associated with HIV, rather than being directly caused by the virus, are "opportunistic," more or less exploiting the biological environment produced by HIV

The cancers associated with HIV, rather than being directly caused by the virus, are "opportunistic," more or less exploiting the biological environment produced by HIV infection and AIDS.

[1275] Johnson WD, Hedges LV, Diaz RM. Interventions to modify sexual risk behaviors for preventing HIV infection in men who have sex with men. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.* 2002.
[1276] Phelps RM, Smith DK, Heilig CM et al. Cancer incidence in women with or at risk for HIV. *International Journal of Cancer*. 2001; 94(5): 753-7.
[1277] Boshoff C, Weiss R. AIDS-related malignancies. *Nature Reviews Cancer.* 2002; 2(5): 373-82.

infection and AIDS.[1278] It is not clear exactly what impact the improved survival of immunosuppressed patients may have on future rates of cancers associated with HIV.[1279] Some believe that the incidence of Kaposi sarcoma and AIDS-related lymphomas is certain to increase.[1280]

The most common virally-associated cancers and / or those with the highest relative risk with HIV co-infection are noted in the following table:[1281]

Cancer	Etiologic or Contributing Agent	Relative Risk in Men with HIV	Relative Risk in Women with HIV
Kaposi sarcoma	Herpesvirus-8	98	203
Non-Hodgkin's lymphoma	EBV / HHV-8	37	55
Cervical (non-invasive)	HPV		9
Hodgkin's disease	Epstein Barr virus	8	6
Tongue	HPV / EBV	2	7
Rectal / anal	HPV	3	3
Liver	HCV	5	
Central nervous system	EBV	3	3
Skin	HPV	21	8

Preventive Interventions

Sexual behaviour is the major factor determining the incidence of HIV infection, and a major target for early primary prevention. In this regard, the trends are not encouraging. UK surveys showed, for example, that since 1990, people have, on average, a greater number of lifetime partners, lower age at first intercourse, and more partners who do not use a condom consistently (especially among male homosexuals).[1282,1283] Motivated and informed by this reality, UK authorities recently developed a conceptual framework for comprehensively reviewing evidence related to early primary intervention strategies.[1284] The framework, which is useful in other developed settings such as Canada, included these features:

- The priority at-risk (or risky) populations involved in the strategy should be men who have sex with men, commercial sex workers, certain immigrant (especially African-origin) communities, and people with HIV.

[1278] Scadden DT. AIDS-related malignancies. *Annual Reviews of Medicine.* 2003; 54: 285-303.
[1279] Beral V, Newton R. Overview of the epidemiology of immunodeficiency-associated cancers. *Journal of the National Cancer Institute Monograph.* 1998; (23): 1-6.
[1280] Marco M. Acquired immunodeficiency syndrome-related cancers: the community perspective. *Journal of the National Cancer Institute Monograph.* 1998; (23): 21-2.
[1281] Boshoff C, Weiss R. AIDS-related malignancies. *Nature Reviews Cancer.* 2002; 2(5): 373-82.
[1282] Johnson AM, Fenton KA, Mercer C. Phase specific strategies for the prevention, control, and elimination of sexually transmitted diseases: background country profile, England and Wales. *Sexually Transmitted Infections.* 2002; 78 Suppl 1: i125-32.
[1283] Hickson F, Nutland W, Doyle T et al. *Making it Count: a Collaborative Planning Framework ot Reduce the Incidence of HIV Infection During Sex Between Men.* London: Sigma Research; 2000.
[1284] Ellis S, Barnett-Page E, Morgan A et al. HIV Prevention: a review of reviews assessing the effectiveness of interventions to reduce the risk of sexual transmission. *NHS Health Development Agency.*2003. Available at http://194.83.94.67/uhtbin/hyperion_image.exe/EBBD_HIV_pdf_ft. Accessed June 2005.

- Interventions need to focus on influencing behaviours, e.g., increasing use of condoms, reducing the number of different partners, and encouraging only people with the same HIV status to have sex.

- Interventions need to address the underlying factors that give rise to risky behaviours, e.g., lack of knowledge and skills, availability of resources, discrimination, and substance abuse.[1285]

- Interventions can be delivered at different levels, from individual (counseling, helplines) to groups (sex education) to whole communities (campaigns, professional development of healthcare personnel). A special topic of interest is peer-based and other approaches to preventing the exposure of women to HIV.[1286,1287,1288]

- Behavioural change will probably require a large-scale program involving multiple components and levels.

The conclusion of the resulting UK literature review were sobering: there was very little or no evidence concerning the impact of interventions on any underlying factors or actual behaviours / health outcomes among any of the target populations. It is important to note that "no evidence" is not the same as evidence of ineffectiveness; it does, however, point to glaring research gaps. A Cochrane review from 2002, which looked at men who have sex with men, came up with a similar assessment: the evidence for behavioural interventions to reduce risky behaviours and HIV infection rates, though promising, is very limited; a meta-analysis of results suggested that the proportion of men engaging in unprotected sex was reduced by almost a quarter.[1289] Another review from that year identified the following best practices for community-based programs dealing with sexually transmitted infections and HIV transmission:[1290]

- establish community partnerships
- use opinion leaders and role models
- delivery by peer educators
- involvement of target groups in design of messages
- diffusion of interventions through existing social networks.

[1285] Semaan S, Des Jarlais D, Sogolow E et al. Interventions to modify sexual risk behaviors for preventing HIV infection in drug users. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*1998.

[1286] Tholandi M, Kennedy G, Wilkinson, D. Female condom for preventing heterosexually transmitted HIV infection in women. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2002.

[1287] Doull M, O'Conner A, Robinson V et al. Peer-based interventions for reducing morbidity and mortality in HIV-infected women. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2004.

[1288] Ehrhardt AA, Exner TM. Prevention of sexual risk behavior for HIV infection with women. *Aids.* 2000; 14 Suppl 2: S53-8.

[1289] Johnson WD, Hedges LV, Diaz RM. Interventions to modify sexual risk behaviors for preventing HIV infection in men who have sex with men. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.* 2002.

[1290] Ross MW, Williams ML. Effective targeted and community HIV/STD prevention programs. *Journal of Sex Research.* 2002; 39(1): 58-62.

To this list, we can add two general points that emerged from the reviews noted earlier: multi-component interventions work best; and voluntary testing and counselling are more effective in combination with other interventions. The Cochrane review on the efficacy of counselling and testing is still in the protocol stage.

The most high profile method of HIV prevention is consistent and correct use of condoms. The efficacy of this approach has been proven, but the uptake is still low in many parts of the world. There are many interventions to promote condom use. The great majority of these have been behavioural interventions targeting individual-level barriers to employing condoms, and most have been conducted in a specific high-risk context (e.g., commercial sex work, drug use, homelessness, prisons).[1291] While there have been acknowledged successes in these as well as population-wide settings, there have been no recent systematic reviews of intervention effectiveness, and no assessment of group or population approaches (even the Cochrane work is still at the protocol stage). The closest comprehensive Cochrane review to this topic noted that consistent use of condoms could reduce heterosexual HIV transmission by 80%.[1292]

The most high profile method of HIV prevention is consistent and correct use of condoms, with the potential to reduce HIV transmission by 80%.

Structural approaches to promoting condom use may prove to be the most useful, though evidence remains to be gathered. The options include:[1293]

- legislation of condom use among commercial sex workers
- improving the visibility, availability and accessibility of condoms
- free condom distribution.

Since sharing syringes and needles is a very efficient way of spreading HIV, interventions related to reducing drug use or making it safer become important in controlling infection and associated diseases. While this topic has already been introduced earlier in the context of hepatitis C prevention, it is significant to note at this point that many studies of so-called structural interventions (e.g., syringe exchange programs) have demonstrated reductions in those behaviours that increase the risk of HIV transmission.[1294] At least one recent systematic review has been published in the context of HIV per se. The Cochrane group looked at oral substitution treatment to reduce high-risk drug behaviours, concluding that there was clear, though limited, support for this approach as a means to reduce HIV infection.[1295] Another study of almost 3,000 injection drug users suggested that

[1291] Myer L. Morroni C, Mathews, C et al. Structural and community-level interventions for increasing condom use to prevent HIV and other sexually transmitted infections. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2001.
[1292] Weller S, Davis K. Condom effectiveness in reducing heterosexual HIV transmission. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2005.
[1293] Myer L. Morroni C, Mathews, C et al. Structural and community-level interventions for increasing condom use to prevent HIV and other sexually transmitted infections. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2001.
[1294] Des Jarlais DC. Structural interventions to reduce HIV transmission among injecting drug users. *Aids.* 2000; 14 Suppl 1: S41-6.
[1295] Gowing L, Farrell M, Bornemann R et al. Substitution treatment of injecting opioid users for prevention of HIV infection. Cochrane Drugs and Alcohol Group *Cochrane Database of Systematic Reviews.*2004.

targeting "incremental risk reduction" may be more successful than promoting abstinence.[1296]

Some specialized populations and topics deserve mention. A Cochrane review of methods to prevent transmission of HIV from mother to child in pregnancy or delivery showed that two antiretroviral drugs were effective in risk reduction. One agent, nevirapine, was useful during labour itself; this drug is not indicated for long term monotherapy because of the potential for resistant viruses to emerge. A final method which reduced HIV transmission to the child was birth by elective caesarean section.[1297] The related topic of breastfeeding is being examined by the Cochrane group, but their assessment is in process. The possible interventions to prevent HIV transmission include formula feeding, early weaning, treatment of breast milk and antiretroviral prophylaxis in child and / or mother.[1298]

Employees in healthcare have a definite risk for inadvertent exposure to HIV. Procedures and protocols like those recommended by the World Health Organization[1299] need to be in place to minimize the danger.

Heterosexual transmission of HIV is increasing globally. This reality prompted a 2002 review of interventions directed to heterosexual men. Elwy et al. found 8 studies designed to reduce sexually transmitted infection (including HIV) rates.[1300] There were 5 successful programs, which included on-site individual counselling and HIV testing, mass communications regarding risk reduction and motivation and skills education. Another 2002 review confirmed that interventions can have a positive effect on risky behaviours and HIV rates.[1301] Most of the included studies took place in healthcare settings, and included the following features: information on HIV and risk behaviours, along with technical and personal skills.

According to the Centers for Disease Control, people under 25 account for 50% of new HIV infections in the US. This has created a great deal of urgency around creating effective prevention programs. A 2003 review of sexual risk reduction among youth found positive results in just over half of the 23 studies identified.[1302]

People under 25 years of age account for 50% of new HIV infections in the US.

[1296] Celentano DD, Munoz A, Cohn S et al. Dynamics of behavioral risk factors for HIV/AIDS: a 6-year prospective study of injection drug users. *Drug and Alcohol Dependence.* 2001; 61(3): 315-22.
[1297] Brocklehurst P. Interventions for reducing the risk of mother-to-child transmission of HIV infection. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.*2001.

[1298] Tholandi M, Wilkinson D, Dabis F et al. Interventions to decrease the risk of mother-to-child transmission of HIV-1 through breast milk. Cochrane HIV/AIDS Group *Cochrane Database of Systematic Reviews.*2003.
[1299] See http://www.avert.org/needlestick.htm. Accessed June 2005.
[1300] Elwy AR, Hart GJ, Hawkes S et al. Effectiveness of interventions to prevent sexually transmitted infections and human immunodeficiency virus in heterosexual men: a systematic review. *Archives of Internal Medicine.* 2002; 162(16): 1818-30.
[1301] Neumann MS, Johnson WD, Semaan S et al. Review and meta-analysis of HIV prevention intervention research for heterosexual adult populations in the United States. *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology.* 2002; 30 Suppl 1: S106-17.
[1302] Pedlow CT, Carey MP. HIV sexual risk-reduction interventions for youth: a review and methodological critique of randomized controlled trials. *Behavior Modification.* 2003; 27(2): 135-90.

Of course, many of the early primary prevention methods related to HIV are based on the knowledge that an infection is in place, and then limiting the spread of that infection. Thus, interventions aimed at promoting voluntary testing is theoretically very important. While the Cochrane work on this area is just starting, an earlier review suggested that testing still remains to be proven as useful in early primary prevention; on the other hand, its role in preventing disease development among the already infected has been demonstrated.[1303]

There is evidence that the "cocktail" of antiretroviral drugs taken by HIV-positive patients can be preventive against cancer development. The incidence of Kaposi sarcoma and AIDS-related lymphoma have dropped as the drugs have come into routine use.[1304] Secondary prevention also comes into play, in the sense that antiretroviral therapy seems to actually resolve established Kaposi sarcoma lesions. Information on treatments targeted to specific HIV-influenced cancers is provided in the sections of this report dealing with the relevant etiologic factor. The sort of immunity-boosting therapies being considered for some of these cancers may in turn be used to treat HIV infection.[1305]

Primary prevention after voluntary exposure to HIV (e.g., through sexual intercourse, intravenous drug needle sharing), which usually means the use of antiretroviral drugs in a prophylactic way, is a controversial topic. It is an expensive proposition, and there are no controlled trials supporting its efficacy. Nevertheless, the demand for such an intervention is great, prompting a Cochrane review of the limited evidence available; so far, only the protocol has been published.[1306] A specialized application for prophylactic treatment is in healthcare workers who experience a needle-stick or some other accidental form of exposure; again, the investigation of this type of intervention has only just begun at the Cochrane group.

HIV vaccine development remains an intense area of focus. Since 1987, more than 30 candidate vaccines have been tested in approximately 60 Phase I/II trails, involving more than 10,000 healthy volunteers. Most of these trials have been conducted in the US and Europe, but several have also been conducted in developing countries. The results have confirmed the safety of the vaccines. Currently, there are only two candidate vaccines being evaluated in Phase III trials.[1307]

[1303] Weinhardt LS, Carey MP, Johnson BT et al. Effects of HIV counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985-1997. *American Journal of Public Health.* 1999; 89(9): 1397-405.

[1304] Boshoff C, Weiss R. AIDS-related malignancies. *Nature Reviews Cancer.* 2002; 2(5): 373-82.

[1305] Kieff E. Current perspectives on the molecular pathogenesis of virus-induced cancers in human immunodeficiency virus infection and acquired immunodeficiency syndrome. *Journal of Nationall Cancer Institute Monograph.* 1998; (23): 7-14.

[1306] Martin NV, Almeda J, Casabona J. Effectiveness and safety of HIV post-exposure prophylaxis after sexual, injecting-drug-use or other non-occupational exposure. Cochrane HIV/AIDS Group. *Cochrane Database of Systematic Reviews.* 2005.

[1307] See the World Health Organization website at http://www.who.int/hiv/topics/vaccines/Vaccines/en/. Accessed June 2005.

Human T Cell Lymphotrophic Virus

An estimated 10 to 20 million people worldwide are infected with human T cell leukemia virus type I (HTLV-I).[1308] Most of these carriers are asymptomatic (though capable of transmitting the infection), but 5 to 10% develop either adult T cell leukemia or a particular myelopathy, a neurologic disease characterized by demyelinating lesions in the brain and spinal chord.[1309] Interestingly, these two conditions are very different, and rarely occur together in the same individual.[1310] The fact that most infected people do not develop disease naturally raises questions about the factors and processes which prompt movement towards one or other of the symptomatic states.

For our purposes, it is useful to know that the 1 to 5% of infected individuals who develop leukemia demonstrate mucosal exposure to the virus as the route of transmission (as opposed to progression to myelopathy, a disease which favours infection via blood).[1311] After transmission by whatever route, "the differential immune response mounted by the host…likely plays a key role in determining the outcome of HTLV-I infection."[1312]

Unfortunately, HTLV-induced malignancies do not respond to conventional chemotherapy; disease progression is often rapid, potentially leading to death within 2 years.[1313]

The specific mechanisms by which leukemogenesis is initiated following HTLV-I infection remains a matter of intense investigation. The hope is that gaining understanding about disease pathways will lead to proven prevention or therapeutic measures, neither of which currently exists.[1314] This makes early primary prevention all the more important. That is to say, modifying activity to eliminate viral exposure is the recommended course for individuals to follow. The main behavioural risk factors for contracting HTLV are intravenous drug use and multiple sexual contacts. Family members of HTLV-positive people also show a higher rate of infection.[1315]

[1308] Edlich RF, Arnette JA, Williams FM. Global epidemic of human T-cell lymphotropic virus type-I (HTLV-I). *Journal of Emergency Medicine.* 2000; 18(1): 109-19.
[1309] Barmak K, Harhaj E, Grant C et al. Human T cell leukemia virus type I-induced disease: pathways to cancer and neurodegeneration. *Virology.* 2003; 308(1): 1-12.
[1310] Yao J, Wigdahl B. Human T cell lymphotropic virus type I genomic expression and impact on intracellular signaling pathways during neurodegenerative disease and leukemia. *Frontiers in Bioscience.* 2000; 5: D138-68.
[1311] Kannagi M, Harashima N, Kurihara K et al. Tumor immunity against adult T-cell leukemia. *Cancer Science.* 2005; 96(5): 249-55.
[1312] Barmak K, Harhaj E, Grant C et al. Human T cell leukemia virus type I-induced disease: pathways to cancer and neurodegeneration. *Virology.* 2003; 308(1): 1-12.
[1313] Poiesz BJ, Poiesz MJ, Choi D. The human T-cell lymphoma/leukemia viruses. *Cancer Investigation.* 2003; 21(2): 253-77.
[1314] Barmak K, Harhaj E, Grant C et al. Human T cell leukemia virus type I-induced disease: pathways to cancer and neurodegeneration. *Virology.* 2003; 308(1): 1-12.
[1315] Poiesz BJ, Papsidero LD, Ehrlich G et al. Prevalence of HTLV-I-associated T-cell lymphoma. *American Journal of Hematology.* 2001; 66(1): 32-8.

Herpesvirus Type 8

HHV-8 appears to have a causal role in several diseases, including certain lymphomas and Kaposi sarcoma. The latter connection lends the virus it's alternate name, Kaposi sarcoma-associated herpesvirus (KSHV). The virus is detected infrequently in people at low risk for Kaposi sarcoma (KS).[1316]

HHV-8 has been isolated in a number of body tissues and fluids, prompting investigation of multiple potential routes of transmission. There is a strong link with HIV infection, as noted earlier. In fact, the predominant means of transmitting HHV-8 appears to be male homosexual sex. About 1 out of 5 men who have sex with men and who have HIV, also show HHV-8 in their blood.[1317] The virus is also present in the saliva of 75% of HIV-infected patients who have KS.[1318] In contrast, there is no evidence that monogamous heterosexual sex is a usual mode of transmission.[1319] Beyond men having sex with men, the only other sexual activity that has been clearly shown to be a risk factor is female prostitution. Studies have shown that the behaviours related to injection-drug use (such as needle sharing) may lead to HHV-8 infection, though less efficiently than HBV, HCV or HIV.[1320] This suggests the need to be vigilant about transmission through blood transfusions, though there is no evidence of this risk so far; for instance, haemophiliacs do not acquire KS.[1321,1322,1323] Finally, the high rate of HHV-8 among African preadolescent children suggests that nonsexual routes of transmission may be in operation, but these are not well understood.[1324]

Associated Cancers

HHV-8 is best known for its connection to KS. A relatively rare condition until 25 years ago, it has become a "sentinel diagnosis" for AIDS, along with a characteristic pneumonia. Prior to the emergence of AIDS, an endemic form of KS has been noted for centuries among elderly males in southern Europe and both adults and children in equatorial Africa.

[1316] Whitby D, Howard MR, Tenant-Flowers M et al. Detection of Kaposi sarcoma associated herpesvirus in peripheral blood of HIV-infected individuals and progression to Kaposi's sarcoma. *The Lancet.* 1995; 346(8978): 799-802.

[1317] Whitby D, Boshoff C. Kaposi's sarcoma herpesvirus as a new paradigm for virus-induced oncogenesis. *Current Opinion in Oncology.* 1998; 10(5): 405-12.

[1318] Koelle DM, Huang ML, Chandran B et al. Frequent detection of Kaposi's sarcoma-associated herpesvirus (human herpesvirus 8) DNA in saliva of human immunodeficiency virus-infected men: clinical and immunologic correlates. *Journal of Infectious Diseases.* 1997; 176(1): 94-102.

[1319] Smith NA, Sabin CA, Gopal R et al. Serologic evidence of human herpesvirus 8 transmission by homosexual but not heterosexual sex. *Journal of Infectious Diseases.* 1999; 180(3): 600-6.

[1320] Cannon MJ, Dollard SC, Smith DK et al. Blood-borne and sexual transmission of human herpesvirus 8 in women with or at risk for human immunodeficiency virus infection. *New England Journal of Medicine.* 2001; 344(9): 637-43.

[1321] Engels EA, Eastman H, Ablashi DV et al. Risk of transfusion-associated transmission of human herpesvirus 8. *Journal of National Cancer Institute.* 1999; 91(20): 1773-5.

[1322] Boshoff C, Chang Y. Kaposi's sarcoma-associated herpesvirus: a new DNA tumor virus. *Annual Review of Medicine.* 2001; 52: 453-70.

[1323] Whitby D, Howard MR, Tenant-Flowers M et al. Detection of Kaposi sarcoma associated herpesvirus in peripheral blood of HIV-infected individuals and progression to Kaposi's sarcoma. *The Lancet.* 1995; 346(8978): 799-802.

[1324] Gessain A, Mauclere P, van Beveren M et al. Human herpesvirus 8 primary infection occurs during childhood in Cameroon, Central Africa. *International Journal of Cancer.* 1999; 81(2): 189-92.

KS has also long been known as a complication among transplant patients undergoing immunosuppressive therapy.[1325] It seems that that a compromised immune system is an essential milieu for the development of KS; the fact is that only a small fraction of *immunocompetent* people infected with HHV-8 end up with a malignancy.[1326]

The more recent form of KS is the epidemic version related to HIV infection. It still requires the presence of HHV-8, with HIV supplying the necessary immunosuppressive component.

KS begins with a few skin lesions, but without treatment it can eventually affect multiple organs, including the lung, liver, digestive tract and spleen.[1327] The clinical course of KS is highly variable, ranging from minimal disease to explosive growth, with significant morbidity and mortality.

There are certain rare lymphomas that are closely related to both HIV infection and KS in men who have sex with men. These malignancies have been connected to HHV-8. They are distinguished from other non-Hodgkin's lymphomas (NHLs) by their presentation as effusions in the visceral cavity; they do not exhibit a significant tumour mass. [1328] Only a few cases of this type of lymphoma have been reported in HIV-negative individuals.[1329]

Preventive Interventions

In the absence of specific vaccines or treatments in the rather complex world of KS and lymphomas related to HHV-8, it becomes all the more important to follow preventive strategies.[1330] The main early primary prevention measures are the same as for HIV, namely, "safe sex" education and practices, especially among male homosexuals (see the earlier section).

There are no specific KS secondary prevention methods. The classic treatments used for KS involve different types of cancer management, and thus are not preventive per se.

The best primary prevention results for HHV-8 diseases are emerging as a by-product of the HIV / AIDS battle. The introduction of effective antiretroviral therapies for HIV infection seems to be having an impact on both KS and AIDS-related NHLs, at least in developed countries.[1331] After a rapid rise over a 20 year period, the incidence

[1325] Boshoff C, Chang Y. Kaposi's sarcoma-associated herpesvirus: a new DNA tumor virus. *Annual Review of Medicine.* 2001; 52: 453-70.
[1326] Boshoff C. Kaposi's sarcoma. Coupling herpesvirus to angiogenesis. *Nature.* 1998; 391(6662): 24-5.
[1327] Boshoff C, Chang Y. Kaposi's sarcoma-associated herpesvirus: a new DNA tumor virus. *Annual Review of Medicine.* 2001; 52: 453-70.
[1328] Boshoff C, Chang Y. Kaposi's sarcoma-associated herpesvirus: a new DNA tumor virus. *Annual Review of Medicine.* 2001; 52: 453-70.
[1329] Baris D, Zahm SH. Epidemiology of lymphomas. *Current Opinion in Oncology.* 2000; 12(5): 383-94.
[1330] Fisher SG, Fisher RI. The epidemiology of non-Hodgkin's lymphoma. *Oncogene.* 2004; 23(38): 6524-34.
[1331] Baris D, Zahm SH. Epidemiology of lymphomas. *Current Opinion in Oncology.* 2000; 12(5): 383-94.

of these diseases has decreased in the US since the mid-1990s. By contrast, non-AIDS-associated NHL rates have continued to climb.[1332,1333]

An unexpected result of successful treatment of immunocompromised individuals, where they then live longer, is the possible development of more NHL in the future.[1334]

[1332] Eltom MA, Jemal A, Mbulaiteye SM et al. Trends in Kaposi's sarcoma and non-Hodgkin's lymphoma incidence in the United States from 1973 through 1998. *Journal of National Cancer Institute.* 2002; 94(16): 1204-10.
[1333] Chiu BC, Weisenburger DD. An update of the epidemiology of non-Hodgkin's lymphoma. *Clinical Lymphoma.* 2003; 4(3): 161-8.
[1334] Fisher SG, Fisher RI. The epidemiology of non-Hodgkin's lymphoma. *Oncogene.* 2004; 23(38): 6524-34.

Helminths

We have already referred to parasitic worms or flukes as another category of infection linked cancer. These animals are sometimes known as helminths, after the Greek word for worm. Of the 72 known species of parasites that can infect humans by food or water,[1335] only two have been definitely identified as carcinogenic: the blood fluke *Schistosoma haematobium* and the liver fluke *Opisthorchis viverrini*. Neither of these occurs naturally in North America.

S. haematobium and related species are endemic in 74 countries of Africa and the eastern Mediterranean. More than 200 million people suffer from schistosomiasis, a condition which accounts for an astounding 1 million annual deaths. *S. haematobium*, whose eggs end up in the urine, also can create an inflammatory reaction in the bladder; in addition to its normal parasitical morbidity, the worm has been associated with bladder cancer in several case-control studies.[1336]

O. viverrini is common in Thailand, Laos and Cambodia, infecting an estimated 9 to 10 million people.[1337] There is strong evidence connecting this liver fluke to cholangiocarcinoma, a rare malignancy situated in the biliary duct system.[1338]

Although the lifecycle of these parasites prevents them from being prevalent in North America, with the growing volume of international travel, migration and smuggling, the infections are increasingly being seen in countries where the disease is not endemic. A recent outbreak of opisthorchiasis in Israel, derived from illegally imported Siberian carp, provided the sort of wake-up call that is needed in our ever more globalized society.[1339] Another consideration is that people in industrialized settings who happen to pick up the relevant parasite in uncommon ways may live longer than if they resided in other countries, increasing the chance of cancer developing.[1340]

As with the other infectious agents, the helminths also represent a fluid area of research in terms of carcinogenesis.[1341] The liver flukes *O. felineus* and *Clonorchis sinensis* have also been implicated in cancer of the biliary ducts, though the evidence is more limited than for their close cousin, *O. viverrini*. Likewise, various *Schistosoma* species have been associated with hepatocellular carcinoma (liver

[1335] Pozio E. Foodborne and waterborne parasites. *Acta Microbiologica Polonica.* 2003; 52 Suppl: 83-96.
[1336] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[1337] Sithithaworn P, Haswell-Elkins M. Epidemiology of Opisthorchis viverrini. *Acta Tropica.* 2003; 88(3): 187-94.
[1338] Herrera LA, Benitez-Bribiesca L, Mohar A et al. Role of infectious diseases in human carcinogenesis. *Environmental & Molecular Mutagenesis.* 2005; 45(2-3): 284-303.
[1339] Yossepowitch O, Gotesman T, Assous M et al. Opisthorchiasis from imported raw fish. *Emerging Infectious Diseases.* 2004; 10(12): 2122-6.
[1340] Herrera LA, Ostrosky-Wegman P. Do helminths play a role in carcinogenesis? *Trends in Parasitology.* 2001; 17(4): 172-5.
[1341] Herrera LA, Ostrosky-Wegman P. Do helminths play a role in carcinogenesis? *Trends in Parasitology.* 2001; 17(4): 172-5.

cancer) and colorectal cancer.[1342,1343] Finally, concerns about the carcinogenicity of *S. haematobium* have been extended beyond the bladder to the urinary tract.[1344]

Conclusions and Recommendations

A number of key insights and conclusions offered throughout the report will be collected here for convenience; some the comments may serve as recommendations for policy-makers and planners.

Burden and Trends

Although some infection-related cancers are dropping in incidence, various factors are keeping the prevalence and mortality burden of these diseases at a high level in the Canadian population. Complacency is not an option. Some have suggested that, following tobacco use, infections as a group may be the most significant arena for preventive measures in cancer control.

Uncertainty and Action

The complexity of working out disease mechanisms and interpreting epidemiological data means that confirmed causality relationships between infectious agents and cancer emerge very slowly. As some of the cancers implicated represent such a serious burden for patients and the health care system, however, planners may need to act in the face of uncertain data.

Levels of Prevention

Emphasising the foundation or base of the prevention hierarchy is important. This means intervening to limit the exposure to the pathogen in the first place. If such early primary prevention is not practical or successful, then classic primary prevention must be pursued; with infections, the "gold standard" approach is prophylactic vaccines which prevent any exposure from becoming a serious problem. Finally, if infection does become established and is not expected to resolve spontaneously, then measures need to be taken to ensure that cancer does not develop; sometimes detecting precancerous cells and lesions through screening programs is the beginning of such secondary prevention.

Cost Considerations

A concerted attack across the prevention levels may be required to ultimately control a disease within a population. A complicating factor is that some interventions are more cost-effective than others. For example, there is debate about whether testing for HPV (to prompt primary prevention, if possible) is worth the expense, especially in reference to highly effective cytological screening, which detects precancer or the early stages of cervical cancer and then prompts appropriate secondary prevention.

[1342] Abdel-Rahim AY. Parasitic infections and hepatic neoplasia. *Digestive Diseases.* 2001; 19(4): 288-91.

[1343] Matsuda K, Masaki T, Ishii S et al. Possible associations of rectal carcinoma with Schistosoma japonicum infection and membranous nephropathy: a case report with a review. *Japanese Journal of Clinical Oncology.* 1999; 29(11): 576-81.

[1344] Hodder SL, Mahmoud AA, Sorenson K et al. Predisposition to urinary tract epithelial metaplasia in Schistosoma haematobium infection. *American Journal of Tropical Medicine & Hygiene.* 2000; 63(3-4): 133-8.

Likewise, though early intervention at the level of transmission is probably preferable, effective vaccines may be as effective as and less costly than preventing exposures to what are sometimes ubiquitous and easily transmitted organisms.

A Key Focus: Sexually Transmitted Infections

The strategies at each of the prevention levels just described should be as comprehensive and aggressive as necessary. Since many of the pathogens covered in this report are sexually transmitted, much of the discussion of early primary prevention revolved around reducing risky behaviours related to sexual activity. This is a crucial area of public health, albeit a sensitive one.

As a framework for the specific programs noted in the report, the list below provides the typical behavioural intervention categories. Understanding the "landscape" of potential interventions provides a context for particular initiatives that have been tried and tested for the various agents. This taxonomy of measures also might suggest some new directions for a jurisdiction to consider if they are aiming towards a truly comprehensive strategy.

Measures Directed at High Risk Populations

1. Community-wide risk reduction education.
   - · prevent initiation or promote cessation of risky behaviour.
   - · reduce risk for getting infection or transmitting to others.
2. Screening for risky behaviour through routine history-taking in medical settings.
3. Recruiting for programs (see nos. 4-6 below) among high-risk populations.

Measures Directed at High Risk Individuals

4. Targeted counselling / education among high-risk individuals not yet infected (e.g., newer, younger, drug users).
   - · prevent initiation or promote cessation of risky behaviour (this includes relapse prevention measures).
   - · reduce risk for getting infection (e.g., diversion to non-injecting routes of drug administration).
5. Substance-abuse treatment.
6. Provide other services among high-risk-individuals ("harm reduction")
   - · vaccinations for those engaging in risky behaviours and / or in contact with infected or potentially infected persons.
   - · syringe / needle exchange.
   - · safer injection sites.
   - · condom distribution.

Measures Directed at Infected Individuals

7. Screening for presence of the virus by testing high-risk individuals (i.e., those injecting drugs or having sex with multiple partners and / or partners who are themselves at risk).
8. Targeted counselling / education among infected individuals.
   - · promote cessation of risky behaviour.
   - · otherwise reduce risk for transmitting to others.
9. Treatment of infection.
10. Provide other services among infected individuals related to stopping transmission ("harm reduction"); see under no. 6 above.
11. Quarantine / prosecution to prevent acts which endanger others.

Overarching Strategies

12. Thorough education for health care professionals in all of the above.
13. Integration of multiple public health and clinical strategies.
14. Surveillance to evaluate effectiveness and guide the development of new programs.

Ongoing Investment in Research and Pilot Projects

It is clear that more needs to be known about the transmission of the various pathogens, the co-factors which may be part of initiating and maintaining carcinogenesis, and the overall course of disease. Greater insight into any of these areas will allow enhancements of the prevention armamentarium, ultimately allowing the disease burden to be reduced and, perhaps, eradicated. The dramatic drop in cervical cancer rates, primarily as a result of screening programs, spurs on public health efforts and holds out hope for similar results with other diseases. The development and imminent launch of vaccines for HPV promises a brand new era for cervical cancer prevention, though many implementation questions remain unanswered. Intense resources will be required to encourage other research frontiers, including a vaccine for HIV.

Finally, continued study of other potential etiologic agents is vital in the overall battle against cancer; the potential for disease prevention represented by each of the candidate pathogens makes this a truly exciting area of medical research.

The Temptation of Technology

As captivating as new health technologies can be, it is also important to continue focusing on the classic “low-tech” public health options related to early primary prevention, including initiatives involving media advocacy, education and counselling. The modest record of progress in this regard, even with high-profile agents such as HIV, is very sobering. Much more needs to be done.

Planners also need to be wary of inappropriately supplanting old technologies with new. For instance, some authorities are suggesting that a new HPV vaccine should work alongside rather than replace screening programs, at least until the backlog of potential cervical cancer cases is cleared. The latency period involved can be up to 20 years.

It is clear that a strong coalition between researchers, clinicians, public health managers and funders will be required to navigate through the complex data and policy options and see the sort of breakthroughs desired with the significant cancers described in this report.

Appendix A: ARC List of Infectious Causes of Cancer

From *IARC Monographs* Volumes 1-88 (a total of 900 agents, mixtures and exposures). In 1969, the International Agency for Research on Cancer (IARC) initiated a program to evaluate the carcinogenic risk of chemicals to humans and to produce monographs containing the evidence and other details. The program has since been expanded to include exposures to mixtures of chemicals and to other agents, such as radiation and viruses. [1345]

- **Group 1:** Carcinogenic to humans (out of a total of 95 agents currently recognized)

Epstein-Barr virus (Vol. 70; 1997)
Helicobacter pylori (infection with) (Vol. 61; 1994)
Hepatitis B virus (chronic infection with) (Vol. 59; 1994)
Hepatitis C virus (chronic infection with) (Vol. 59; 1994)
Human immunodeficiency virus type 1 (infection with) (Vol. 67;1996)
Human papillomavirus types 16 and 18 (Vol. 64; 1995)
Human T-cell lymphotropic virus type I (Vol. 67; 1996)
Opisthorchis viverrini (infection with) (Vol. 61; 1994)
Schistosoma haematobium (infection with) (Vol. 61; 1994)

- **Group 2A:** Probably carcinogenic to humans (out of 66)

Clonorchis sinensis (infection with) (Vol. 61; 1994)
Human papillomavirus types 31 and 33 (Vol. 64; 1995)
Kaposi sarcoma herpesvirus / human herpesvirus 8 (Vol. 70; 1997)

- **Group 2B:** Possibly carcinogenic to humans (out of 241)

Human immunodeficiency virus type 2 (infection with) (Vol. 67;1996)
Human papillomavirus: some types other than 16, 18, 31 and 33 (Vol. 64; 1995)
Schistosoma japonicum (infection with) (Vol. 61; 1994)

- **Group 3:** Not classifiable as to human carcinogenicity (out of 497)

Hepatitis D virus (Vol. 59; 1994)
Human T-cell lymphotropic virus type II (Vol. 67; 1996)
Opisthorchis felineus (infection with) (Vol. 61; 1994)

[1345] From the preamble to the Monograph series. Available at http://www-cie.iarc.fr/monoeval/preamble.html. Accessed July 2005.

Appendix B: NTP List of Infectious Causes of Cancer

From *The Report on Carcinogens, 11th Edition* (2004). Published by the National Toxicology Program (NTP), US Dept. of Health & Human Services (Public Health Service). The NTP is formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA).

Known to be Human Carcinogens.

Hepatitis B Virus
Hepatitis C Virus
Human Papillomas Viruses: Some Genital-Mucosal Types

Note: all of these agents were added as of this edition of the Report.

Reasonably Anticipated to be Human Carcinogens.

None

Appendix C: ACS List of Infectious Causes of Cancer

From American Cancer Society (ACS) *Cancer Facts & Figures 2005.*

Hepatitis B virus
Hepatitis C virus
Human papillomavirus
Helicobacter pylori
Human herpesvirus type 8
Human immunodeficiency virus
Epstein-Barr virus
Human T cell lymphotrophic virus

Appendix D: Dr. J. Goldie's List of Cancers and Infectious Causes

Dr. James Goldie, University of British Columbia

Source: **Is there a case for infectious agents playing a significant role in causing cancers?** *Presentation to BC Cancer Agency Conference 2003* Available at http://www.bccancer.bc.ca/RS/CommunitiesOncologyNetwork/EducationandPlanningConferences/ACC2003/MSS/default.htm. Accessed July 2005.

Proven

Gastric carcinoma	*H. pylori*
Gatric MALT lymphoma	*H. pylori*
Hepatocellular carcinoma	Hepatitis B, C
Cervical and other anogenital carcinoma	Human papillomavirus
Posttransplantation lymphoproliferative disorder	Epstein-Barr virus
Burkitts' lymphoma	Epstein-Barr virus
Nasopharyngeal carcinoma	Epstein-Barr virus
Kaposi sarcoma	Epstein-Barr virus
Primary effusion lymphoma	Epstein-Barr virus
Adult T-cell leukemia	Human T cell lymphotrophic virus-1

Strongly Suggested

Bladder carcinoma	*S. haematobium*
Squamous skin and oral mucosa	Human papillomavirus
Hodgkin's disease	Epstein-Barr virus
Non-Hodgkin's lymphoma	Epstein-Barr virus; Hepatitis C

Tentative Association

Gall bladder carcinoma	*S. typhi*
Breast cancer	Human mammary tumour virus
Primary CNS tumours / mesothelioma	Polyomaviruses
Ovarian carcinoma	*Chlamydia*
Ocular MALT lymphoma	*Chlamydia*
Primary CNS lymphoma	Epstein-Barr virus
Childhood acute lymphoblastic leukemia	???

Combined Lifestyle Interventions in Primary Care and Public Health

Individuals do not always manifest one health risk factor at a time. There are compelling reasons to devise interventions that will help people on different aspects of their lifestyle in order to maximize their health benefit. Before addressing how to approach the question of multiple risk factor interventions, it is important to recognize a distinction that to this point has been subliminal in this report. Identified in passing in various sections above is the fact that there are two complementary approaches to targeting behaviour modification in individuals:[1346]

"Addressing multiple risk behaviors has tremendous public health significance while posing significant intellectual challenges."
Strecher V, Wang C, Derry H et al. Tailored interventions for multiple risk behaviours *Health Education Research* 2002; 17(5): 619-26.

- The public health perspective, which seeks to achieve small changes in the majority of the population (thus shifting the overall risk profile of a population to a lower level).

- The clinical perspective, which targets individual patents, usually at high risk, and seeks to achieve a substantial reduction in their risk profile.

The present report has often looked at interventions in these two arenas in tandem, without much distinction. The topic of multiple risk factors and lifestyle modification, however, offers an opportunity to highlight the differences between the two perspectives.

Comparing Primary Care and Public Health

Those who subscribe to the position that public health approaches are needed for society-wide (and, eventually, global) changes make an intuitively defensible point. If the goal is reducing risk factors for chronic disease as much as possible, for as many people as possible, then it is arguable that the primary care setting is not the most efficient platform to pursue. Surely, one might believe, the broad appeal of public or population health interventions are the best way to proceed.

It is possible that this "debate" between public health and clinical care is an artificial one. When primary care providers become more and more integrated with community-wide campaigns as active partners and re-enforcers of the common health promotion "message," then the distinctions begin to fade.

When primary care providers become more and more integrated with community-wide campaigns as active partners and re-enforcers of the common health promotion message, then the distinctions between primary care and public health begin to fade.

There is little doubt that a sustained mass media health campaign like anti-tobacco advertising will both shape and support the provision of primary care. Likewise, when one recognizes that the most effective risk factor reduction in community settings often occurs with interventions that involve individual health assessments and intensive counselling, then it is clear that the public health

[1346] Ashenden R, Silagy C, Weller D. A systematic review of the effectiveness of promoting lifestyle change in general practice *Family Practice* 1997; 14(2):160-76.

care and primary healthcare worlds are coalescing. There is differential *and* overlapping value in both clinical and population approaches to risk factor reduction and health enhancement.

Promotion of Lifestyle Change in Primary Care Settings

Rationale for Primary Care Prevention and Health Promotion

There are several reasons for targeting primary healthcare as a setting for risk factor interventions, including:

- The high rate of at least one annual visit to primary care physicians in the population, combined with the fact that someone presenting with illness may be very motivated to receive and act on health advice.
- The fact that primary care providers are uniquely positioned to assess the risk level of a patient (e.g., through a family history and appropriate screening test) and assign an appropriate level of preventive measures tailored to precise personal circumstances.
- The pattern of regular follow-up in clinical settings that may make it possible for sustained behavioural change.
- The fact that patients still see their primary care provider as the first place to turn for risk factor reduction.
- As seen in this report, the respected and influential role that general practitioners can play even with relatively low-intensity interventions such as brief advice to patients about changing risky behaviours.
- If sustainable, the proven effectiveness of more intense interventions such as behavioural counselling, tailored self-help materials, follow-up systems, exercise prescriptions, and pharmacotherapy (e.g., for tobacco cessation or weight loss) that could all be available in primary care.
- General practitioners are the traditional referral gateway to other important resources, such as anti-smoking clinics, nutritionists/dietitians, and structured exercise options.

Barriers also exist, standing in the way of seeing primary care as an arena for prevention and health promotion. The impediments include:

- The professional tradition of offering medical interventions for disease rather than measures to prevent illness and promote wellness.
- The perception that too much time will be required to enter into preventive care with patients. This is exacerbated by the sense that many patients will not respond to advice very well, thus reducing the effectiveness of that advice.

> *"To prevent and reduce complications related to chronic conditions, prevention and health promotion should be part of every health care encounter, but this is far from routine clinical care."*
>
> WHO *Chronic conditions: current systems of care.*

- Reimbursement structures do not compensate primary care provider very well, if at all, for preventive care aimed at reducing risk factors.

- The primary care provider is not always confident of the most effective measures to employ, and which should have priority in a "staged" approach to modifying risk.

- The sheer volume of potential risk factors to assess and modify can seem overwhelming to already busy primary care providers.

- There is a sense, perhaps even among primary care providers, that social marketing and other public health measures can provide more effective interventions for risk factor reduction, or at least more cost-effective ones that will reach a larger audience.

To make a change in general attitudes and primary care practice will take considerable effort. One review concluded: "it is clear that if general practice-based interventions are to be effective in a public health sense, a greater number of GPs will need to become involved in promoting behaviour change than the literature currently suggests is occurring."[1347]

The current movement in BC and across Canada to restructure primary care offers an important opportunity to incorporate this change. With an enhanced focus on group practices that integrate a greater spectrum of health care providers and seek to make better use of available information technology, the stage is set to incorporate prevention into the primary care setting.

Promoting Prevention in Primary Care

The question is: if it is accepted and even desired that health promotion should happen routinely in the clinical setting, how can risk factor improvements be maximized in each patient encounter?

A relatively new technique of influencing knowledge and behaviour in the primary care setting is known as *academic detailing*, i.e., visits from qualified healthcare professionals to improve specific clinical practices. This concept has been adapted in some jurisdictions to influence actions in the realm of health promotion. One might call this promising approach *prevention detailing.*

Prevention Detailing

Visits in clinician's offices of "detailers" from pharmaceutical companies who explain (and promote) new drug products are commonplace. This much-debated practice has served as a model for other, presumably more objective on-site, face-to-face encounters with primary care providers by knowledgeable healthcare educators. The practice, known by a variety of names[1348] but most commonly called "academic

[1347] Ashendon R, Silagy C, Weller D. A systematic review of the effectiveness of promoting lifestyle change in general practice *Family Practice* 1997; 14(2): 160-75.

[1348] Other terms include university-based educational detailing, public interest detailing and educational outreach visits.

detailing,"[1349] has become a growing fixture over the last 15 years in the arsenal of options to influence knowledge and practice in the primary care setting.[1350,1351,1352,1353,1354]

Prevention detailing involves on-site, face-to-face or group encounters with primary care providers by healthcare educators knowledgeable about risk factors and related interventions.

The method and format of academic detailing can vary. It can involve as little as 15-minute personal sessions 2 to 3 times per year, with topics selected in accordance with enquiries received from the physicians. A variation on the theme of personalized visits is a trained educator interacting with a group of primary care providers.[1355,1356]

As the application of academic detailing in primary prevention is relatively new, its potential usefulness in modifying knowledge, attitudes and activities of primary care providers and, ultimately, patient behaviours and health outcomes, has not been assessed. Some understanding of that usefulness can be inferred from the evidence of academic detailing in other arenas over the last couple of decades.

A Cochrane review of 18 studies on academic detailing noted that most of the projects related to altering drug-prescribing behaviour and focused on physician practices.[1357] Only 3 studies involved preventive services such as counselling for smoking cessation. Sometimes the detailing intervention was allied with complementary approaches such as patient materials, reminder systems, or audit and feedback. As positive effects were observed in all studies, academic detailing appears to be a promising approach to modifying health professional behaviour.

The basic conclusion of the Cochrane review is that academic detailing (with or without complementary interventions) is more effective than no intervention (or just providing educational materials and traditional conferences), but the results are strongest in the multi-component approaches based on social marketing.[1358, 1359] A

[1349] Soumerai SB, Avorn J. Principles of educational outreach ('academic detailing') to improve clinical decision making *Journal of the American Medical Association* 1990; 263(4): 549-56.
[1350] Siegel D, Lopez J, Meier J et al. Academic detailing to improve antihypertensive prescribing patterns *American Journal of Hypertension* 2003; 16(6): 508-11.
[1351] Hall L, Eccles M, Barton R et al. Is untargeted outreach visiting in primary care effective? A pragmatic randomized controlled trial *Journal of Public Health Medicine* 2001; 23(2): 109-13.
[1352] Solomon DH, van Houten L, Glynn RJ. Academic detailing to improve use of broad-spectrum antibiotics at an academic medical center *Archives of Internal Medicine* 2001; 161(15): 1897-902.
[1353] Markey P, Schattner P. Promoting evidence-based medicine in general practice—the impact of academic detailing *Family Practice* 2001; 18(4): 364-6.
[1354] Hill CD, Bunn DN, Hawkins JR. Stretching the managed care dollar in the new millennium: the practice of detailing primary care physicians *Managed Care Quarterly* 2002; 10(2): 18-23.
[1355] Diwan VK, Wahlstrom R, Tomson G et al. Effects of "group detailing" on the prescribing of lipid-lowering drugs: a randomized controlled trial in Swedish primary care *Journal of Clinical Epidemiology* 1995; 48(5): 705-11.
[1356] Siegel D, Lopez J, Meier J et al. Academic detailing to improve antihypertensive prescribing patterns *American Journal of Hypertension* 2003; 16(6): 508-11.
[1357] Thomson O'Brien MA, Oxman AD, Davis DA et al. Educational outreach visits: effects on professional practice and health care outcomes *Cochrane Database of Systematic Reviews*, 2004.
[1358] Thomson O'Brien MA, Oxman AD, Davis DA et al. Educational outreach visits: effects on professional practice and health care outcomes *Cochrane Database of Systematic Reviews*, 2004.
[1359] The techniques of social marketing include:

- interviewing to determine baseline knowledge held by physicians

(footnote continued)

2003 study (not examined by the Cochrane review) showed that smokers who visited physicians that had experienced smoking cessation detailing were almost twice as likely to quit as smokers in the control group.[1360]

Combined Lifestyle Interventions

Interventions to change most risk factors, such as smoking, unhealthy diet or physical inactivity, have tended to focus on a single behaviour. Many patients will present with more than one of the significant risk factors outlined in this report.

If a prioritized response is necessary, then it is not immediately clear which risk factor should be addressed first, and why. The literature describing such a scenario is incomplete. It seems that what would be needed ultimately is a personalized risk assessment tool. Such a tool has been proposed by Beery and colleagues in their Health Risk Appraisal.[1361]

The criteria used for prioritizing risk-related behaviours are based on epidemiologic estimates of life expectancy; in these terms, a smoking patient with an alcohol problem ought to concentrate on smoking cessation first, as that particular risky behaviour has the greatest impact, on average, in terms of reduced life expectancy.

Other researchers, seeing the limitation of such "cold-blooded" information in motivating people in the real world, have gravitated towards a more patient-centred approach, e.g., asking them which risk factor they are most interested in changing.[1362]

Combined Approaches

Rather than the challenges of prioritizing, it may seem easier and more useful to simply tackle multiple risk factors at the same time. The case for this approach includes the following facets:

- As suggested in an earlier section of this report, some risk factors are inextricably bound together. For instance, research supports the premise that obesity most effectively can be addressed through a combined focus on poor diet and physical inactivity.

- focusing on specific categories of physicians and their opinion leaders
- defining clear objectives
- establishing credibility in a variety of ways, e.g., by being unbiased
- stimulating active participation in the educational interaction
- using concise graphic materials
- highlighting and repeating the essential message
- providing positive feedback about improvements on follow-up visits.

See Soumerai SB, Avorn J. Principles of educational outreach ('academic detailing') to improve clinical decision making *Journal of the American Medical Association* 1990; 263(4): 549-56.

[1360] Goldstein MG, Niaura R, Willey C et al. An academic detailing intervention to disseminate physician-delivered smoking cessation counseling: smoking cessation outcomes of the Physicians Counseling Smokers Project *Preventive Medicine* 2003; 36(2): 185-96.

[1361] Beery W L, Schoenbach V J, Wagner EH et al. *Health Risk Appraisal: Methods and Programs with Annotated Bibliography*. National Center for Health Services Research and Health Care Technology, Washington, DC, 1986.

[1362] Strecher V, Wang C, Derry H et al. Tailored interventions for multiple risk behaviours *Health Education Research* 2002; 17(5): 619-26.

- Certain risk factors are potentially so severe that to delay addressing them may be literally "fatal." For example, smoking is frequently a killer via lung cancer and other diseases, while central obesity is a precursor of the metabolic syndrome, which may lead to type 2 diabetes and cardiovascular disease.[1363,1364] If a patient manifests with both risk factors, it would be hard to justify only addressing one of them at a time, as the patient may deteriorate while waiting for the second intervention.

Counter-Arguments

These perspectives notwithstanding, sometimes it may seem that dealing with risk factors one at a time is still the best plan. It is difficult enough for patients to modify one behaviour, let alone addressing more than one simultaneously.[1365] Also, from the point of view of the patient, their motivation to address different factors can be quite separate and variable.[1366] Good momentum can be created when success is experienced with one risk factor, which ultimately can be encouraging in other vital areas. King and colleagues concluded in a 1996 study: "an increase in level of motivation in one behaviour produces progressive changes in another behaviour at a later time."[1367] Another concern is the fact that a patient presenting with multiple risk factors may have a hidden underlying factor, such as depression, which needs to be addressed before any other behavioural change is realized.[1368]

> *"One of the greatest challenges in the health behavior field has been to understand on which behavior(s) to intervene and in what order—simultaneously or sequentially."*
> Ory MG, Jordan PJ, Bazzarre T. The Behavior Change Consortium: setting the stage for a new century of health behavior-change research *Health Education Research* 2002; 17(5): 500-511.

Promotion of Lifestyle Change Through Public Health

While addressing multiple risk factors simultaneously in individuals has its challenges, such an approach is much more plausible on a population level.

An effective, long-term, multi-factorial program targeted at reducing key risk factors in the population at large is critically important. Throughout this report, we have noted that the most effective interventions are often those that take a multi-pronged approach. This approach is reinforced by the Behavior Change Consortium of the US

[1363] Appel SJ, Jones ED, Kennedy-Malone L. Central obesity and the metabolic syndrome: implications for primary care providers *Journal of the American Academy of Nurse Practitioners* 2004; 16(8): 335-42.
[1364] Shirai K. Obesity as the core of the metabolic syndrome and the management of coronary heart disease *Current Medical Research & Opinion.* 2004; 20(3): 295-304.
[1365] Strecher V, Wang C, Derry H et al. Tailored interventions for multiple risk behaviours *Health Education Research* 2002; 17(5): 619-26.
[1366] Boudreaux ED, Francis JL, Carmack Taylor CL et al. Changing multiple health behaviors: smoking and exercise *Preventive Medicine* 2003; 36(4): 471-8.
[1367] King TK, Marcus BH, Pinto BM et al. Cognitive-behavioral mediators of changing multiple behaviors: smoking and a sedentary lifestyle *Preventive Medicine* 1996; 25(6): 684-91.
[1368] Strecher V, Wang C, Derry H et al. Tailored interventions for multiple risk behaviours *Health Education Research* 2002; 17(5): 619-26.

National Institutes of Health.[1369] The team members have identified a number of critical emphases for the future, all of which have been reflected in our project:

- Changing population health must involve multi-level approaches that recognize the environmental and social context. Impacts of programs to date have been modest and hard to maintain. "Interventions that include a social-environmental approach are believed to be more sustainable and cost-effective over the long term...and although community-level interventions are not usually as intense as individual interventions, they have the potential of reaching more people and thus having a greater impact on population health."[1370]

- Truly multi-level approaches will not ignore the individual patient nor the tailored, personalized approaches embodied by the clinical care setting; understanding the importance of "readiness to change" must be part of the "total intervention armamentarium."

- A behavioural medicine perspective is important for understanding the complex interactions among multiple risky behaviours.

- Instead of taking a disease focus, a multiple behaviours approach recognizes the "physiological synergy" of different risk factors. The value of this approach is that ultimately many chronic conditions, from cancer to heart disease to diabetes, may be mitigated through a well-designed multi-factorial program.

- Much more work is needed in multiple-risk research to enhance recruitment and retention in public health programs, improve the quality of program execution, and develop outcome metrics that will allow for good evaluation across and between programs. [1371] Some of these criteria overlap with the RE-AIM program evaluation framework described below in the conclusion of this report.

A final challenge and opportunity should be mentioned for the role of public health in transforming the health status of an entire society, namely, the importance of *primordial* prevention. Even before the primary prevention of reducing behavioural risk factors or the secondary prevention of reducing the resulting biological risk factors, comes the task of preventing the risk factors before they emerge. One study, in describing the new frontline of primordial public health, issued a call for "a radical expansion of our investment in preventing the risk factors in the first place."[1372]

Primordial prevention seeks to prevent the risk factor before it emerges.

[1369] Source: http://www1.od.nih.gov/behaviorchange/ (accessed December 2004).
[1370] Ory MG, Jordan PJ, Bazzarre T. The Behavior Change Consortium: setting the stage for a new century of health behavior-change research *Health Education Research* 2002; 17(5): 500-11.
[1371] Nigg CR, Allegrante JP, Ory M. Theory-comparison and multiple-behavior research: common themes advancing health behavior research *Health Education Research* 2002; 17(5): 670-9.
[1372] Labarthe DR. Prevention of cardiovascular risk factors in the first place *Preventive Medicine* 1999; 29(6 Pt 2): S72-8.

Summary and Conclusions

Summary

Throughout this report we have used the following taxonomy to group interventions:

- Community-based Interventions
- Workplace-based Interventions
- School-based Interventions
- Home-based Interventions
- Clinical Interventions and Management
- Regulatory and Economic Interventions
- Comprehensive Strategies

While not all categories are applicable to all risk factors, we will use these categories to summarize the results of this project. That is, in the following sections, we will sort interventions for which there is significant evidence of effectiveness into these seven categories.

We have also grouped interventions under the following three levels of evidence:

Level 1 - Interventions of proven effectiveness with strong evidence

Level 2 - Interventions of promising effectiveness with moderate or mixed evidence

Level 3 - Interventions of no or low effectiveness and / or with insufficient evidence

In the following summary categorization, the focus is appropriately on interventions with Level 1 evidence. For some interventions, however, achieving a Level 1 status is virtually impossible. This can be due to the fact that the intervention is integrally linked with other interventions and thus it is difficult to asses the intervention in isolation, or because evidence is still accumulating for newer interventions. Educational interventions involving media advocacy, for example, are difficult to evaluate in isolation as they are often one component of a multi-faceted approach. Therefore, we have included interventional approaches in the following summary that are supported by Level 1 evidence as well as those supported by the most extensive Level 2 evidence or where the evidence is still accumulating.

Finally, in some areas, such as in the area of regulatory and economic interventions associated with overweight and obesity, evaluations of effectiveness are essentially lacking. A number of promising interventions can be proposed, however, particularly in light of the known impact of similar interventions for tobacco control.

> *"Those looking for quick, easy solutions, however, be warned: there is no quick fix. To achieve results it will take concentrated, coordinated effort, supported over a number of years."* Standing Committee on Health, *The Path to Health and Wellness: Making British Columbians Healthier by 2010.* November 2004.

Community-based Interventions

- Encouragements to create smoke-free personal environments when children are present, e.g. homes, cars. (Currently level 2 evidence).
- The recent move by the tobacco industry regarding product placement and the glamorization of smoking in movies and television is a trend that requires a response (Currently level 2 evidence).
- Enhanced access to places for physical activity particularly when combined with community social supports such as walking groups (Level 1 evidence).
- Notices encouraging healthy alternatives at the point of decision, such as signs encouraging stairway usage (Level 1 evidence).
- Educational and policy initiatives to encourage sun-safety for adults in recreational settings (Level 1 evidence).

Workplace-based Interventions

- Smoking bans in work and public places to reduce exposure to second hand smoke and to encourage reduced consumption by smokers. (Currently level 2 evidence). Smoking bans in the hospitality industry do not have a negative impact on sales or employment (Level 1 evidence).

School-based Interventions

- School-based physical education to encourage physical activity (Level 1 evidence).
- Involvement of parents together with cafeteria and vending machine changes in the school setting to encourage healthy nutritional choices (Level 1 evidence).
- Subsidized pricing of healthy foods in the school setting. If healthy foods are more affordable than unhealthy one, research has shown a significant shift to higher sales of the healthy foods (Level 1 evidence).
- Educational and policy initiatives to encourage sun-safety in primary schools (Level 1 evidence).

Home-based Interventions

- Family / parental involvement for weight loss in children (Level 1 evidence).
- Behavioural/social approaches to increase physical activity based at home and reinforced by frequent telephone contact, focusing on moderate-intensity physical activity such as walking (Level 1 evidence).

Clinical Interventions and Management

- Intensive counselling, including group therapy, particularly in combination with NRT, to encourage smoking cessation. Youth (including First Nations), pregnant women, and the mentally ill may be particularly effective targets (Level 1 evidence).
- Cessation advice in the context of an adverse health event, particularly when combined with NRT (Level I evidence).

- Involvement of primary care providers in lifestyle interventional input with at-risk patients, including appropriate compensation for this involvement (Level 1 evidence).
- Ensuring that insurance and / or public reimbursement plans cover patient costs for smoking cessation counselling and any nicotine replacement therapy products. While the use of counselling, particularly in combination with NRT, is highly effective (see above), there is currently somewhat limited evidence on whether reimbursement for drug therapy would encourage higher enrolment and subsequent cessations. Given the evidence on the price sensitivity of smokers, reimbursement is likely to encourage additional cessation attempts (Currently level 2 evidence).
- Exercise combined with healthy eating, using behaviour therapy if necessary, for weight loss and the maintenance of weight loss (Level 1 evidence).
- Drug treatment, or surgery, for morbid obesity (Level 1 evidence).

Regulatory and Economic Interventions

- Increasing the unit price of tobacco products through taxation. This may be the single most effective intervention to reduce initiation rates and to encourage cessation efforts. Adolescents in particular are very price sensitive when it comes to the purchase of tobacco products. Marketing efforts by the tobacco industry targeting young people, and the research which indicates that individuals are unlikely to start smoking after the age of 19, strongly support efforts in this area (Level 1 evidence).
- Control of activities promoting tobacco consumption, such as advertising, power wall displays, sponsorship of sporting events, and so on (Level 1 evidence).
- Controlling tobacco sales to minors. The success of interventions in this area is highly dependent on enforcement (Level 2 evidence).

> "*The evidence is clear: a greater focus of effective prevention is a critical part of the health care puzzle that will keep people out of our overcrowded hospital systems, reduce crisis care intervention, reduce death and suffering, and create a healthier, more active and productive population.*" Standing Committee on Health, *The Path to Health and Wellness: Making British Columbians Healthier by 2010*. November 2004.

- Given the importance of the above regulatory and economic interventions in tobacco control, a range of possible similar interventions have been suggested in the area of energy intake. While these promising interventions currently have not been evaluated for effectiveness, they are included here as promising possibilities.
    - Taxes on foods with a low content of a range of nutrients, e.g. soft drinks.
    - Restrictions on advertising, promotion, and sponsorship (especially that directed at young people).
    - Nutrition labelling using a standard format for ingredients and quantities per recognized unit weight.

- Nutrition signposting based on an agreed standard for fat, fibre, vegetable and fruit content which the consumer can recognize as appropriate in a healthy diet.

Comprehensive Strategies

- Multi-component community programs targeting the various risk factors. At a minimum these programs should include school curricular programs with a focus on social influence training plus counter-advertising and other forms of media advocacy that are appropriately designed to be most effective. (Multiple level 2 evidence).

Ongoing Evaluation of Interventions

Interventions designed to enhance healthy behaviours will need to be carefully developed and implemented over the long term. As noted above, there are a number of possible interventions for which the accumulation of evidence is still in its infancy. Furthermore, few successful population-wide strategies exist in the areas of unhealthy diet, physical inactivity and overweight. As noted in *The Path to Health and Wellness: Making British Columbians Healthier by 2010*, "(w)hile proof of successful strategies to reduce obesity and to promote healthy eating and active lives on a population-wide level does not yet exist, many countries are embarking on ambitious programs in a struggle to make a difference" (pg. 4).

Several population-based initiatives have been proposed in Canada and other jurisdictions, especially to control obesity. For example,

- Legislation to regulate portions of a "reasonable" size and enforce disclosure of nutritional content of fast food at point-of-purchase.
- Using taxes and subsidies, change price structures to favour healthy food.
- Remove sales tax on exercise equipment.
- Offer tax incentives to employers providing exercise facilities.
- Taxation to encourage densification and active commuting.
- Urban design to promote walking and bicycling.
- Polices to support adequate income for individuals and families.

The effectiveness of these interventions is not yet known. Many authorities are convinced, in light of the relative ineffectiveness of interventions geared to individuals, that tackling the "obesogenic" environment is definitely the most beneficial way to move forward.

Given this situation, there will be an ongoing need for evaluation of the effectiveness of interventions taken in the British Columbia environment. ***Taking a leadership role will require risks in implementing interventions before others have shown them to be effective.*** Ongoing evaluation of these interventions will allow for the continual reassessment of interventions with appropriate changes based on new evidence.

Taking a leadership role will require risks in implementing interventions before others have shown them to be effective.

A grid to evaluate population health initiatives has been

devised by Glasgow, Estabrooks and colleagues[1373]. Known by the acronym RE-AIM, the intention of their approach is to evaluate health behaviour interventions with a large public health impact.

The five criteria in their planning system are:

Reach:	How do we reach those who need the intervention?
Effectiveness:	How do we know our intervention is effective?
Adoption:	How do we develop organizational support to deliver the intervention?
Implementation:	How do we ensure it is delivered in a high-quality way?
Maintenance:	How do we get the intervention to be delivered over the long term?

To support evaluation initiatives, there is the need to collect high-quality data at the community level. While the Canadian Community Health Survey, utilized extensively in the other components of this project, provides ongoing surveillance at the health services delivery area, many individuals working in the health authorities have noted the need to have more detailed data available for natural communities.

Ongoing research into the mechanisms that influence behaviour change would be critical in appropriately designing, implementing, evaluating and ultimately redesigning interventions.

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Conclusion

In November of 2004, Colin Hansen (Minister of Health Services) noted that "by the time B.C. welcomes the 2010 Winter Olympics and Paralympic Games, we could be the healthiest population ever to act as host. The true legacy of the Games will be more than new buildings or gold medals. It will be a higher standard of health and wellness for all British Columbians."[1374]

The 2010 Olympic Winter Games, with its image of teamwork and peak physical fitness and activity, is a perfect target date for improving population health to levels never before seen in the province. In fact, this may be the opportunity of the century, for it is unlikely that a comparable public focal point with such compatible overtones (i.e., physical health and performance) will come to the province again in the near future. The potential platform for media advocacy alone is staggering. Another advantage is that 2010 is within sight, close enough to begin

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Colin Hansen, Minister of Health

[1373] Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework *American Journal of Public Health* 1999; 89(9): 1322-7.
[1374] Ministry of Health Services. *Toward Better Health Care for British Columbians.* November, 2004. Available at http://www.healthservices.gov.bc.ca/cpa/publications/betterhealthcare_2004.pdf (accessed January 2005).

building some momentum, and yet far enough away to allow some real improvements to be established. And change will beget change, so that there could be a drive towards health improvement that not only builds towards 2010, but extends beyond as one of the real and powerful legacies of the Games.

A positive step in this direction was taken on November 23, 2004 when Premier Gordon Campbell announced an investment of $15.5 million as part of a "comprehensive plan to make B.C. students the healthiest and most physically active in Canada".[1375]

Much, however, remains to be done.

In terms of smoking, it is true that B.C. operates among the elite players in North America, being second only to Utah in terms of the low level of smoking prevalence among its population. But this should not create complacency but instead stir action to go further. There are at least two reasons to keep up the "training" regimen and see even lowers smoking rates emerge by 2010:

- Jurisdictions that have relaxed spending on tobacco control have seen their gains quickly eroded.
- There are still too many smokers in B.C., especially among certain high-risk cohorts.

The best news is that the regimen for increased population performance in terms of smoking is well-established. As this report has confirmed, the top 5 disciplines that should be pursued with redoubled attention and resources include:

- Increased taxation on tobacco products; in terms of increasing cessation or preventing uptake, this works for all segments of the population, including important subgroups such as teens and pregnant women.

- Increased control of activities that promote tobacco consumption, as a further step towards "denormalizing" both smoking and the image of the tobacco industry; this is all part of the environmental changes needed to produce a sustained shift in population health behaviour.

- Increased involvement of all primary care providers in clinical cessation efforts for all smokers and especially at-risk target groups (e.g., the mentally ill, those recovering from illness or preparing for surgery); at the same time as other change agency methods are employed, it is vital to cover the real costs to providers and patients of such cessation interventions (e.g., nicotine replacement therapy).

- Increased high-impact media advocacy; this will work best when counter-advertising is combined with a comprehensive strategy which includes the best school and workplace programs, and initiatives tailored for special

[1375] Office of the Premier. *Province Launches Plan to Help Students Get Healthier*, News Release, November 23, 2004. Available at http://www2.news.gov.bc.ca/nrm_news_releases/2004BCED0077-000987.htm (Accessed January, 2005).

populations; further exploring communication technology (from telephone to the Internet) to support quit attempts should be part of the agenda.

- Increased efforts to enforce smoke-free public places and encourage smoke-free homes and automobiles, especially where children are present.

The best results are going to be seen if each of these circles of activity happen in a consistent and coordinated way; the simultaneous integration of approaches could perhaps be best symbolized by the interlocking Olympic rings themselves.

Although the art and science of controlling weight are less developed than that of tobacco control, one way to "set the pace" as a province is to pursue the most promising interventions even in the absence of complete outcome data. This approach will work if there is a strong commitment to evaluating and adjusting any adopted regimen in mid-course. In this way, learning will be developed that will influence population health not only in B.C. but around the world.

Any "weight training" effort in the province will involve the twin goals of reducing food energy intake and increasing energy expenditure; the latter efforts will have the complementary benefit of improving physical fitness.

The most promising interventions to pursue in an initial obesity control campaign include:

- Increased use of financial levers such as positioning healthy food to be the "low price" choice in the marketplace.

- Increased attention to the environmental signals concerning diet and activity, from the nutrition labelling of products and menu items to the accessibility of good food and attractive exercise options. Controlling the marketing of unhealthy foods to children is an important component of this course.

- Increased clinical counselling programs for diet and exercise changes, with drug therapy and surgery being added in as needed.

- Increased advertising and media advocacy, combined with school physical education, workplace health promotion, and community-wide programs that focus on diet and exercise (the latter enhanced by social support such as walking clubs and personal feedback through technology such as pedometers); the telephone can also be a simple and inexpensive tool to allow follow-up reinforcement.

- Increased involvement of parents in influencing children and modelling healthy diet and activity levels.

This summary has been organized around the same 5 circles seen in tobacco control: financial mechanisms, other environmental signals and supports, clinical interventions, complementary community-wide programs, and, finally, the critical area of influencing the health and healthy choices of the next generations within their everyday domestic environment.

The outcomes in a race are easy to see - who crosses the finish line first. It is important to identify the comparable measurement of success in health promotion so that no intermediate measures distract from the ultimate goal. **What is the "finish line" in population health among British Columbians? It is more than changing beliefs and attitudes, or even shifting intentions; it must be a clear focus on manifestly changing risky behaviours so that disease and disability rates are reduced and well-being, quality of life, and productivity in all spheres of human endeavour are increased.** To this end, British Columbia wants to become the "gold standard" for population health by 2010 and beyond, with an enduring legacy of being the healthiest jurisdiction ever to host an Olympics.

To assist in this worthy goal, the BC Healthy Living Alliance has worked with groups throughout the province in establishing targets for physical activity, healthy eating and living smoke-free.

Setting targets is one thing; achieving them is another.

The present report offers a comprehensive review of the interventions used over the years to control or reduce these risk factors.

The final step in the process will be to use the information in this report, combined with an economic analysis, to select the most cost-effective interventions for a province-wide program aimed at reducing these risk factors and preventing chronic disease. This business plan clearly identifies the resources required, as well as the projected personal and economic benefits, in order for British Columbia to become the "gold standard" for population health by 2010.

Appendix A: Reviews Used in This Report

One influential service for researchers, clinicians, health planners, and policy-makers is the *Cochrane Database of Systematic Reviews* (CDSR or Cochrane). In 1979, the British epidemiologist Archie Cochrane[1376] called for "a critical summary, adapted periodically, of all…relevant randomized controlled trials."[1377] By the early 1990s many practitioners and consumers had fully realized the importance of systematic reviews, in an easily accessible form, for making decisions in healthcare.

Systematic reviews are prepared and maintained by the Cochrane Collaboration in *The Cochrane Library*, along with quality-assessed material on the effects of healthcare interventions submitted by others. The Cochrane Collaboration, made up of various Review Groups, remains a loose-knit organization. Nevertheless, their reports, which are regularly updated as more information becomes available, "are now widely regarded as being of better quality, on average, than their counterparts in print journals."[1378] The CDSR was regularly accessed as an evidence base for the interventions reviewed in this report. This was especially useful when large volumes of studies are available focusing on specific interventions, as is the case for interventions to reduce consumption of and exposure to tobacco.

In this report we accessed many reviews prepared by groups other than the CDSR. For example, the Canadian Task Force on Preventive Health Care (formerly the Canadian Task Force on the Periodic Health Examination) will inform the discussion, as well as a key report from the Canadian Population Health Initiative. Also useful were the assessment programs which exist in the UK (e.g., Health Technology Assessment / National Institute of Clinical Excellence) and in the US (e.g., Surgeon General reports, Task Force on Community Preventive Services or TFCPS, etc.).

The TFCPS bears more comment as it may not be as well known as CDSR, though it has already produced influential evidence reviews for smoking, physical inactivity, and exposure to ultraviolet light, with work on nutrition currently in process. This independent non-federal Task Force makes recommendations for population health programs and policies based on scientific evidence about what practices have worked to improve health. Its main output is the *Guide to Community Preventive Services* (*Community Guide*), which summarizes the scientific literature on a specific topic, evaluates their quality according to established criteria, and makes evidence-based recommendations according to an intervention's proven effectiveness. The continuously updated results have been published on the internet and in various publications since 1999.[1379]

[1376] Hill GB. Archie Cochrane and his legacy. An internal challenge to physicians' autonomy? *Journal of Clinical Epidemiology* 2000; 53(12): 1189-92.

[1377] Source: http://www.update-software.com/history/clibhist.htm#Dickersin_etal1998 (accessed October 2004).

[1378] Jadad AR, Cook DJ, Jones A et al. Methodology and reports of systematic reviews and meta-analyses: a comparison of Cochrane reviews with articles published in paper-based journals *Journal of the American Medical Association* 1998; 280: 278-80. Other review articles are often highly dependent on Cochrane summaries.

[1379] Briss PA, Brownson RC, Fielding JE et al. Developing and using the Guide to Community Preventive Services: lessons learned about evidence-based public health *Annual Review of Public Health* 2004; 25: 281-302.

Cochrane and equivalent systematic reviews tend to focus mainly on randomized controlled trials (RCTs). Well-designed and implemented RCTs are considered the "gold standard" for evaluating an intervention's effectiveness. In the absence of RCTs, however, other methodologically sound studies are sought regarding the effectiveness of an intervention.[1380] For example, in a recent CDSR review[1381] the "authors recognise the possibility of not finding such a design (RCT) for general population prevention studies; therefore the review will include data from 'controlled before-and-after studies' and 'interrupted time series'."

Another potential source of information is general practice guidelines. These are useful as they often attempt to pull together data on a number of interventions; however, such reviews are usually not as up-to-date as CDSR and sometimes lack rigor in ensuring that all claims are linked to evidence.

In addition to accessing review programs and articles, this report will scan the published and 'grey' literature[1382] to identify any more recent studies that are of sufficient quality methodologically to include in the summary of interventions.

[1380] Stroup DF, Berlin JA, Morton SC et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting *Journal of the American Medical Association* 2000; 283(15): 2008-12.

[1381] Gimenez-Perez G, Gonzalez-Clemente JM and Aauricio D. Lifestyle interventions for preventing type 2 diabetes mellitus (protocol). Cochrane Tobacco Addiction Group *Cochrane Database of Systematic Reviews.* 3, 2004. The authors define a controlled before-and-after study "as a design where there is contemporaneous data collection before and after the intervention and an appropriate control site or activity". An interrupted time series is defined as "a design where there is a clearly defined point in time when the intervention occurred and at least three data points before and three after the intervention".

[1382] "Grey literature refers to publications issued by government, academia, business, and industry, in both print and electronic formats, but not controlled by commercial publishing interests, and where publishing is not the primary business activity of the organization. Scientific grey literature comprises newsletters, reports, working papers, theses, government documents, bulletins, fact sheets, conference proceedings and other publications distributed free, available by subscription, or for sale." Weintraub I. *The Role of Grey Literature in the Sciences.* Available at http://library.brooklyn.cuny.edu/access/greyliter.htm (accessed November 2004).

Appendix B: Logic Models and Planning

Logic models provide an analytical tool for examining the purpose and appropriateness of programs, and for identifying key measures of success. A logic model essentially reflects a series of "if/then" statements. If a program engages in activity X, then the result is output Y. If the program produces output Y, then this will cause immediate outcome Z, and so on. A logic model "identifies the linkages between the activities of a policy, program, or initiative and the achievement of its outcomes. It succinctly clarifies the set of activities that make up a policy, program, or initiative and the sequence of outcomes that are expected to flow from these activities. As such, a logic model serves as a 'roadmap,' showing the chain of results connecting activities to the final outcomes and, thus, identifying the steps that would demonstrate progress toward their achievement."[1383]

In May 2003, the Auditor General of British Columbia endorsed the use of logic models to develop performance measurement and accountability frameworks between health authorities and ministries. The report on performance agreements between the British Columbia Ministry of Health Services and the health authorities recommends that "the ministry and the health authorities consider using logic models as part of the process of selecting measures of outcomes for the British Columbia health care system."[1384]

[1383] Treasury Board of Canada. *Guide to the Development of Results-based Management and Accountability Framework.* Available at http://www.tbs-sct.gc.ca/eval/pubs/RMAF-CGRR/rmafcgrr03_e.asp (accessed January 20, 2004).
[1384] Auditor General of British Columbia. *A Review of Performance Agreements between the Ministry of Health Services and the Health Authorities*, May 2003, page 48.