Methodology for Childhood Cancer Surveillance

Study Population

The study population included all children aged 0 to 14 years residing in British Columbia who were diagnosed with cancer. The population at risk includes all children residing in British Columbia during this time period.

1. Data Sources

Registered cases of children diagnosed with cancer were obtained from the BC Cancer Registry, a population-based provincial registry that records diagnostic and demographic data for all incident cancer cases in BC.

Childhood cancers were classified using the International Classification of Childhood Cancers Third Edition (ICCC 3E), a system that emphasizes tumor cell and tissue type (morphology) [1]. While adult cancers are classified using the International Classification of Diseases for Oncology (ICD-O), which primarily groups them by site of origin (topography), the ICCC 3E provides a more appropriate framework for childhood cancers [1].

Population estimates were obtained from the Population Estimates & Projections for British Columbia dashboard [2]. Annual mid-year population estimates from July 1st stratified by age and sex were retrieved for the selected year. For each year of analysis, population denominators were aligned to December 31st of the index year using linear extrapolation between consecutive mid-year population estimates.

Age-standardized incidence and prevalence rates were calculated using the Canadian standard population data, obtained from Statistics Canada [3].

Covariates

Covariates are characteristics that may influence cancer outcomes and are used to describe and stratify the results. The dashboard presents estimates by:

- Age at diagnosis: all ages combined (0-14 years), <1, 1-4, 5-9, 10–14 years.
- Sex recorded in the health record.
- Cancer type and subtype (all cancers combined and ICCC main group and subgroup).

2. Measures & Definitions

Age-standardized rates

The age-standardized incidence and mortality rate (ASIR/ASMR) is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups in a standard

population. This adjustment reduces the effect of differences in age structure over time or between groups. The Canadian standard population from Statistics Canada is used as the standard.

Confidence interval

A confidence interval is the estimated range of values with a given probability that the true value of a variable, such as a rate, is contained within. A confidence interval indicates the precision of an estimate.

Crude rates

Crude incidence or prevalence rates are the number of new cancer cases or prevalent rates per million people in a population during a specific time period.

Incidence Counts

Incidence counts are the number of new cases in the British Columbia population, aged 0-14 years, during a specific time period.

Mortality counts

The number of deaths among children with cancer, aged 0-14 years at time of death. Deaths are assigned to the calendar year in which the death occurred.

Percentage distribution

For all cancers combined, the percentage distribution is the number of new cancer cases by sex divided by the total number of cases for all sexes combined.

Prevalence

Prevalence is the proportion of people alive on a certain date in a population who previously had a cancer diagnosis during childhood (0-14 years). Five-year limited duration prevalence proportions are often calculated and represent the average rates over the previous five years.

3. Analysis Approach

4.1 Incidence

To examine temporal trends in childhood cancer incidence in British Columbia, both crude incidence rates and age-standardized incidence rates (ASIRs) were calculated.

Crude rates were calculated as the annual total of cancer cases per million children in the BC population. Confirmed childhood cancer cases were classified using the ICCC 3E and grouped by diagnosis year, sex, age group, and cancer type. Population counts were derived from BC Stats population projection data.

ASIRs were calculated using the direct method of standardization, with the Canadian standard population. For each diagnosis year, age-specific incidence rates were calculated and then weighted by the proportion of the population in each age group within the standard population. Age groups of interest include: “<1,” “1-4,” “5-9,” and “10-14.”

Given the relative rarity of childhood cancers, particularly when analyses are further grouped by age, sex, or cancer subtype, some incidence estimates are based on small case counts. Due to this, both crude and age-standardized rates may exhibit variability. Any observed fluctuations should therefore be cautiously interpreted, especially for less common cancer subtypes and in years with low incidence counts, where small changes in case counts can result in relatively large changes in estimated rates.

Certain case types were excluded from our analysis:

- Tumor cases with behaviour codes 0 (benign) and 1 (borderline malignant/intermediate behaviour) represent abnormal cellular growths that, unlike malignant tumors, generally lack the capacity to invade surrounding tissues or metastasize to distant sites. Because they do not meet the defining criteria of cancer, these cases are often excluded from incidence analyses in the literature.
- Secondary cancer diagnoses were excluded from the incidence analysis. Instead, a patient-based approach was used where each child was counted once at the time of their first malignant diagnosis and any additional malignant diagnoses occurring within the first 6 months of the previous diagnosis were classified as synchronous and did not classify as separate incidence events. Diagnoses occurring 6 months or more after the previous diagnosis were classified as new primary incidence events. This approach aligns with national and international registry practices and emphasizes the number of affected children rather than the number of tumors.

4.2 Prevalence

Five-year limited duration prevalence was calculated to examine the number of children living with a previous cancer diagnosis who were alive on January 1st of each index year. Prevalent cases were identified by filtering BC Cancer Registry data for diagnoses occurring within each five-year interval of interest (e.g., 2018–2022) and excluding individuals who had died prior to January 1st of the index year.

The age at prevalence date was used to ensure that children were still within the pediatric age range during the prevalence date. This was calculated using the interval between the child's date of birth and the end date of the interval. Only individuals 14 and younger at the prevalence date were included in the analysis.

Crude prevalence proportions per million children in the population were calculated for each interval using BC Stats population data for the pediatric population at the midpoint of each interval. Age-standardized prevalence proportions were calculated using the direct standardization method based on the Canadian standard population. This allowed for comparability across time in data by accounting for changes in the population.

4.3 Mortality

Mortality data were extracted from the BC Cancer Registry for all children aged 0-14 who were diagnosed with cancer. Records were included in the mortality analysis if a valid date of death was recorded.

Mortality counts were summarized to examine temporal patterns in childhood cancer deaths by cancer type, age group, and sex. Given the relatively small number of childhood cancer deaths in British Columbia, death counts were randomly rounded. Similarly, incident and prevalent cases were randomly rounded as well.

Age-standardized mortality rates (ASMRs) were calculated to allow for comparison of mortality over time while accounting for changes in the underlying population age structure. ASMRs were calculated using the direct method of standardization with the Canadian standard population. Age-specific mortality rates were computed for the following age groups: "<1," "1-4," "5-9," and "10-14," and weighted according to the standard population distribution. Mortality rates were pooled into five-year periods to improve stability of estimates and reduce the influence of random year-to-year variation due to small case counts.

Given the rarity of childhood cancer mortality, particularly in more recent periods, ASMR estimates may exhibit variability across time. As such, observed fluctuations should be interpreted with caution and understood in the context of small numbers rather than as definitive evidence of improving or worsening survival trends.

4. References

1. Barr RD, Holowaty EJ, Birch JM. Classification schemes for tumors diagnosed in adolescents and young adults. American Cancer Society [Internet]. 2006;106(6). Available from: https://acsjournals.onlinelibrary.wiley.com/doi/10.1002/cncr.21773
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