CHILDHOOD CANCER IN ONTARIO 1986-2015

A SURVEILLANCE REPORT FROM

POGO

PEDIATRIC ONCOLOGY GROUP OF ONTARIO

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POGO Partner Pediatric Oncology Programs

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Cancer Care Ontario

We thank the staff at Cancer Care Ontario for their work in linking POGONIS data to the Ontario Cancer Registry and the Ontario Registrar General Death File data to allow for population-based capture of subsequent neoplasms and mortality data. Parts of this POGO report are based on data and information compiled and provided by Cancer Care Ontario. However, the analyses, conclusions, opinions and statements expressed herein are those of the authors, and not necessarily those of Cancer Care Ontario.

Additional Data Sources

Statistics Canada
Surveillance, Epidemiology, and End Results Program (SEER)
United States Census Bureau

Database Support

POGONIS 2.0 was developed collaboratively by POGO and Artificial Intelligence in Medicine Inc. (AIM).

Graphic Design

16x9

LIST OF COMMONLY USED ABBREVIATED TERMS

AAC – Average Annual Change

ALL – Acute Lymphoblastic Leukemia

AML – Acute Myeloid Leukemia

ASIR – Age-Standardized Incidence Rate

ASMR – Age-Standardized Mortality Rate

CNS – Central Nervous System

CYP-C – Cancer in Young People in Canada

HGA – High-Grade Astrocytoma

ICCC – International Classification of Childhood Cancer

ICD-O – International Classification of Diseases for Oncology

LGA – Low-Grade Astrocytoma

NIB – Neoplasm of Indeterminate Behaviour

OSP – Overall Survival Proportion

PHI – Personal Health Information

PHIPA – Personal Health Information and Protection Act

POGONIS – Pediatric Oncology Group of Ontario Networked Information System

SEER – Surveillance, Epidemiology, and End Results Program

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EXECUTIVE SUMMARY

Although cancer in children is uncommon, it has profound and wide-reaching impacts on the child, the family and the healthcare system. The objective of this report is to provide information regarding childhood cancer incidence, mortality, survival and prevalence in Ontario. The report describes the patterns and trends in the occurrence of cancer in children in order to facilitate and support service delivery planning, policy development and research, with the ultimate goal of improving the well-being of Ontario's children with cancer, survivors of childhood cancer and their families. This report addresses one of the five goals of the *Childhood Cancer Care Plan: A Roadmap for Ontario 2018–2023* [1], to ensure the right data are available and being used to drive an effective childhood cancer system.

Children diagnosed with cancer between 0 and 14 years of age are the focus of this report, with the exception of data related to prevalence, which is based on individuals aged 0–19 years diagnosed with cancer.

Incidence

KEY MESSAGE: A diagnosis of childhood cancer is relatively rare. However, the incidence of childhood cancer in Ontario is increasing.

IMPLICATION: Research into the causes of childhood cancer is needed.

SUMMARY OF FINDINGS:

- In this report, 10,339 children in Ontario, aged 0 to 14 years, were diagnosed with cancer over a 30-year period (1986-2015) and treated at a pediatric oncology program in Ontario.
- A trend toward increasing incidence of childhood cancer in Ontario was observed over the 30-year period, with the rate increasing by approximately 1% per year.
- Despite this trend and given the relative rarity of childhood cancer, incidence rates fluctuate year over year, at times dramatically, and particularly so for subgroups of childhood cancer.
- In the most recent 5-year period, childhood cancer was diagnosed at a rate of 181.5 new cases per million children, an average of approximately 395 new cases per year.
- More boys were diagnosed with cancer than girls for all cancers combined.
- Patterns of diagnoses varied greatly between age groups.
    - » In infants under the age of 1, neuroblastoma accounted for 24.9%, followed by leukemias (17.3%) and central nervous system (CNS) tumours (14.6%).
    - » Among 1–4 year olds, leukemias were the most common diagnoses (41.8%), followed by CNS tumours (20.6%) and neuroblastoma (9.1%).
    - » Among 5–9 year olds, leukemias and CNS tumours were the most common diagnoses (32.7% and 30.3% respectively). However, lymphomas became increasingly more common, accounting for 13.9% of incident cases.
    - » Among 10–14 year olds, CNS tumours were the most common diagnoses (25.9%), followed by leukemias (21.9%) and lymphomas (20.6%).

- Leukemias (50.2 per million), CNS tumours (37.8 per million) and lymphomas (18.7 per million) were the most common types of new cases of cancer.

Mortality

KEY MESSAGE: Mortality due to childhood cancer has remained stable over the past 25 years in Ontario.

IMPLICATION: Cancer remains the most common cause of disease-related deaths among children in Canada over the age of 1 year.

SUMMARY OF FINDINGS:

- Over a 25-year period (1991–2015), age-standardized mortality rates (ASMRs) among children aged 0-14 years, diagnosed with cancer in Ontario between 1986 and 2015, have remained stable, at an average annual rate of 35 deaths per million population.
- Differences in the patterns and trends of mortality exist by specific cancer types, where leukemias were the only diagnosis group which demonstrated a significant average annual decline in the number of deaths (-0.223 per million population per year).
- The ASMRs for each International Classification of Childhood Cancer (ICCC) diagnosis group were similar, ranging from 0 to 16 deaths per million population per year.
- The distribution of deaths by age group at diagnosis is similar to the distribution of incident cases by age group. The majority of deaths occurred amongst children diagnosed between 1–4 years of age (32.4%), 10–14 years of age (28.6%), and 5–9 years of age (28.2% of deaths). The remaining 10.8% of deaths occurred amongst infants diagnosed with cancer at age <1 year.

Survival

KEY MESSAGE: The survival rates are continuing to improve for many, but not all, types of childhood cancer.

IMPLICATION: Novel treatments will be required to cure more children with poor prognosis, while reducing the intensity of treatment may improve outcome for those currently with high cure rates.

SUMMARY OF FINDINGS:

- For children, aged 0–14 years, diagnosed with cancer between 1986 and 2015, the 5-year overall survival proportion (OSP) for all cancers combined has increased significantly, from 75.0% (1986–1990) to 86.2% in the most recent 5-year period (2011–2015).
- Despite continued improvements in survival, childhood cancer survival rates differ by age and cancer type.
    - » Over the most recent 10-year period (2006-2015), infants diagnosed under the age of 1 year had the lowest 5-year OSP among all age groups (79.5%), while children aged 1–4 years at diagnosis had the highest 5-year OSP among all age groups (86.8%).

- Over the most recent 5-year period (2011-2015):
  - the highest 5-year OSPs were observed amongst children diagnosed with renal tumours (97.7%), retinoblastoma (95.5%), germ cell tumours (93.2%), acute lymphoblastic leukemia (92.9%), lymphomas (92.1%), and other and unspecified tumours (ICCC Groups XI and XII, 90.4%).
  - the poorest 5-year OSPs were observed amongst children diagnosed with high-grade astrocytomas (33.9%), acute myeloid leukemia (61.8%), malignant bone tumours (67.9%) and soft tissue sarcomas (77.6%).

Prevalence

KEY MESSAGE: The prevalence of childhood cancer survivors has risen steadily due to the increasing incidence of childhood cancer, combined with marked improvements in survival over the last few decades.

IMPLICATION: Caring for survivors of childhood cancer is increasingly important given the growing population and increased healthcare needs that are associated with late effects of treatment.

SUMMARY OF FINDINGS:

- As of January 1, 2014, there are an estimated 17,750 childhood cancer survivors in Ontario diagnosed with cancer at any point in time between ages 0 and 19 years.
- The estimated prevalence increased by over 20% over an 8-year period (2007-2014).
- Over time, an increasing proportion of childhood cancer survivors will be adults, accounting for 75% of the total estimated prevalence in 2014.
- As of January 1, 2014, it is estimated that 1 in 500 adults between 20 and 39 years of age is a childhood cancer survivor.
- Prevalence varies by attained age: nearly 50% of childhood cancer survivors are <30 years of age.

INTRODUCTION

Although cancer in children is uncommon, it has profound and wide-reaching impacts on the child, the family and the healthcare system.[2] Despite significant improvements in survival over the last three decades, childhood cancer remains the leading cause of disease-related death in Canadian children over the age of 1 year.[3]

Cancers in children differ from those that occur in adults in many respects. Childhood cancers are less common, with less than 1% of all new cancers in Ontario diagnosed in children and adolescents under the age of 20.[4] Childhood cancers may also differ from adult cancers in the way they grow and spread, how they are treated and how they respond to treatment. Currently, only a small proportion of childhood cancers have known causes, limiting the potential for primary prevention.[5,6] The majority of cancers in adults are carcinomas of the epithelial tissues that line organs, such as the breast, lung, colon and prostate. However, childhood cancers are more likely to be embryonic or hematopoietic (arising in the blood or lymphatic cells and tissues) in origin.[5-7] Leukemias, lymphomas and central nervous system (CNS) tumours are the most common types of cancer diagnoses in children.[2,6]

The management of childhood cancer is complex, intensive and costly [8,9], with care in Ontario delivered primarily in specialized, pediatric oncology programs in five tertiary care hospitals. The social and financial impact of childhood cancer is especially significant for families who reside outside of these catchment areas.[10] Because of the intensity of treatment, the young age of many of the families, and the uncertain outcome of treatment, in terms of both survival and potential late effects of treatment, the impact of the diagnosis and treatment of childhood cancer is significant.

With marked improvements in survival over the last few decades, the number of survivors of childhood cancer has increased steadily. Improved survival has placed increased importance on understanding the long-term consequences of cancer in childhood and its treatment. Childhood cancer can lead to a high burden of late effects related to physical and psychological health, and neurocognitive and psychosocial impacts.[11-15] It is estimated that more than 60% of childhood cancer survivors experience at least one chronic condition and almost 30% have a severe or life-threatening health condition.[16,17] Late effects related to physical health can include damage to major organs, infertility and increased risk of developing second cancers due to treatment.[18-22] A portion of survivors of childhood cancer also experience difficulties related to education, employment, social welfare and financial stability.[23-26]

About POGO

POGO's mission is to ensure access to and availability of state-of-the art cancer care for all of Ontario's children, and to improve the circumstances of all children who are afflicted with cancer and those of their families and caregivers. As a collaboration of care providers and stakeholders, POGO plans for provincial needs and provincial coordination and is the official advisor to the Ontario Ministry of Health and Long-Term Care (the Ministry) on children's cancer control and treatment. *The Childhood Cancer Care Plan: A Roadmap for Ontario 2018-2023* is the fifth provincial pediatric oncology plan led by POGO.

POGO is a collaboration of the five specialty pediatric cancer programs within academic tertiary hospitals in Ontario,[1] and the community hospitals and cancer centres that deliver POGO programs, including:

- patient care programs (i.e., the POGO Pediatric Oncology Satellite Clinic Program and POGO Interlink Community Cancer Nursing Program);
- supportive programs for families during active cancer treatment (via the POGO Financial Assistance Program); and
- survivor care programs (including long-term follow up clinics in POGO's AfterCare Program, and academic and vocational counselling through POGO's Successful Academic and Vocational Transition Initiative or SAVTI).

POGO also plays an important role in providing researchers, hospitals and the Ministry with the most up-to-date and accurate population-based childhood cancer surveillance statistics to inform childhood cancer control policies and high-quality patient care. As part of POGO's mandate for advancing and monitoring the childhood cancer system, POGO has, since 1985, actively and prospectively collected sociodemographic, diagnostic, therapeutic and outcome data on each new case of childhood cancer diagnosed and treated at one of the five specialty pediatric oncology programs in Ontario through the Pediatric Oncology Group of Ontario Networked Information System (POGONIS).[27]

1 Includes Children's Hospital, London Health Sciences Centre (London); Children's Hospital of Eastern Ontario (Ottawa); Kingston Health Sciences Centre, Kingston General Hospital Site (Kingston); McMaster Children's Hospital, Hamilton Health Sciences (Hamilton); and The Hospital for Sick Children (Toronto).

MILESTONES IN CHILDHOOD CANCER SURVEILLANCE IN ONTARIO AND POGONIS

POGONIS (Pediatric Oncology Group of Ontario Networked Information System) is an active, population-based registry of incident cancer cases since 1985, diagnosed and/or treated in one of the five centres with a specialty pediatric oncology program in Ontario. It is one of the most comprehensive of its kind in North America. POGONIS is being actively used for monitoring and surveillance to generate new research into various facets of childhood cancer and to generate data to inform program and policy development.

1985

A pediatric cancer registry, designed to record incident (new) cases by active registration, is created and begins capturing data. Data elements are restricted to demographic and diagnostic information, and data managers enter information into a simple electronic database. Comparison with the Ontario Cancer Registry reveals that a proportion of children are being treated at institutions other than within one of the five specialty pediatric oncology programs in Ontario.

1995

Data scope is extended to encompass standardized treatment information and key outcomes. POGONIS, an electronic, networked, relational database, is born. The system is developed in collaboration with Artificial Intelligence in Medicine Inc. The Ontario Ministry of Health and Long-Term Care financially supports the creation of POGONIS and its ongoing maintenance and data collection.

2003

POGO publishes "Childhood Cancer Registries in Ontario, Canada: Lessons Learned in Comparison of Two Registries" in *International Journal of Cancer* [28] , evaluating the quality and completeness of the two registries and describing age-related variation in locations where children with cancer receive treatment.

2004

POGO receives 45 Entity Status under Ontario's Personal Health Information Protection Act (PHIPA), allowing POGO to collect, use and disclose personal health information for analysis and research purposes and to permit linkages with other 45.1 entities and other population-based data holdings, e.g., Cancer in Young People in Canada (CYP-C), the national surveillance database of the Public Health Agency of Canada.

2006

With 20 years of data collected, POGO publishes its first paper on incidence trends and projections of childhood cancer in Ontario in the *International Journal of Cancer*, using population-based POGONIS data.[29]

2008

POGONIS 2 is reorganized as a patient/event-driven data model, enabling capture of key events in diagnosis, treatment and outcomes, including survival and other late effects, in a chronological timeline. This model also provides enhanced data management controls for data quality; enhanced exportability for linkage and researcher use; and enhanced data security compliance.

2010 to 2013

POGO retrospectively collects treatment data not captured on the original cohort registered between 1985 and 1995. This effort is funded by operating grants from the Canadian Institutes of Health Research and the Canadian Cancer Society, Ontario Division. POGONIS now contains detailed demographic, diagnostic, treatment and outcome data for the entire cohort, starting in 1985, enhancing the usefulness of POGONIS for the study of many population-based outcomes.

2015

POGO publishes the "Atlas of Childhood Cancer in Ontario 1985-2004," the first comprehensive overview of childhood cancer trends in the province.

2017

POGO completes a mapping table for its pediatric nomenclature that incorporates the 12 diagnostic groups/subgroups of the International Classification of Childhood Cancer (ICCC-3) and the last three versions of the World Health Organization's (WHO) International Classification of Diseases for Oncology (ICD-O).

2018

POGONIS data collection is being streamlined and alignment with CYP-C is being strengthened to enable more pan-Canadian comparisons.

Purpose of this Report

The objective of this report is to provide surveillance information regarding childhood cancer incidence, mortality, survival and prevalence in Ontario. It describes the patterns and trends of the occurrence of cancer in children in the population, including the number of children affected, their age and sex, the types of cancers they experience and their survival outcomes following a diagnosis of cancer. This information also provides the basis for new research questions and may influence the study of causation, particularly when combined with contemporary molecular biology. Lastly, this report will enable an understanding of healthcare utilization and system needs, prediction of future needs, and healthcare resource and system planning.

This report is intended to support healthcare professionals, researchers, health system planners, policymakers and the public health community in planning, investigating, measuring, monitoring and evaluating childhood cancer-related health programs and initiatives. This report may also be useful for patients, survivors of childhood cancer, their families, and the general public and the media with an interest in childhood cancer.

Data Sources

Childhood cancer data collection

Childhood cancer data were obtained from POGONIS. Dedicated data managers/clinical research associates, funded by the Ministry, actively collect standardized POGONIS data at each tertiary hospital based on comprehensive hospital chart review, internal hospital information systems and direct connections with the patient's healthcare team. POGONIS captures detailed clinical information and specifics regarding children's demographic information, their diagnosis of cancer, treatment, complications and long-term outcomes.

Under the Ontario Personal Health Information Protection Act (PHIPA), POGO is a "prescribed entity" and is authorized to collect, use and disclose personal health information (PHI) for the purposes of analysis or compiling of statistical information with respect to the management, evaluation or monitoring of the allocation of resources to, or planning for, all or part of the health system, including the delivery of services. PHI must be held, used and disclosed under the strict security specifications outlined and enforced by the office of Ontario's Information and Privacy Commissioner. POGO has created and operationalized detailed policies and procedures that govern all aspects of the collection, use and disclosure of PHI. These are detailed in POGO's Privacy and Data Security Code and its procedures.

Additionally, this designation permits POGO to establish linkages between POGONIS and other large, designated administrative databases, creating the potential for more in-depth studies related to epidemiology, outcomes, health service utilization and health economics.

Enhancement of POGONIS capture of death data

To systematically capture deaths in the entire cohort (from 1986 to 2015), regardless of location and age at death, death information is identified via record linkage to the Ontario Cancer Registry and the Ontario Registrar General Death File under a data sharing agreement with Cancer Care Ontario.

Population data for calculating standardized incidence and mortality rates

All standardized rates in this report are based on the 2011 Canadian census population, obtained from Statistics Canada. [30]

Complete Prevalence Estimates for Ontario

Given that POGONIS began capturing data on incident childhood cancers in Ontario in 1985, complete Ontario registry-based estimates of all-time prevalence in Ontario were not feasible for the purposes of this work.[28]

To address this limitation, cancer statistics data from the United States' (US) Surveillance, Epidemiology, and End Results Program (SEER) were adjusted for the size and composition of the Ontario population to estimate the total number of childhood cancer survivors diagnosed between 0 and 19 years of age in Ontario, including those diagnosed prior to 1985.

Methods & Data Notes

The POGONIS database classifies childhood cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3).[31] This system groups similar cancers into 12 main diagnostic groups and 47 subgroups for additional refinement. Only select diagnostic subgroups are presented in this report in detail. The classification of each case applied in this analysis is true to the timing of the diagnosis and the associated International Classification of Diseases for Oncology (ICD-O) morphology code for that period. Because the ICCC-3 (published in 2005) does not incorporate coding changes made in the updated version of the ICD-O-3 system (ICD-O-3.1, published in 2013), POGO has incorporated changes to the ICD-O-3.1 codes into the ICCC classification, based on Ontario clinical and epidemiological expertise. Specific details of the differences in coding between POGONIS and the ICCC-3 are available in the **Technical Appendix**.

In this report, children diagnosed under the age of 15 years and residents of Ontario, who were treated in a pediatric oncology program in Ontario, with a diagnosis included in the POGO updated ICCC-3 coding system, were included in the incidence, mortality and survival analyses. This age range (0-14 years) aligns with international childhood cancer surveillance reporting. Children who were not residents of Ontario but were diagnosed and/or treated in a POGO-affiliated pediatric oncology program were excluded from these analyses. In addition, cases not diagnosed and fully treated in a POGO-affiliated pediatric oncology program were excluded.

Rates were calculated, regardless of the number of aggregated cases, unless otherwise specified. Given the relative rarity of some cancers, the rates presented in this report should be interpreted with caution, as it can be difficult to distinguish differences over time based on random variation from true differences when the number of cases is small. In addition, the numbers published in this report reflect the state of POGONIS as of December 2017. Therefore, these analyses should be considered provisional, as a few cases and deaths may be registered in subsequent years.

It is important to note that this document contains both actual and estimated rates and cases; distinctions are made for estimated rates/cases only. Most notably, this report used SEER cancer statistics data (for individuals aged 0-19 years at diagnosis) and data from the US Census Bureau to generate age-specific prevalence rates in the US, adjusted for the size and composition of the Ontario

population. As such, the presented prevalence data should be interpreted with caution, due to differences in data sources (the US cancer registry being passive and mostly adult versus POGONIS as an active, pediatric cancer-specific registry), populations and health system contexts. These differences may result in a slight overestimate of the complete prevalence of childhood cancer in Ontario.

Further details regarding the methods and data sources used in this report are summarized in the **Technical Appendix**.

CHAPTER 1

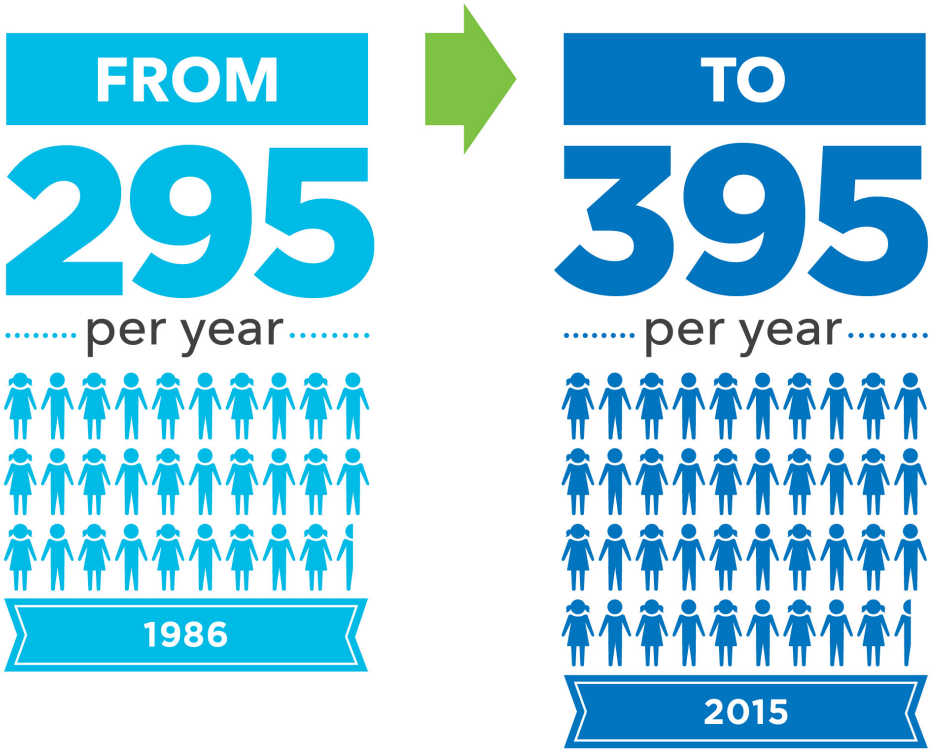
CHILDHOOD CANCER INCIDENCE RATES AND TRENDS

The incidence (i.e., number of new cancer cases) and incidence rates provided in this chapter are based on all childhood cancer patients (aged 0-14 years at time of diagnosis) diagnosed between 1986 and 2015 and registered in POGONIS. Every occurrence of childhood cancer is considered an incident (or new) case. In patients diagnosed with a subsequent, different primary cancer during follow up, each cancer was considered an incident case.

Included with each figure is the average annual change (AAC) in age-standardized incidence rate (ASIR) and associated p-value, estimated using linear regression. This statistical test assesses if the AAC is different from zero. P-values equal to or less than 0.05 indicate the change is statistically significant. Given the relatively rare nature of pediatric cancer, the yearly ASIR fluctuates from year to year, sometimes dramatically. For this reason, it is important to consider the p-value when trying to ascertain if trends over time are due to normal statistical variation. See Technical Appendix for further methodological details.

Incidence of Childhood Cancer in Ontario (for all cancers combined)

Each year in Ontario, the number of new cancer cases and the incidence rate of childhood cancer amongst 0-14 year olds has increased since 1986.



Over the 30 years covered (1986 to 2015), 10,339 cases of cancer were diagnosed among those aged 0 to 14 years in Ontario and were registered in POGONIS. Cancer in children aged 0 to 14 years accounts for <1% of the total cancer incidence.[4] The ASIR of childhood cancer increased from 148.5 per million to 196.8 per million, an increase of 32% over the 30-year period (or 1.34 per million population) **(Figure 1.1)**. This increase in the ASIR reflects a 50% increase in the actual number of new cancer cases in children, from 284 in 1986 to 427 in 2015 **(Figure 1.1)**. The increase in the number of new cases over this time period may be due to a combination of the increasing incidence of childhood cancer, as well as a slight increase in the population of children living in Ontario (i.e., an average annual increase of 0.05% per year).[30]

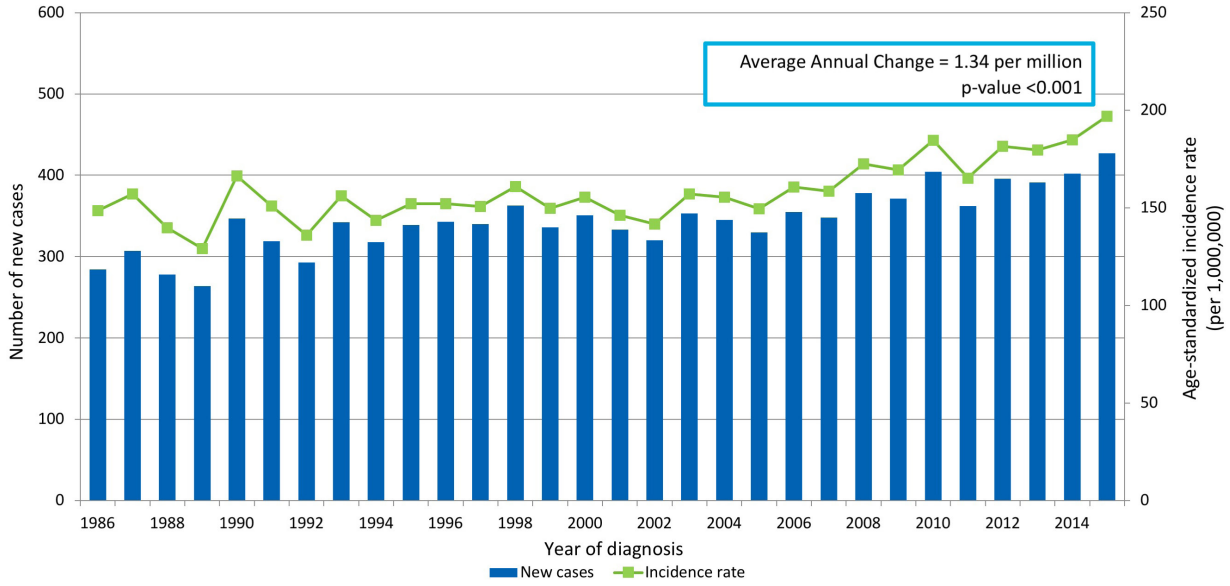
Incidence Rates are Higher in Boys than in Girls

Overall, from 1986 to 2015 in Ontario, childhood cancers occurred more frequently in boys than in girls, with a sex ratio (male:female cases) of 1.21:1 **(Figure 1.2)**. The mean ASIR for boys in this period is 169.4 per million. Between 1986 and 2015, the ASIR significantly increased from 165.2 per million to 215.0 per million, an increase of 1.26 per million per year. This increase is less than the increase seen among girls.

From 1986 to 2015 in Ontario, childhood cancers occurred less frequently in girls than in boys, with a sex ratio (female:male cases) of 0.83:1 **(Figure 1.3)**. The mean ASIR for girls in this period is 146.7 per million. Between 1986 and 2015, the ASIR significantly increased from 131.0 per million to 177.6 per million, an increase of 1.42 per million per year. This increase in incidence rate is greater than the increase seen among boys.

FIGURE 1.1

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, ALL CANCERS COMBINED, AGED 0-14 YEARS, ONTARIO, 1986-2015



For Figures 1.1-1.3

1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) 3.1 system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Source: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO*

FIGURE 1.2

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, ALL CANCERS COMBINED, BOYS, AGED 0-14 YEARS, ONTARIO, 1986-2015

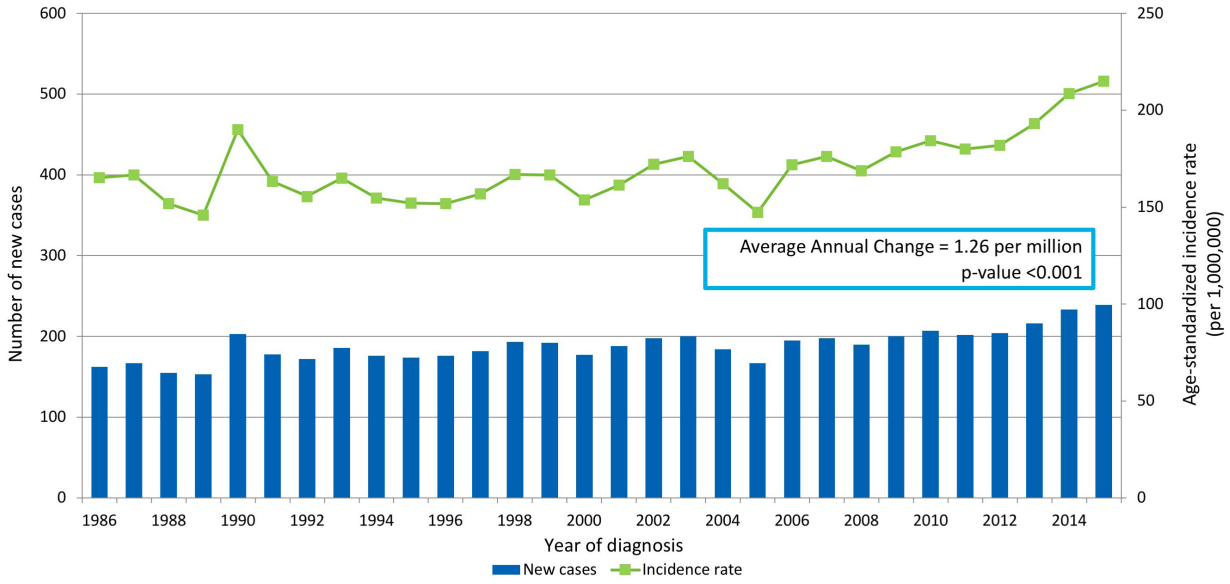
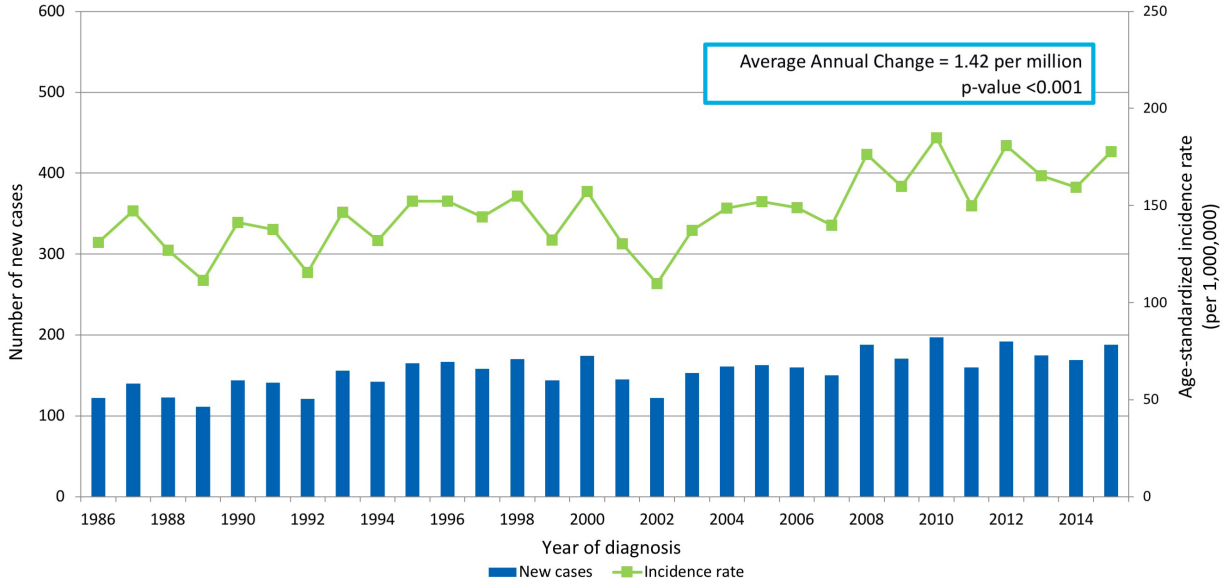


FIGURE 1.3

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, ALL CANCERS COMBINED, GIRLS, AGED 0-14 YEARS, ONTARIO, 1986-2015



Incidence by Type of Childhood Cancer

Over the past 30 years in Ontario, the most common types of cancer in children were leukemias (31.6%), CNS tumours (24.0%) and lymphomas (12.0%), accounting for over 65% of all new childhood cancer diagnoses in Ontario.

Leukemias (50.2 per million), CNS tumours (37.8 per million), and lymphomas and reticuloendothelial neoplasms (18.7 per million) were the most common incident cancers in children in Ontario. The disease-specific ASIR per year is provided for each main category of the ICCC-3 classification system.

Table 1 provides the number of new cases diagnosed, along with the ASIR, for 5-year periods by ICCC-3 main diagnosis group, stratified by sex. Average annual case counts and the associated ranges are provided. Overall, there was an average of 296 cases diagnosed per year in the earliest 5-year period (1986-1990), while in the latest 5-year period (2011-2015), there was an average of 396 cases diagnosed per year. The sex distribution of cases has remained stable throughout the time period.

Leukemias, Myeloproliferative Diseases and Myelodysplastic Diseases

ICCC-3 Group I includes lymphoid leukemia, acute myeloid leukemia (AML) and myeloproliferative diseases, which combined, have an average ASIR of 50.2 per million over the entire 30-year period (**Figure 2.1**). The rate is overwhelmingly represented by lymphoid leukemia (often referred to as acute lymphoblastic leukemia or ALL). Statistically significant annual increases in the incidence is estimated at 0.52 cases per million per year. Approximately 129 incident cases were diagnosed with leukemias in Ontario per year amongst children over the most recent 5-year period (2011–2015). The 2001 version of the International Classification of Diseases for Oncology (ICD-O-3) incorporates myelodysplastic disorders of the bone marrow in the leukemia category and therefore assigns them a malignant behaviour code. Myelodysplastic disorders were not considered malignant in prior versions of the ICD-O. These codes account for approximately 2.7% of total cases with leukemias, diagnosed between 2001–2014.

Lymphomas and Reticuloendothelial Neoplasms

ICCC-3 Group II includes Hodgkin lymphoma, non-Hodgkin lymphoma, Burkitt lymphoma, miscellaneous reticuloendothelial neoplasms and unspecified lymphomas. The average ASIR for lymphomas and reticuloendothelial neoplasms in Ontario over the 30-year period is 18.7 per million **(Figure 2.2)**, with an average of 43 incident cases per year. There is no obvious change in the Ontario incidence rate over the entire period.

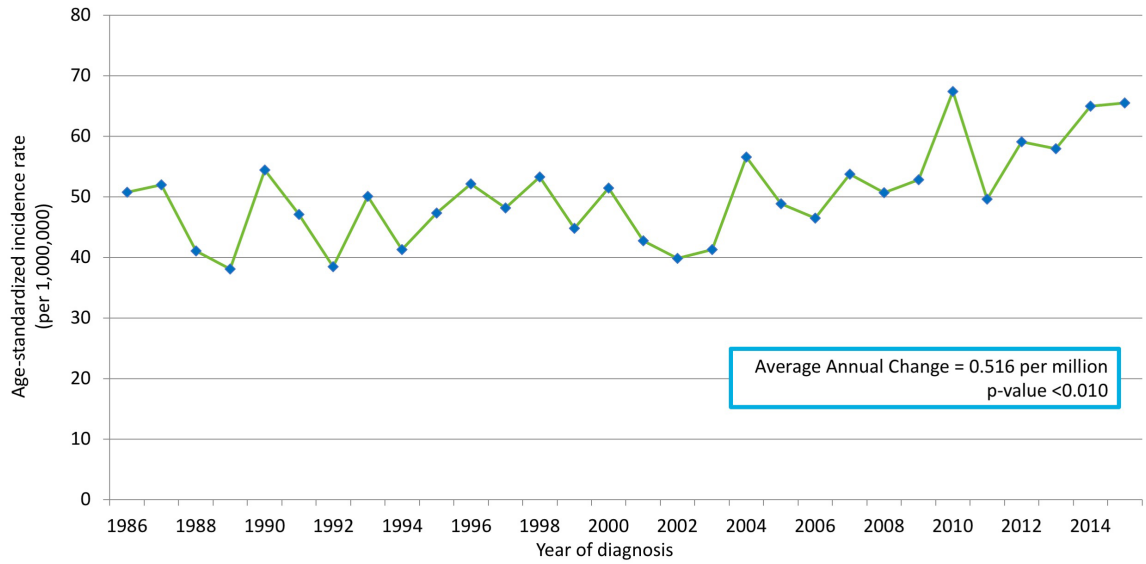
CNS and Miscellaneous Intracranial and Intraspinal Neoplasms

ICCC-3 Group III includes ependymomas, astrocytomas, intracranial and intraspinal embryonal tumours, other gliomas and other specified intracranial and intraspinal neoplasms. In this category, certain neoplasms are included that are not considered malignant in adult populations. In particular, juvenile pilocytic astrocytoma and other low-grade astrocytomas (LGA), classified in ICD-O as neoplasms of uncertain behaviour and allocated a behaviour code of 1, are included in the ICCC-3 (ICD-O assigns a behaviour code of 3 to malignant neoplasms, 0 to benign neoplasms and 1 to neoplasms of indeterminate behaviour). This group with neoplasms of uncertain behaviour constitutes about 45%

of astrocytomas among people under 20 years of age.[32] The average ASIR for CNS tumours in Ontario over the 30-year period is 37.8 per million **(Figure 2.3)**, with an average of 92 incident cases per year over the most recent 10-year period (2006–2015). Statistically significant annual increases in the incidence of CNS tumours is estimated at 0.34 cases per million per year. It is important to note that approximately 6.2% of the incident CNS cases diagnosed between 2000–2015 were attributable to additions and changes to the ICD-O coding system over that time period.

FIGURE 2.1

AGE-STANDARDIZED INCIDENCE RATES OF LEUKEMIAS, MYELOPROLIFERATIVE DISEASES AND MYELODYSPLASTIC DISEASES IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015



For Figures 2.1-2.10

1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Source: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO*

FIGURE 2.2

AGE-STANDARDIZED INCIDENCE RATES OF LYMPHOMAS AND RETICULOENDOTHELIAL NEOPLASMS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

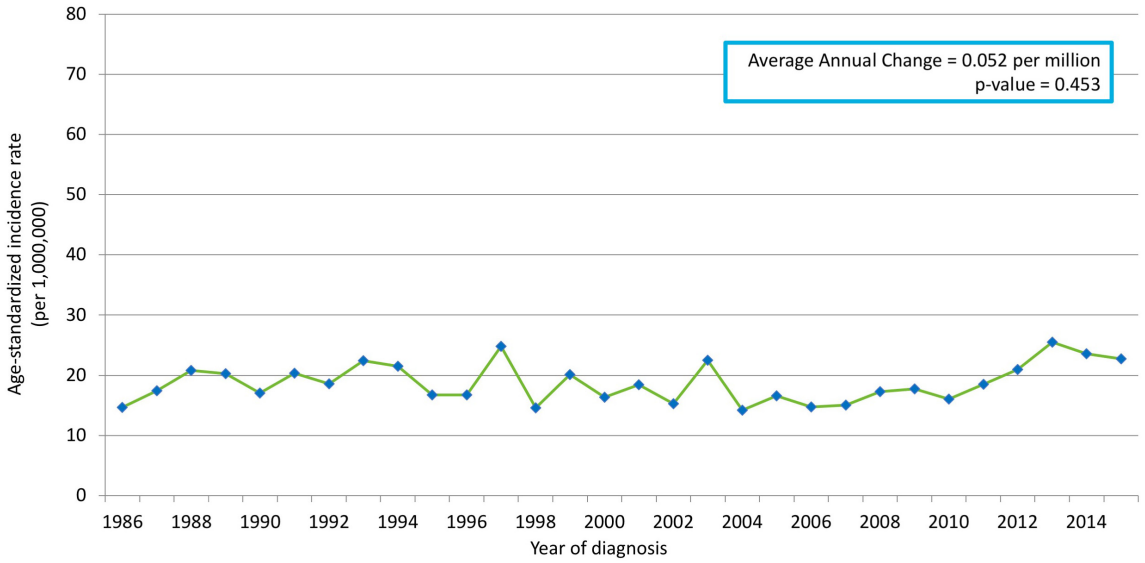


FIGURE 2.3

AGE-STANDARDIZED INCIDENCE RATES OF CENTRAL NERVOUS SYSTEM AND MISCELLANEOUS INTRACRANIAL AND INTRASPINAL NEOPLASMS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

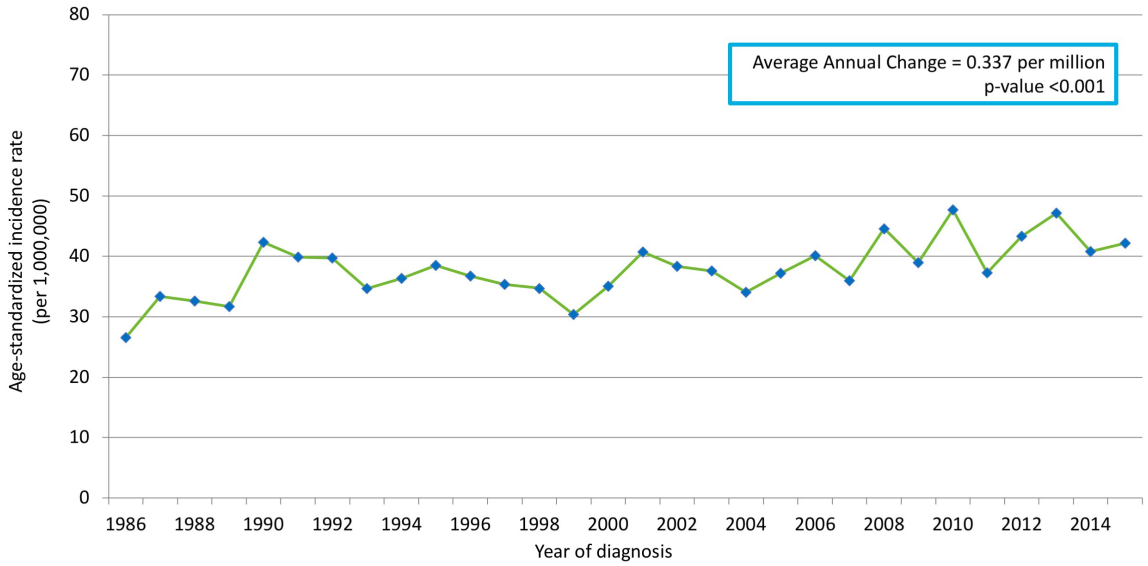
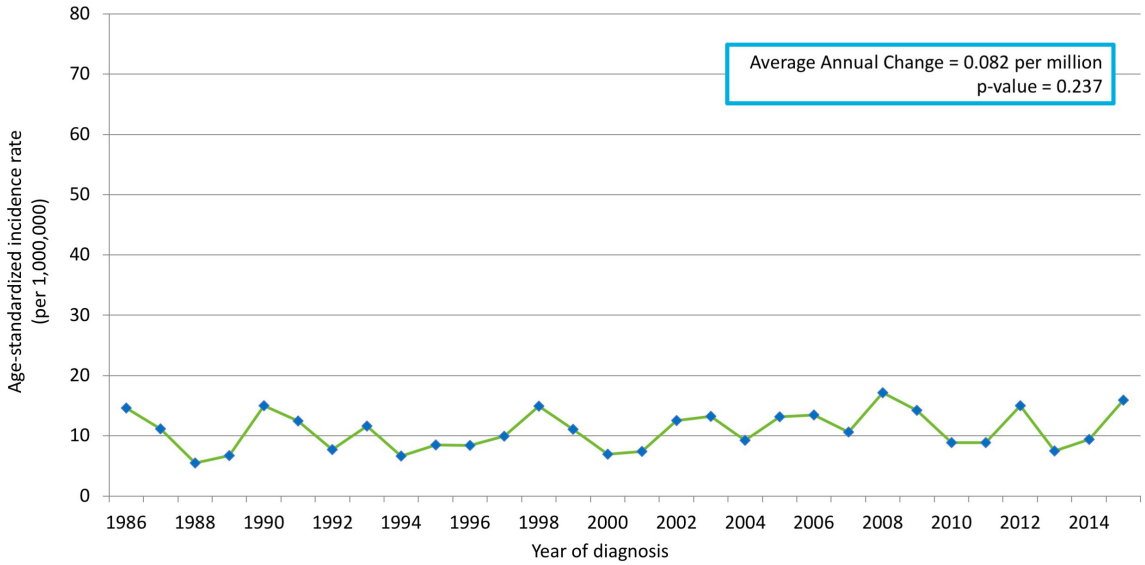


FIGURE 2.4

AGE-STANDARDIZED INCIDENCE RATES OF NEUROBLASTOMA AND OTHER PERIPHERAL NERVOUS SYSTEM TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015



Neuroblastoma and other Peripheral Nervous System Tumours

The average ASIR for neuroblastoma in Ontario over the 30-year period is 10.9 per million **(Figure 2.4)**, with an average of 26 incident cases diagnosed per year in Ontario in the most recent 10-year period (2006–2015). This ASIR has been relatively stable over the last three decades.

Retinoblastoma

The average ASIR for retinoblastoma in Ontario over the 30-year period is 4.5 per million **(Figure 2.5)**, with an average of nine incident cases diagnosed per year in Ontario. This ASIR has been relatively stable over the last three decades.

Renal Tumours

This ICCC-3 category (Group VI) encompasses nephroblastoma, clear cell sarcoma, renal rhabdoid tumours, renal cell carcinoma and unspecified malignant renal tumours. Together, clear cell sarcoma and renal rhabdoid tumours constitute less than 5% of renal tumours. The overall ASIR for renal tumours in Ontario over the 30-year period is 8.1 per million per year **(Figure 2.6)**, with an average of 17.5 incident cases diagnosed per year. This ASIR has been relatively stable over the last three decades.

Hepatic Tumours

This ICCC-3 category encompasses hepatoblastoma and hepatic carcinomas. The overall ASIR for hepatic tumours in Ontario over the 30-year period is 2.4 per million per year **(Figure 2.7)**, with an average of five incident cases per year. This ASIR has been relatively stable over the last three decades.

FIGURE 2.5

AGE-STANDARDIZED INCIDENCE RATES OF RETINOBLASTOMA IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

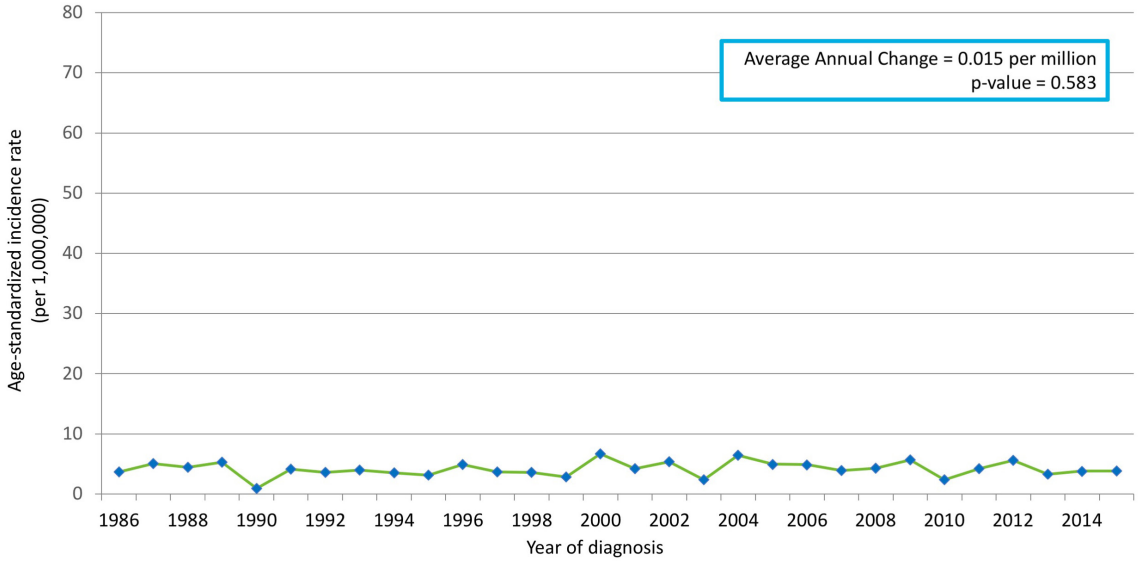


FIGURE 2.6

AGE-STANDARDIZED INCIDENCE RATES OF RENAL TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

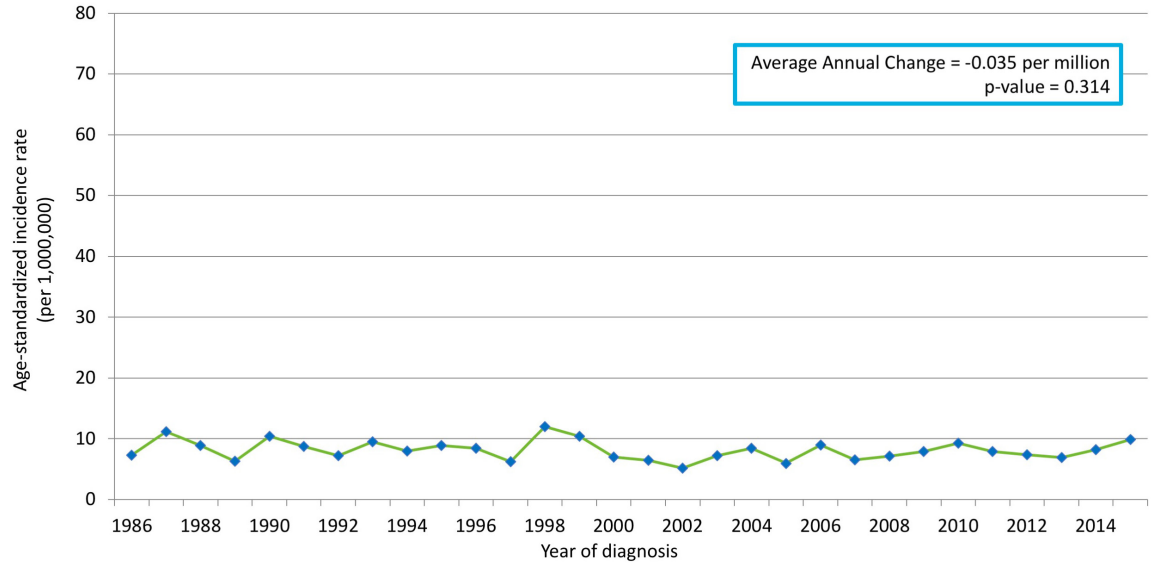


FIGURE 2.7

AGE-STANDARDIZED INCIDENCE RATES OF HEPATIC TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

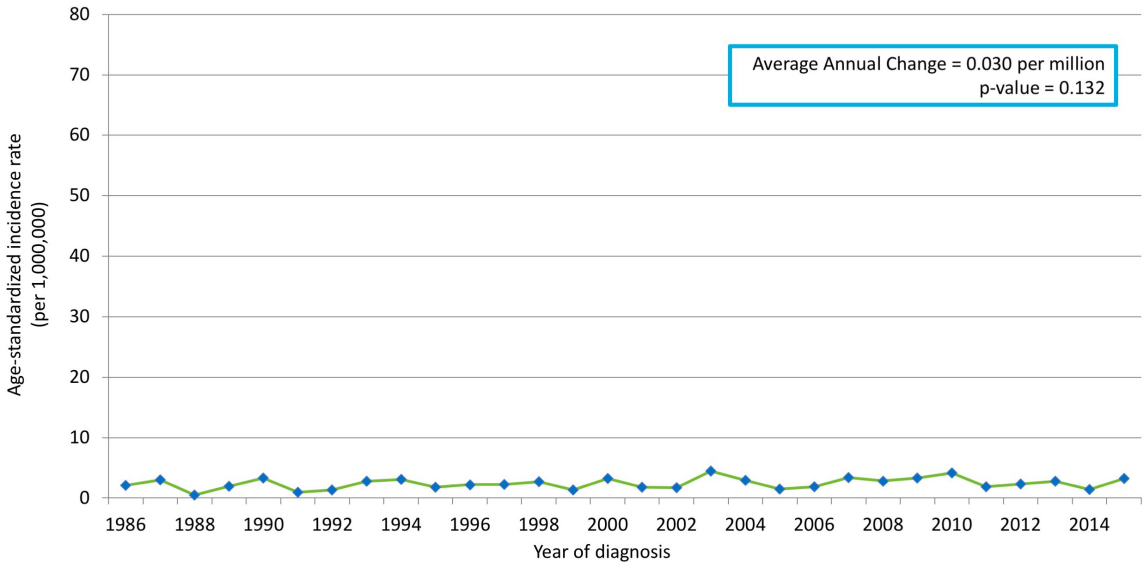
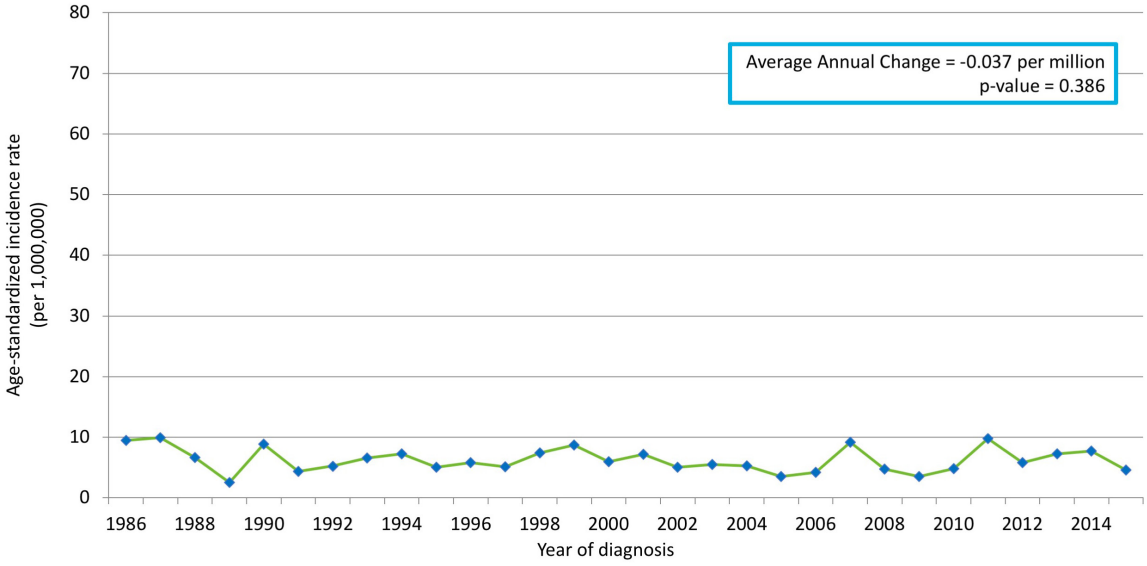


FIGURE 2.8

AGE-STANDARDIZED INCIDENCE RATES OF MALIGNANT BONE TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015



Malignant Bone Tumours

This ICCC-3 category encompasses osteosarcoma, chondrosarcomas and Ewing sarcoma. Osteosarcoma constitutes approximately 50% of bone tumours. The overall ASIR for bone tumours in Ontario over the 30-year period is 6.2 per million per year **(Figure 2.8)**, with an average of 14 incident cases per year. This ASIR has been relatively stable over the last three decades.

Soft Tissue and other Extraosseous Sarcomas

This ICCC-3 category encompasses rhabdomyosarcoma, peripheral nerve sheath tumours and Kaposi sarcoma. Rhabdomyosarcoma constitutes approximately 45% of soft tissue sarcomas. The overall ASIR for soft tissue sarcomas in Ontario over the 30-year period is 9.9 per million per year **(Figure 2.9)**, with an average of 25 incident cases diagnosed per year over the most recent 10-year period (2006-2015). Statistically significant annual increases in the incidence are estimated at 0.11 cases per million per year.

Germ Cell Tumours

This ICCC-3 category encompasses intracranial and intraspinal germ cell tumours, extracranial and extragonadal germ cell tumours, and gonadal carcinomas. Gonadal carcinomas constitute approximately 35% of germ cell tumours. The overall ASIR for germ cell tumours in Ontario over the 30-year period is 4.9 per million per year **(Figure 2.10)**, with an average of 13 incident cases per year in the most recent 10-year period (2006-2015). Statistically significant annual increases in the incidence are estimated at 0.10 cases per million per year.

Other Tumours

This category, which includes both ICCC-3 Groups XI and XII, encompasses adrenocortical carcinomas, thyroid carcinoma, nasopharyngeal carcinomas and other unspecified tumours. Thyroid carcinomas constitute approximately 22% of other tumours. The overall ASIR for other tumours in Ontario over the 30-year period is 4.9 per million per year **(Figure 2.11)**. Statistically significant annual increases in the incidence is estimated at 0.18 cases per million per year, increasing from 3.13 per million in 1986 to 8.25 per million in 2015. An average of 16 incident cases were diagnosed per year over the most recent 10-year period (2006-2015).

FIGURE 2.9

AGE-STANDARDIZED INCIDENCE RATES OF SOFT TISSUE AND OTHER EXTRAOSSEOUS SARCOMAS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

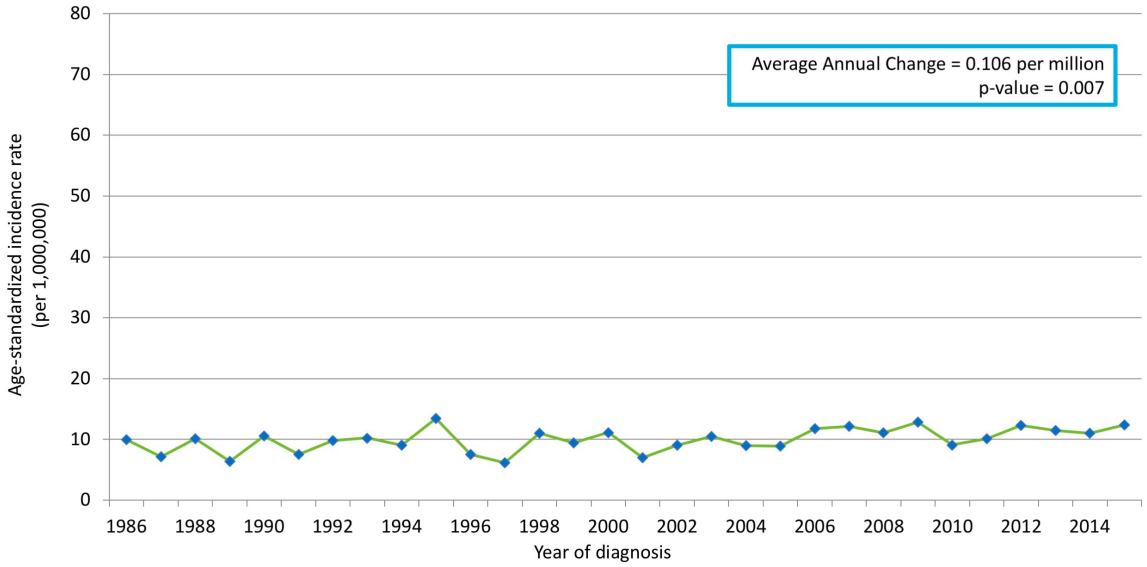


FIGURE 2.10

AGE-STANDARDIZED INCIDENCE RATES OF GERM CELL TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015

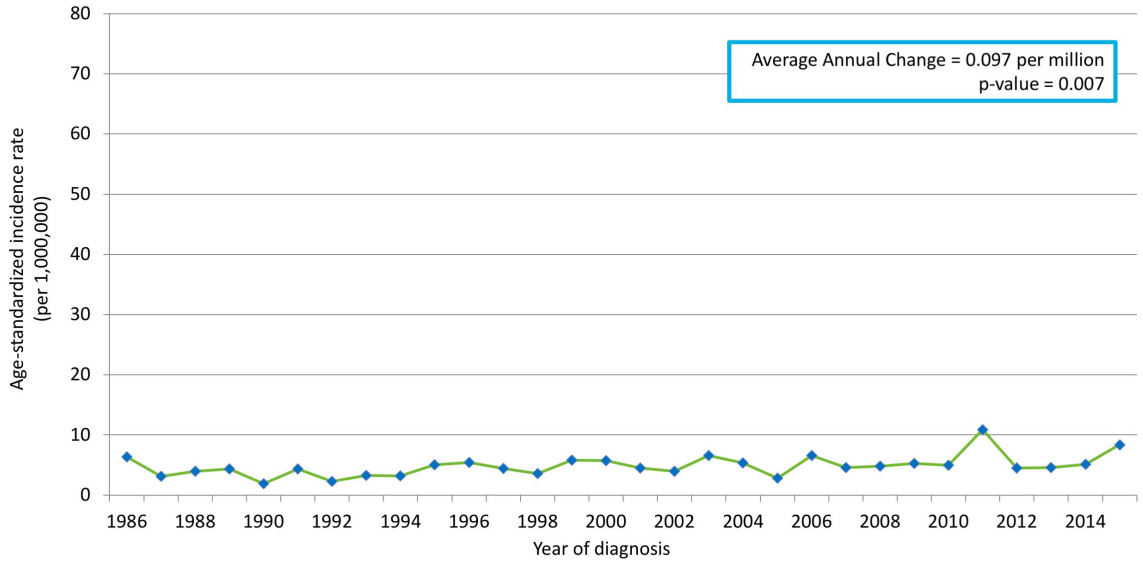
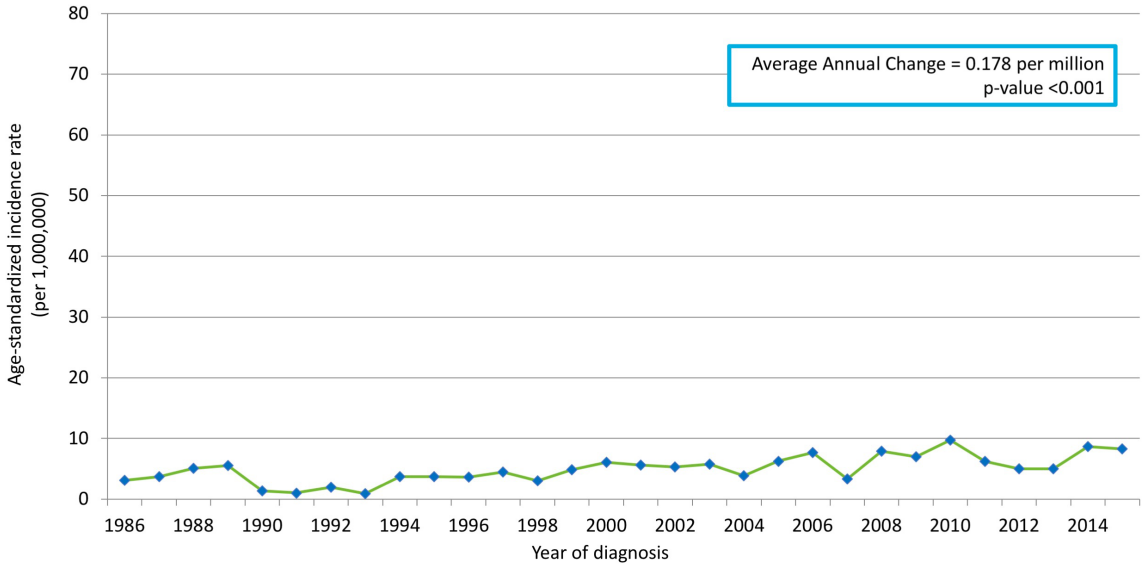


FIGURE 2.11

AGE-STANDARDIZED INCIDENCE RATES OF OTHER AND UNSPECIFIED TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1986-2015



1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Other tumours include ICCC-3 diagnostic category XI and XII (Other and Unspecified Malignant Neoplasms)*
4. *Data Source: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO*

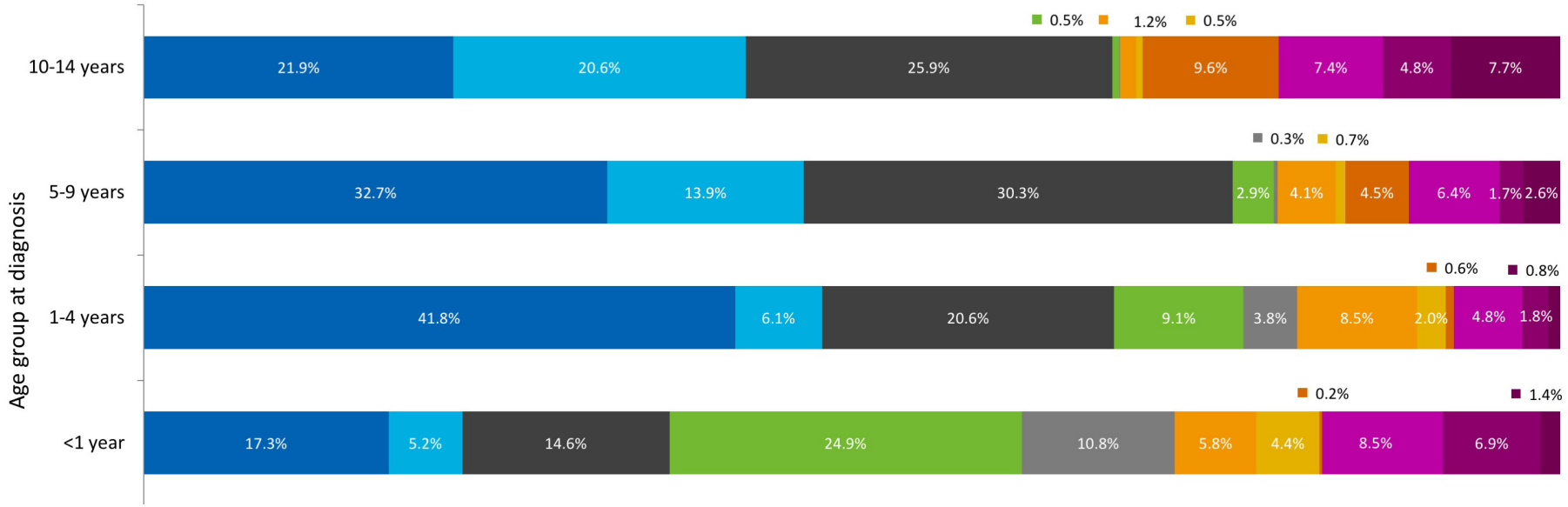
Childhood Cancer Incidence by Age Group

Patterns in the age at diagnosis vary by type of childhood cancer.

Figure 3 illustrates the distribution of childhood cancer incidence by four age groups: <1, 1–4, 5–9 and 10–14 years at diagnosis. Leukemias are diagnosed at all ages, but the highest proportion occur in the 1–4 age group, representing nearly 42% of the total cancer diagnoses in that age group. The proportion of lymphomas increases with age, with nearly a four-fold greater proportion in the 10–14 years age group compared to the <1 age group. CNS tumours comprise a substantial proportion of tumours at all ages, ranging from 15% in the youngest age group to 26% in the oldest. Neuroblastoma is largely a tumour of the very young, comprising 25% of tumours diagnosed in the <1 year age group.

FIGURE 3

DISTRIBUTION OF INCIDENT CANCER CASES IN CHILDREN, BY AGE GROUP AND CANCER TYPE, AGED 0-14 YEARS, ONTARIO, 1986-2015



- **I.** Leukemias, myeloproliferative diseases and myelodysplastic diseases
- **II.** Lymphomas and reticuloendothelial neoplasms
- **III.** Central nervous system and miscellaneous intracranial and intraspinal neoplasms
- **IV.** Neuroblastoma and other peripheral nervous system tumours
- **V.** Retinoblastoma
- **VI.** Renal tumours
- **VII.** Hepatic tumours
- **VIII.** Malignant bone tumours
- **IX.** Soft tissue and other extraosseous sarcomas
- **X.** Germ cell tumours, trophoblastic tumours and neoplasms of gonads
- **XI. & XII.** Other and unspecified malignant neoplasms

1. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
2. *Data Source: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO*

TABLE 1

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	1986 - 1990											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**296.0**	**264-347**	**100.0**	**148.2**	**168.0**	**153-203**	**100.0**	**164.0**	**128.0**	**111-144**	**100.0**	**131.5**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	94.6	78-114	32.0	47.2	52.8	42-65	31.4	51.5	41.8	29-49	32.7	42.8
II. Lymphomas and reticuloendothelial neoplasms	35.8	28-41	12.1	18.1	24.0	20-29	14.3	23.6	11.8	8-15	9.2	12.3
III. CNS and miscellaneous intracranial and intraspinal neoplasms	66.8	51-88	22.6	33.4	37.0	28-47	22.0	36.0	29.8	23-41	23.3	30.6
IV. Neuroblastoma and other peripheral nervous system tumours	21.4	11-32	7.2	10.6	11.8	8-16	7.0	11.4	9.6	3-16	7.5	9.8
V. Retinoblastoma	7.8	2-11	2.6	3.9	3.2	1-6	1.9	3.1	4.6	3-10	3.6	4.7
VI. Renal tumours	17.8	13-22	6.0	8.8	9.0	5-16	5.4	8.7	8.8	6-13	6.9	8.9
VII. Hepatic tumours	4.4	1-7	1.5	2.2	3.0	1-5	1.8	2.9	1.4	1-3	1.1	1.4
VIII. Malignant bone tumours	14.6	5-19	4.9	7.5	8.2	3-15	4.9	8.2	6.4	2-11	5.0	6.7
IX. Soft tissue and other extraosseous sarcomas	17.6	13-22	5.9	8.8	11.8	8-17	7.0	11.5	5.8	5-7	4.5	6.0
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	7.8	4-12	2.6	3.9	4.2	1-10	2.5	4.1	3.6	2-6	2.8	3.7
XI. & XII. Other and unspecified malignant neoplasms	7.4	3-11	2.5	3.8	3.0	2-5	1.8	3.0	4.4	1-6	3.4	4.6

ASIR – Age-Standardized Incidence Rate; CNS – Central Nervous System; ICCC – International Classification of Childhood Cancer

1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Source: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO*

TABLE 1 (CONTINUED)

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	1991 – 1995											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**322.2**	**293-342**	**100.0**	**147.8**	**177.2**	**172-186**	**100.0**	**158.1**	**145.0**	**121-165**	**100.0**	**136.9**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	98.6	84-111	30.6	44.9	54.2	50-61	30.6	48.1	44.4	33-56	30.6	41.5
II. Lymphomas and reticuloendothelial neoplasms	42.6	37-48	13.2	19.9	28.0	21-36	15.8	25.4	14.6	11-18	10.1	14.1
III. CNS and miscellaneous intracranial and intraspinal neoplasms	82.2	76-86	25.5	37.8	44.2	37-50	24.9	39.5	38.0	35-43	26.2	36.1
IV. Neuroblastoma and other peripheral nervous system tumours	20.8	15-27	6.5	9.4	11.2	9-12	6.3	9.8	9.6	6-15	6.6	8.9
V. Retinoblastoma	8.2	7-9	2.5	3.7	5.6	4-8	3.2	4.9	2.6	1-4	1.8	2.4
VI. Renal tumours	18.8	16-21	5.8	8.5	8.6	7-11	4.9	7.5	10.2	9-12	7.0	9.4
VII. Hepatic tumours	4.4	2-7	1.4	2.0	2.4	1-4	1.4	2.1	2.0	1-4	1.4	1.9
VIII. Malignant bone tumours	12.2	9-16	3.8	5.7	6.6	6-8	3.7	6.1	5.6	3-9	3.9	5.4
IX. Soft tissue and other extraosseous sarcomas	21.8	16-30	6.8	10.1	11.8	6-18	6.7	10.6	10.0	6-13	6.9	9.5
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	7.8	5-11	2.4	3.6	2.8	1-4	1.6	2.5	5.0	4-7	3.4	4.8
XI. & XII. Other and unspecified malignant neoplasms	4.8	2-8	1.5	2.3	1.8	1-4	1.0	1.7	3.0	1-5	2.1	2.9

TABLE 1 (CONTINUED)

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	1996 - 2000											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**346.6**	**336-363**	**100.0**	**153.7**	**184.0**	**176-193**	**100.0**	**159.0**	**162.6**	**144-174**	**100.0**	**148.1**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	112.4	100-120	32.4	49.9	59.0	54-69	32.1	51.2	53.4	39-61	32.8	48.7
II. Lymphomas and reticuloendothelial neoplasms	42.4	34-56	12.2	18.5	25.4	18-33	13.8	21.6	17.0	13-25	10.5	15.3
III. CNS and miscellaneous intracranial and intraspinal neoplasms	78.0	69-83	22.5	34.4	45.6	35-51	24.8	39.2	32.4	28-36	19.9	29.3
IV. Neuroblastoma and other peripheral nervous system tumours	22.6	15-33	6.5	10.3	12.4	8-17	6.7	11.0	10.2	7-16	6.3	9.5
V. Retinoblastoma	9.4	6-14	2.7	4.3	5.2	2-8	2.8	4.7	4.2	2-6	2.6	4.0
VI. Renal tumours	19.8	14-27	5.7	8.9	6.6	4-9	3.6	5.7	13.2	10-18	8.1	12.1
VII. Hepatic tumours	5.2	3-7	1.5	2.4	3.4	2-6	1.8	3.0	1.8	1-3	1.1	1.7
VIII. Malignant bone tumours	15.2	12-20	4.4	6.6	7.6	6-12	4.1	6.4	7.6	4-11	4.7	6.9
IX. Soft tissue and other extraosseous sarcomas	20.4	14-25	5.9	9.0	10.4	3-14	5.7	9.0	10.0	7-13	6.2	9.1
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	11.2	8-13	3.2	5.0	4.6	2-7	2.5	4.0	6.6	5-8	4.1	6.0
XI. & XII. Other and unspecified malignant neoplasms	10.0	7-14	2.9	4.4	3.8	1-6	2.1	3.3	6.2	5-10	3.8	5.6

TABLE 1 (CONTINUED)

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	2001 - 2005											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**336.2**	**320-353**	**100.0**	**149.8**	**187.4**	**167-200**	**100.0**	**163.7**	**148.8**	**122-163**	**100.0**	**135.3**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	101.8	89-125	30.3	45.8	59.6	50-66	31.8	52.6	42.2	32-59	28.4	38.8
II. Lymphomas and reticuloendothelial neoplasms	40.8	33-53	12.1	17.4	25.6	21-35	13.7	21.4	15.2	9-18	10.2	13.2
III. CNS and miscellaneous intracranial and intraspinal neoplasms	85.2	76-94	25.3	37.6	48.0	42-58	25.6	41.5	37.2	30-46	25.0	33.5
IV. Neuroblastoma and other peripheral nervous system tumours	23.0	16-27	6.8	11.1	14.2	9-22	7.6	13.4	8.8	5-14	5.9	8.7
V. Retinoblastoma	9.6	5-13	2.9	4.7	4.4	3-7	2.3	4.2	5.2	2-8	3.5	5.1
VI. Renal tumours	14.4	11-18	4.3	6.7	6.6	5-8	3.5	6.0	7.8	4-10	5.2	7.3
VII. Hepatic tumours	5.2	3-9	1.5	2.5	2.4	2-4	1.3	2.1	2.8	1-5	1.9	2.8
VIII. Malignant bone tumours	12.6	8-17	3.7	5.3	5.4	1-10	2.9	4.4	7.2	6-9	4.8	6.2
IX. Soft tissue and other extraosseous sarcomas	20.4	16-24	6.1	8.9	11.2	6-14	6.0	9.4	9.2	6-13	6.2	8.3
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	10.4	6-15	3.1	4.6	4.6	1-7	2.5	4.1	5.8	3-8	3.9	5.2
XI. & XII. Other and unspecified malignant neoplasms	12.8	9-15	3.8	5.4	5.4	3-8	2.9	4.5	7.4	5-10	5.0	6.3

TABLE 1 (CONTINUED)

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	2006 - 2010											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**371.2**	**348-404**	**100.0**	**169.1**	**198.0**	**190-207**	**100.0**	**175.9**	**173.2**	**150-197**	**100.0**	**161.9**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	117.6	101-146	31.7	54.3	64.2	55-76	32.4	57.7	53.4	46-70	30.8	50.6
II. Lymphomas and reticuloendothelial neoplasms	36.8	34-40	9.9	16.2	24.2	21-28	12.2	20.7	12.6	11-15	7.3	11.3
III. CNS and miscellaneous intracranial and intraspinal neoplasms	92.0	80-105	24.8	41.5	48.6	41-56	24.5	42.7	43.4	38-50	25.1	40.1
IV. Neuroblastoma and other peripheral nervous system tumours	27.0	19-36	7.3	12.8	14.0	9-18	7.1	13.0	13.0	9-20	7.5	12.7
V. Retinoblastoma	8.8	5-12	2.4	4.2	3.8	1-7	1.9	3.6	5.0	2-8	2.9	4.9
VI. Renal tumours	17.0	14-20	4.6	8.0	7.4	6-10	3.7	6.8	9.6	6-14	5.5	9.2
VII. Hepatic tumours	6.6	4-9	1.8	3.1	5.6	4-8	2.8	5.1	1.0	1-2	0.6	1.0
VIII. Malignant bone tumours	12.2	8-21	3.3	5.3	6.6	4-13	3.3	5.6	5.6	4-8	3.2	5.0
IX. Soft tissue and other extraosseous sarcomas	25.0	20-28	6.7	11.4	12.8	8-17	6.5	11.4	12.2	9-15	7.0	11.4
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	11.8	10-15	3.2	5.2	5.4	3-7	2.7	4.7	6.4	3-9	3.7	5.8
XI. & XII. Other and unspecified malignant neoplasms	16.4	8-22	4.4	7.1	5.4	4-7	2.7	4.6	11.0	4-17	6.4	9.8

TABLE 1 (CONTINUED)

INCIDENCE COUNTS AND AGE-STANDARDIZED INCIDENCE RATES OF CANCER IN CHILDREN, BY CANCER TYPE, SEX, AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	2011 - 2015											
	TOTAL				BOYS				GIRLS			
	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)	Number of New Cases		% of New Cases	ASIR (per 1,000,000)
	Average per year	Range			Average per year	Range			Average per year	Range		
ALL CANCERS COMBINED	**395.6**	**362-427**	**100.0**	**181.6**	**218.8**	**202-239**	**100.0**	**195.8**	**176.8**	**160-192**	**100.0**	**166.7**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	129.2	108-142	32.7	59.4	75.2	60-88	34.4	67.4	54.0	48-58	30.5	51.1
II. Lymphomas and reticuloendothelial neoplasms	49.0	41-56	12.4	22.3	32.4	25-40	14.8	28.7	16.6	16-17	9.4	15.5
III. CNS and miscellaneous intracranial and intraspinal neoplasms	92.2	82-103	23.3	42.1	49.2	47-50	22.5	43.8	43.0	35-53	24.3	40.3
IV. Neuroblastoma and other peripheral nervous system tumours	24.2	16-34	6.1	11.3	13.2	9-19	6.0	12.1	11.0	5-16	6.2	10.6
V. Retinoblastoma	8.8	7-12	2.2	4.2	5.2	4-6	2.4	4.8	3.6	3-6	2.0	3.5
VI. Renal tumours	17.4	15-21	4.4	8.1	7.6	4-10	3.5	6.9	9.8	7-11	5.5	9.3
VII. Hepatic tumours	5.0	3-7	1.3	2.3	3.4	2-5	1.6	3.1	1.6	1-2	0.9	1.5
VIII. Malignant bone tumours	15.6	10-22	3.9	7.1	7.8	2-13	3.6	6.9	7.8	6-9	4.4	7.2
IX. Soft tissue and other extraosseous sarcomas	25.0	22-27	6.3	11.5	14.0	13-16	6.4	12.5	11.0	9-14	6.2	10.4
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	14.6	10-24	3.7	6.7	5.6	2-10	2.6	5.0	9.0	6-14	5.1	8.5
XI. & XII. Other and unspecified malignant neoplasms	14.6	11-19	3.7	6.6	5.2	2-8	2.4	4.6	9.4	4-13	5.3	8.8

CHAPTER 2

CHILDHOOD CANCER MORTALITY AND SURVIVAL

This chapter describes the mortality and the 5-year overall survival experience of children aged 0–14 years who were diagnosed with one or more cancers (as defined by the International Classification of Childhood Cancer, ICCC) between 1986 and 2015, Ontario residents at the time of diagnosis and treated in one of the specialized pediatric oncology programs in Ontario.

Given that the Pediatric Oncology Group of Ontario Networked Information System (POGONIS) began capturing data on incident cancer cases in 1985, mortality data in the earlier years of POGONIS do not include death information on cancer patients diagnosed in years prior to 1985. Therefore, all mortality data presented in this report are for years 1991–2015, amongst patients diagnosed 1986–2015. Included with each figure is the average annual change (AAC) in age-standardized mortality rate (ASMR) and associated p-value, estimated using linear regression. P-values equal to or less than 0.05 indicate that the change is statistically significant.

Survival analyses were based on the first primary cancers and patients were followed until December 31, 2016. Overall survival proportions (OSPs) were estimated using the cohort method when complete follow-up data were available (i.e., for cases diagnosed 1986–2011). For recently diagnosed cases whose complete follow-up data were not available (from 2012-2015), estimates were calculated using the period survival methodology. Each figure related to survival presents the AAC in 5-year OSP and associated p-value. For more details regarding the methodology used to generate data in this chapter, please see the **Technical Appendix**.

MORTALITY

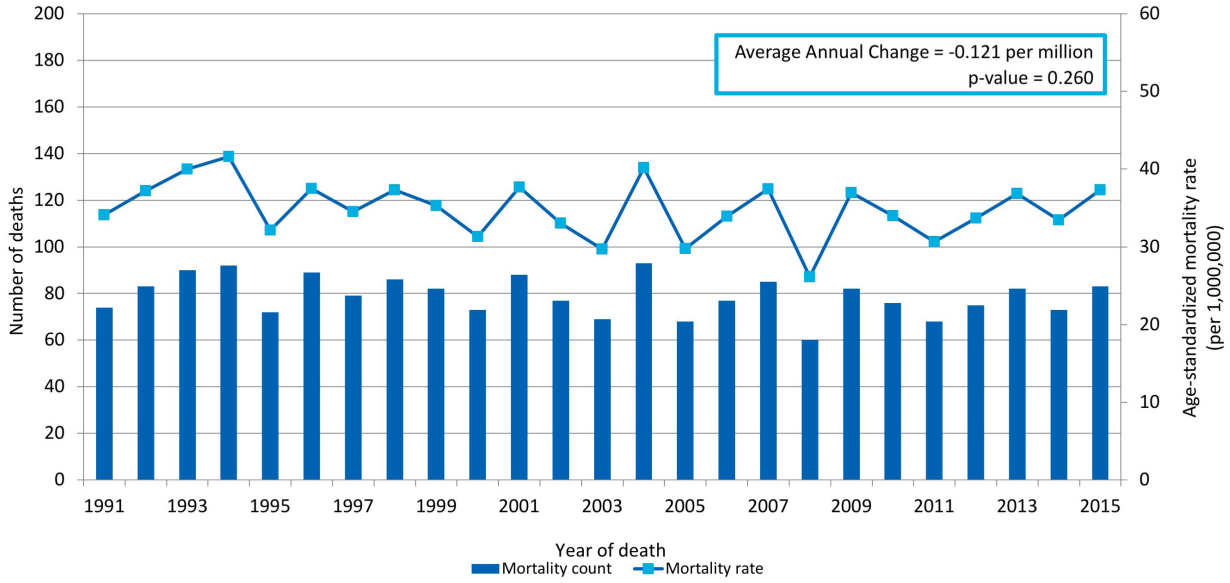
Mortality of Childhood Cancer in Ontario (for all cancers combined)

The number of deaths due to childhood cancer has remained stable over the past 30 years.

Figure 4 shows the ASMR over a 25-year period, for years between 1991 and 2015. The ASMR has been stable over the 25-year period, with an AAC of -0.121 per million (p=0.260) and approximately 80 deaths per year. The number of deaths per year has been relatively stable, with slight decreases observed, from approximately 82 in the earlier period (1991–2002) to 76 later in the period (2002–2015).

FIGURE 4

MORTALITY COUNTS AND AGE-STANDARDIZED MORTALITY RATES OF CANCER IN CHILDREN, ALL CANCERS COMBINED, AGED 0-14 YEARS, ONTARIO, 1991-2015



1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases diagnosed between 1986–2015 with cancer, as classified based on the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

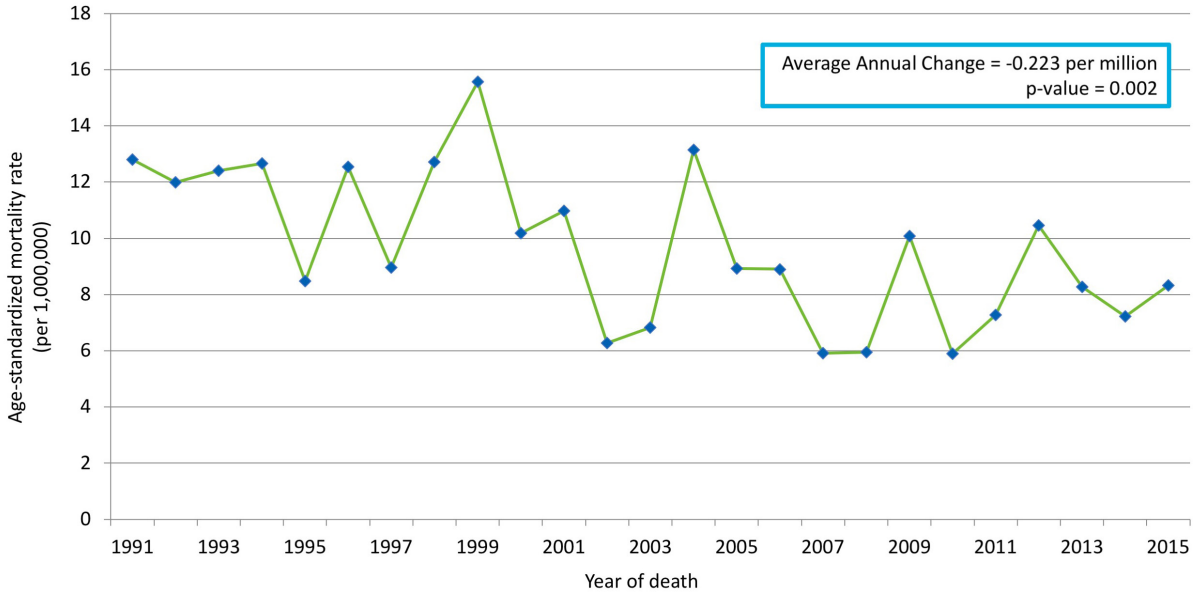
Mortality by Type of Childhood Cancer

Figures 5.1 to 5.7 present the ASMR per 1,000,000 population per year, amongst children aged 0–14 with selected diagnoses, 1991–2015, including: leukemias, myeloproliferative diseases and myelodysplastic diseases **(Figure 5.1)**; lymphomas and reticuloendothelial neoplasms **(Figure 5.2)**; central nervous system (CNS) and miscellaneous intracranial and intraspinal neoplasms **(Figure 5.3)**; neuroblastoma and other peripheral nervous system tumours **(Figure 5.4)**; malignant bone tumours (**Figure 5.5**); soft tissue and other extraosseous sarcomas **(Figure 5.6)**; and all other and unspecified tumours **(Figure 5.7)**. The ASMRs for each specific ICCC group are similar, ranging from 0 to 16 deaths per million population per year. No changes in ASMRs were observed, except for leukemias **(Figure 5.1)**, with an average annual decrease in ASMR of -0.223 deaths per million over the 25-year period (1991 to 2015).

Further analyses were conducted examining the timing of death among cohorts of children diagnosed with cancer over the 30-year period (data not shown). The majority of deaths (between 35 to 45%) occurred during the first year of diagnosis. Nearly 15-20% of deaths occurred in the second year and about 10 to 15% of deaths occurred five years after diagnosis.

FIGURE 5.1

AGE-STANDARDIZED MORTALITY RATES OF LEUKEMIAS, MYELOPROLIFERATIVE DISEASES AND MYELODYSPLASTIC DISEASES IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015



For Figure 5.1–5.6

1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases diagnosed between 1986–2015 with cancer, as classified based on the International Classification of Childhood Cancer, third edition (ICCC-3) and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

FIGURE 5.2

AGE-STANDARDIZED MORTALITY RATES OF LYMPHOMAS AND RETICULOENDOTHELIAL NEOPLASMS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015

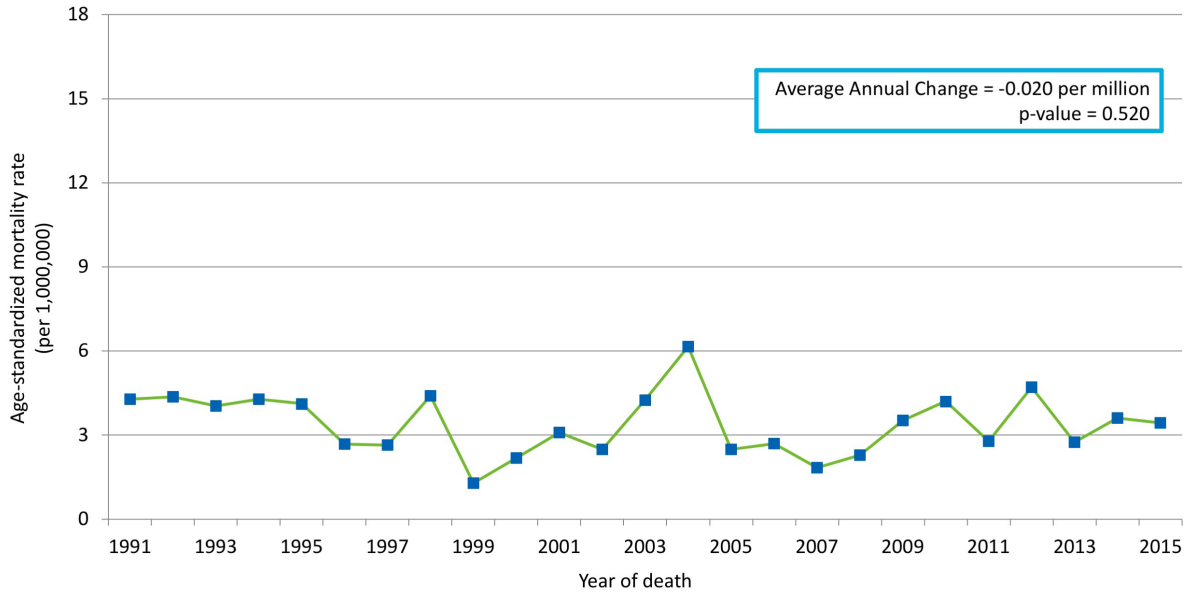


FIGURE 5.3

AGE-STANDARDIZED MORTALITY RATES OF CENTRAL NERVOUS SYSTEM AND MISCELLANEOUS INTRACRANIAL AND INTRASPINAL NEOPLASMS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015

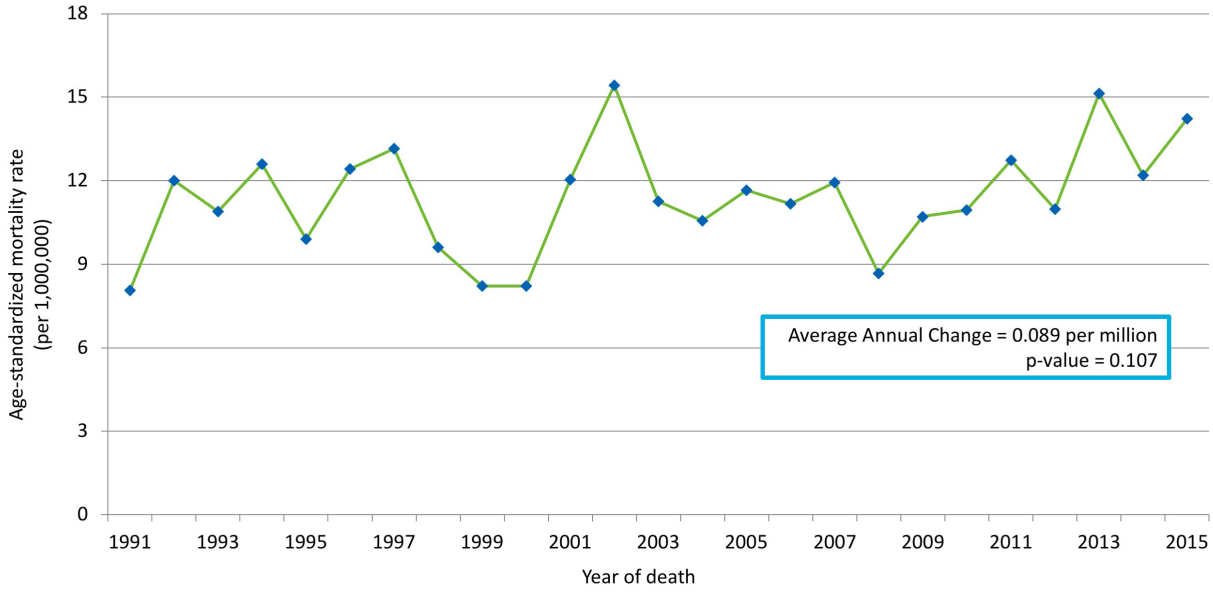


FIGURE 5.4

AGE-STANDARDIZED MORTALITY RATES OF NEUROBLASTOMA AND OTHER PERIPHERAL NERVOUS SYSTEM TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015

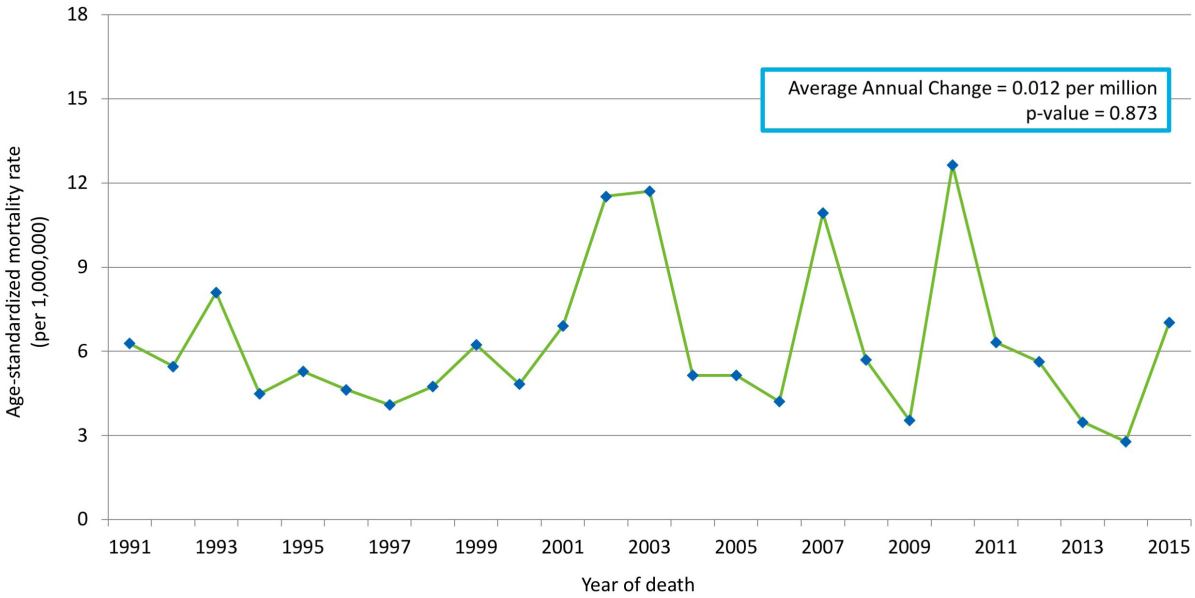


FIGURE 5.5

AGE-STANDARDIZED MORTALITY RATES OF MALIGNANT BONE TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015

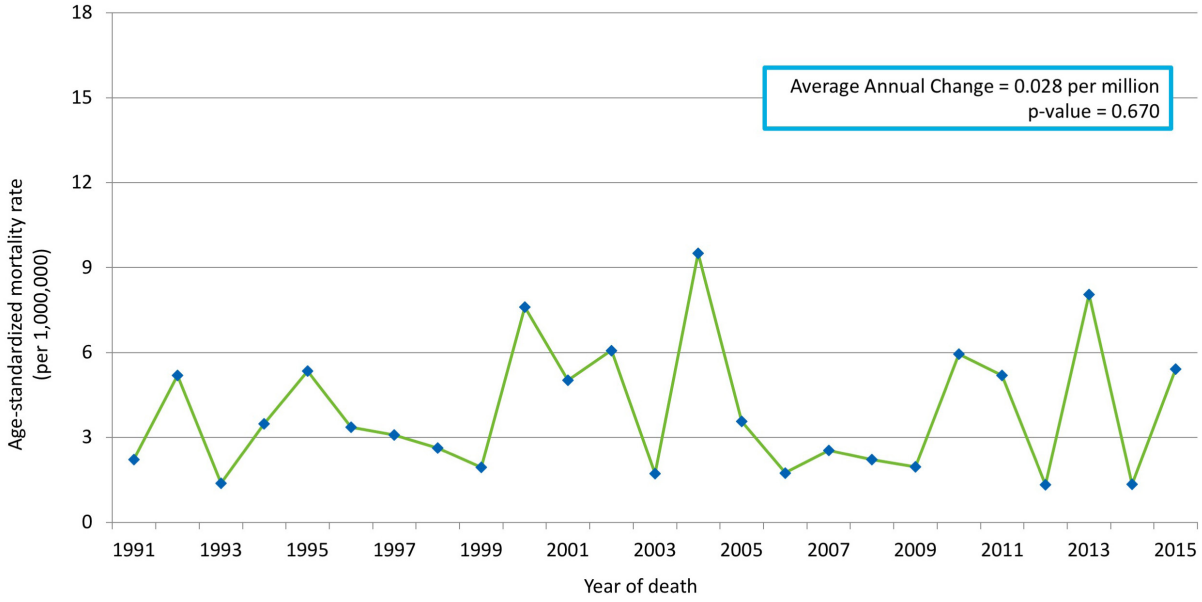


FIGURE 5.6

AGE-STANDARDIZED MORTALITY RATES OF SOFT TISSUE AND OTHER EXTRAOSSEOUS SARCOMAS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015

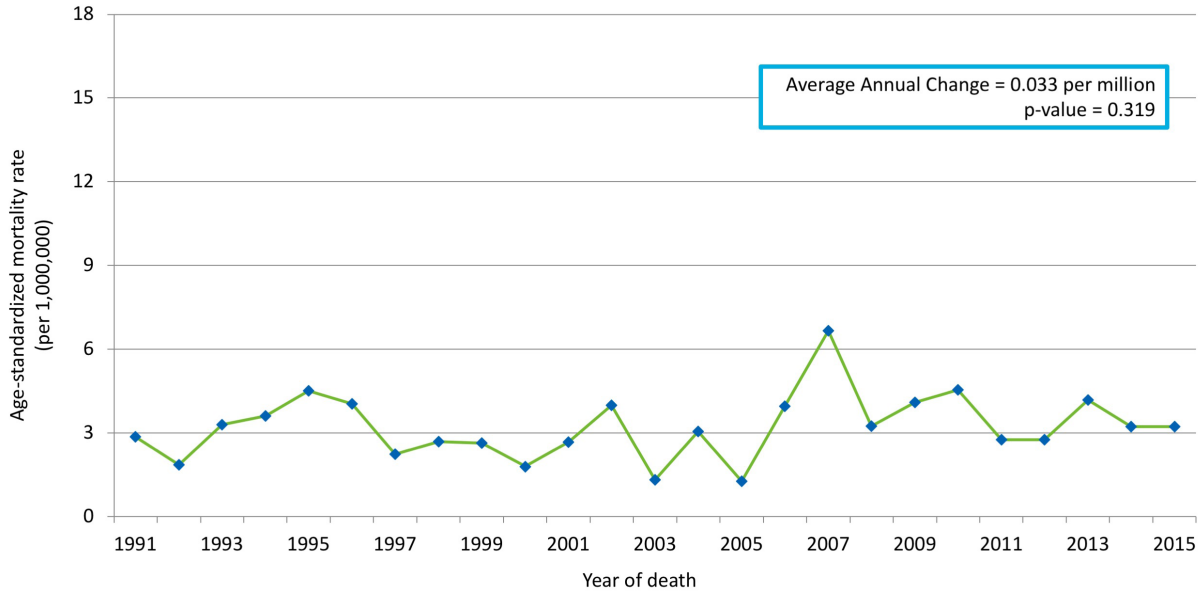
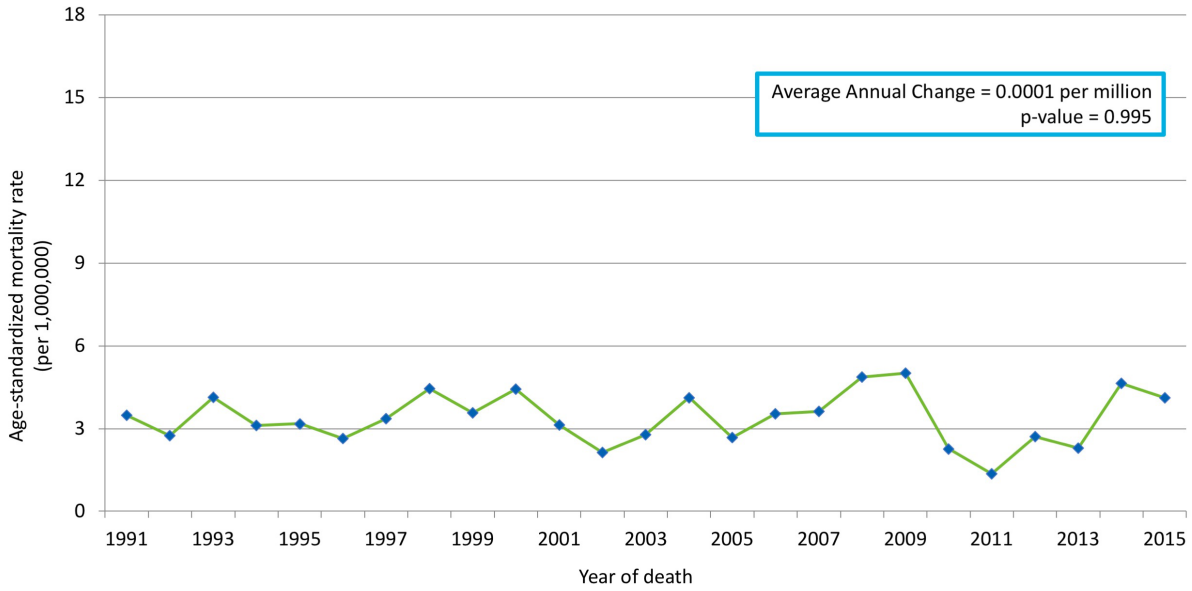


FIGURE 5.7

AGE-STANDARDIZED MORTALITY RATES OF ALL OTHER AND UNSPECIFIED TUMOURS IN CHILDREN, AGED 0-14 YEARS, ONTARIO, 1991-2015



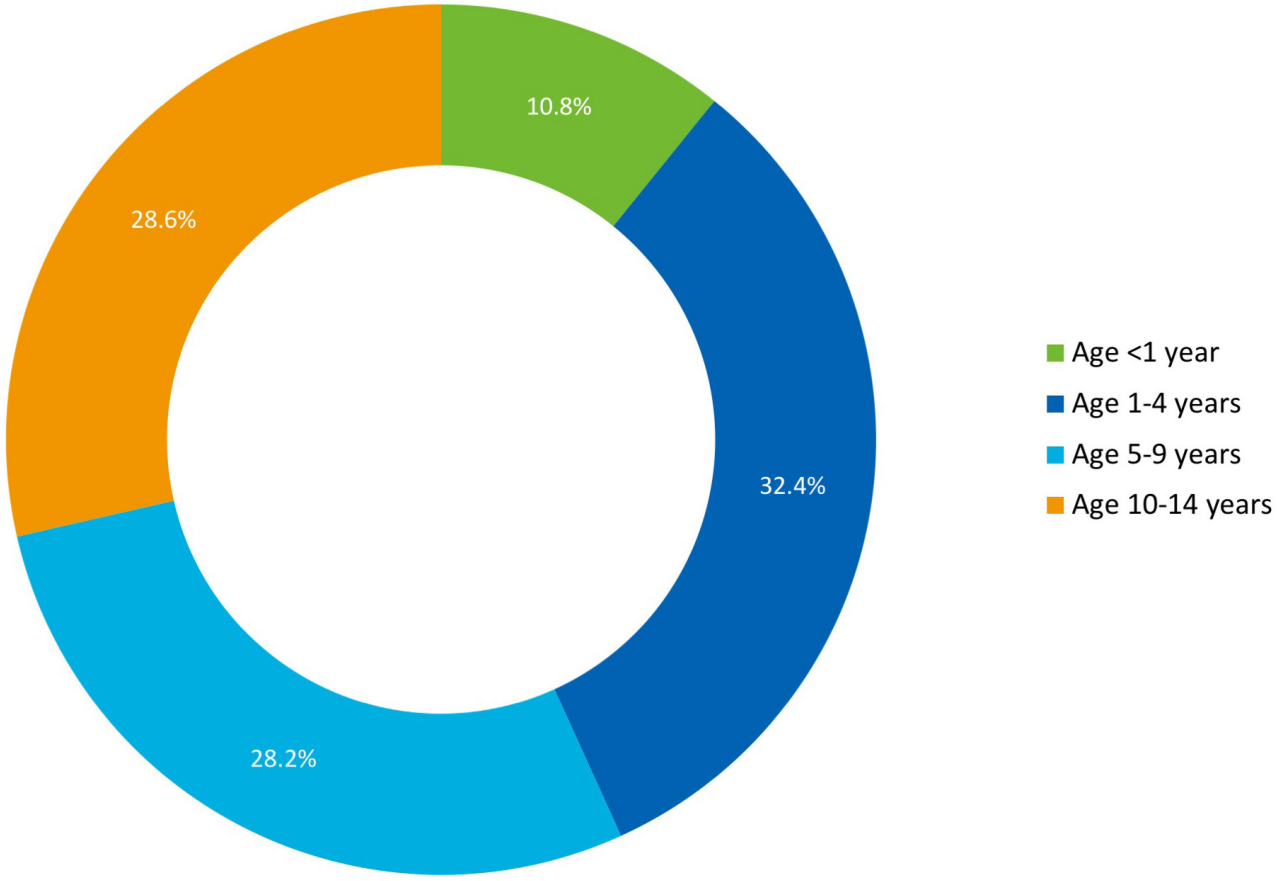
1. *Rates are per 1,000,000 and are standardized to the age distribution of the 2011 Canadian population*
2. *Includes cases diagnosed between 1986–2015 with cancer, as classified based on the International Classification of Childhood Cancer, third edition (ICCC-3) and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *"All other and unspecified tumours" include retinoblastoma, renal tumours, hepatic tumours, germ cell tumours and other/unspecified tumours*
4. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

Childhood Cancer Mortality by Age Group

Figure 6 provides data on the distribution of childhood cancer deaths by four age groups: <1, 1–4, 5–9 and 10–14 years, based on age at time of diagnosis. Deaths among patients diagnosed under 1 year of age account for nearly 11% of total deaths, while deaths among patients diagnosed 1-4 years of age, account for approximately one third of deaths. As discussed in Chapter 1 (Incidence), different tumours affect different age groups. The distribution of deaths by age group at diagnosis is similar to the distribution of incident cases by age group.

FIGURE 6

DISTRIBUTION OF DEATHS AMONG CHILDREN WITH CANCER, BY AGE GROUP AT DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1991-2015



1. *Includes cases diagnosed between 1986–2015 with cancer, as classified based on the International Classification of Childhood Cancer, third edition (ICCC-3) and incorporates specific changes to the ICD-O system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
2. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

SURVIVAL

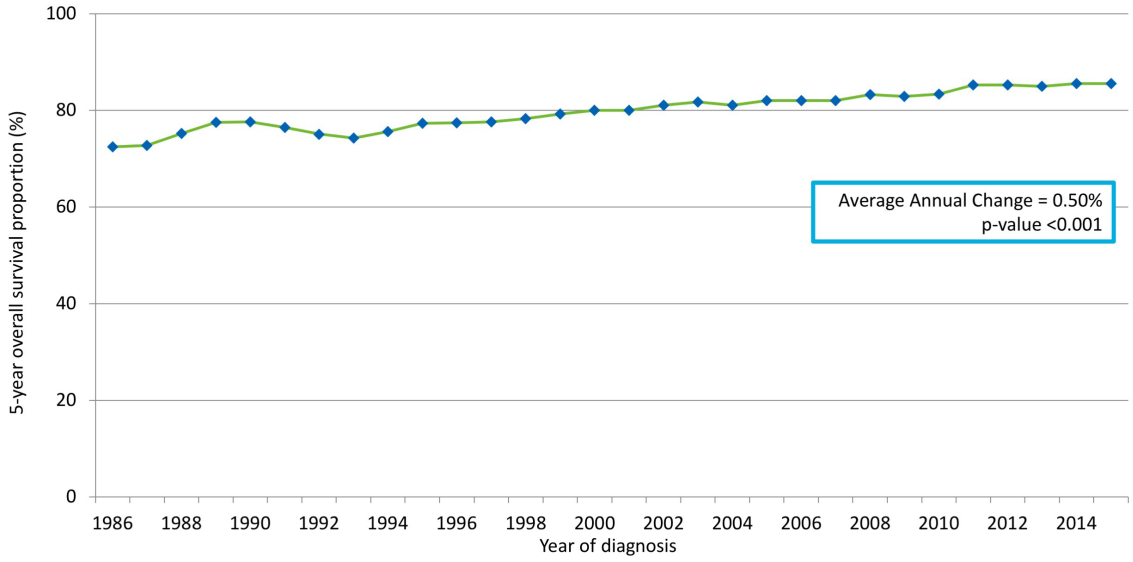
Childhood Cancer Survival in Ontario (for all cancers combined)

Survival from childhood cancer has increased steadily over the past 30 years.

Figure 7 presents trends over time for 5-year OSPs among children diagnosed with cancer in Ontario between 1986 and 2015. The data indicate a clear improvement in 5-year OSPs, from 72.4% in 1986 to 85.5% in 2015, nearly a 13% improvement in survival. The average annual increase in the 5-year OSP during this period was about 0.5%.

FIGURE 7

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH CANCER, ALL CANCERS COMBINED, AGED 0-14 YEARS, ONTARIO, 1986-2015



1. *The cohort method was used for cases diagnosed 1986–2011; the period method was used for cases diagnosed 2012–2015; rates are smoothed*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012, forward that are not reflected in the ICCC-3*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

Survival by Type of Childhood Cancer

There is significant variation in survival between childhood cancer types.

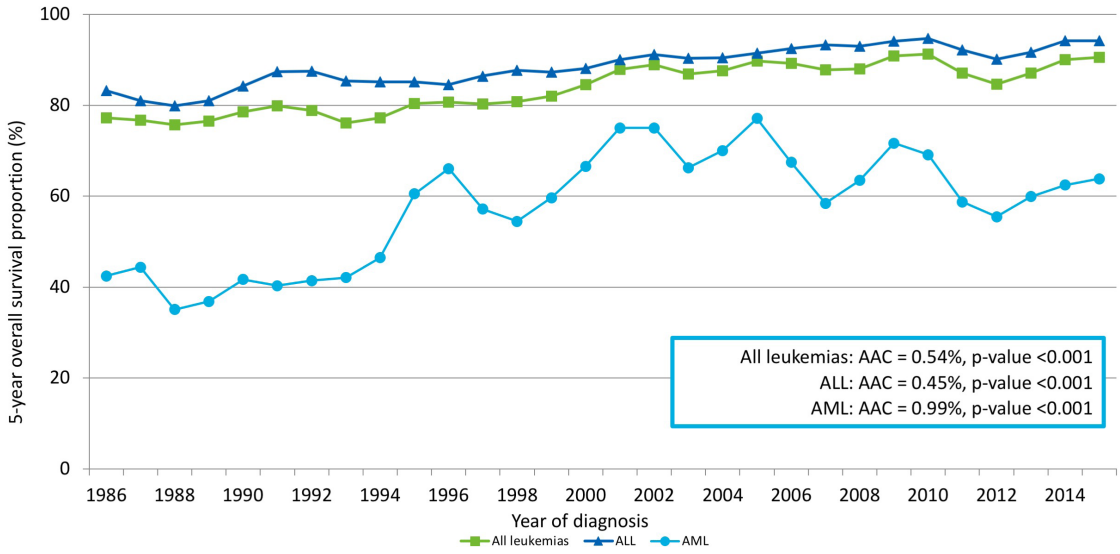
Table 2 provides the 5-year OSPs and 95% confidence intervals, by 5-year period of diagnosis from 1986–2015, for all cancers combined and by ICCC-3 main diagnosis group. Overall, the 5-year OSP has increased over the 30-year period, from 75.0% in 1986–1990 to 86.2% in 2011–2015. In the most recent 5-year period (2011–2015), children with renal tumours had the highest 5-year OSP (97.7%), followed by those with retinoblastoma (95.5%), germ cell tumours (93.2%) and lymphomas (92.1%). Children diagnosed with malignant bone tumours had the lowest 5-year OSP (67.9%), followed by those with soft tissue sarcomas (77.6%) and CNS tumours (78.7%).

Leukemias, Myeloproliferative Diseases and Myelodysplastic Diseases

Improvement in survival rates occurred in many diagnostic groups (**Figures 8.1–8.7**). **Figure 8.1** shows survival for all children diagnosed with leukemia and for major leukemia subgroups, including ALL, AML and all leukemias combined. While the average annual increase in the 5-year OSP for all leukemias and ALL was approximately 0.5%, patients with AML experienced about 1.3% increase in their survival annually. However, 5-year survival for children diagnosed with AML was substantially lower than those diagnosed with ALL. All increases in survival amongst the three leukemia groups (ALL, AML and all leukemias) were statistically significant ($p<0.05$).

FIGURE 8.1

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH LEUKEMIAS, MYELOPROLIFERATIVE DISEASES AND MYELODYSPLASTIC DISEASES, OVERALL AND BY DIAGNOSIS SUBGROUP, AGED 0-14 YEARS, ONTARIO, 1986-2015

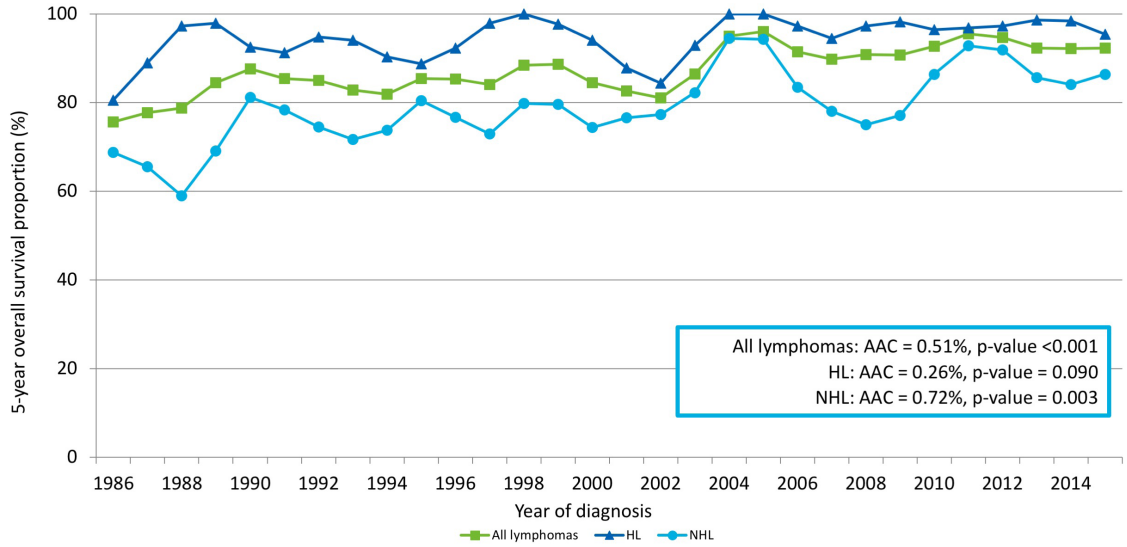


AAC Average Annual Change; ALL – Acute Lymphoblastic Leukemia; AML – Acute Myeloid Leukemia

1. *The cohort method was used for cases diagnosed 1986–2011; the period method was used for cases diagnosed 2012–2015; tests of significance are based on non-smoothed data*
2. *All leukemias include leukemias, myeloproliferative diseases and myelodysplastic diseases (as categorized by International Classification of Childhood Cancer, third edition [ICCC-3] Group I)*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

FIGURE 8.2

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH LYMPHOMAS AND RETICULOENDOTHELIAL NEOPLASMS, OVERALL AND BY DIAGNOSIS SUBGROUP, AGED 0-14 YEARS, ONTARIO, 1986-2015



AAC – Average Annual Change; HL – Hodgkin Lymphoma; NHL – Non-Hodgkin Lymphoma

1. *The cohort method was used for cases diagnosed 1986–2011; the period method was used for cases diagnosed 2012–2015; tests of significance are based on non-smoothed data*
2. *All lymphomas include lymphomas and reticuloendothelial neoplasms*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

Lymphomas and Reticuloendothelial Tumours

Patients diagnosed with all lymphomas and reticuloendothelial tumours **(Figure 8.2)** experienced significant improvements in survival of 0.5% on average per year. Specifically, there were significant improvements in 5-year OSP amongst patients with non-Hodgkin lymphoma of approximately 0.7% per year (p=0.003). The 5-year OSP for patients with Hodgkin lymphoma was stable over the 30-year period, with an average annual survival of >97% in the most recent 10-year period (2006–2015).

Central Nervous System (CNS) and Miscellaneous Intracranial and Intraspinal Neoplasms

The 5-year OSPs vary among patients with CNS and miscellaneous intracranial and intraspinal neoplasms, depending on the type of CNS tumour **(Figures 8.3.1 and 8.3.2)**. Overall, for all CNS tumours combined, there was a statistically significant increase in 5-year OSP over the 30-year period of an average of 0.38% per year, from 63.9% in 1986 to 74.0% in 2015 (p=0.001).

The 5-year OSP of patients with low-grade astrocytoma (LGA) or high-grade astrocytoma (HGA) were stable over the 30-year period, with an average annual 5-year OSP of 89.0% for LGA and 30.5% for HGA **(Figure 8.3.1)**. Conversely, there were significant improvements in the 5-year OSPs of patients with ependymomas (p=0.020) and medulloblastomas—or cerebellar primitive neuroectodermal tumours (PNET)—(p<0.001), which both increased on average by 1.2% per year **(Figure 8.3.2)**, to an average annual 5-year OSP of 83.7% for ependymomas and 78.4% for medulloblastoma over the most recent 10-year period (2006-2015).

Neuroblastoma and Other Peripheral Nervous System Tumours

Patients diagnosed with neuroblastoma and other peripheral nervous cell tumours experienced significant improvements in 5-year OSP over the 30-year period, increasing from 61.8% in 1986 to 83.6% in 2015 (average of 0.96% per year, p<0.001) **(Figure 8.4)**.

Malignant Bone Tumours and Soft Tissue and Extraosseous Sarcomas

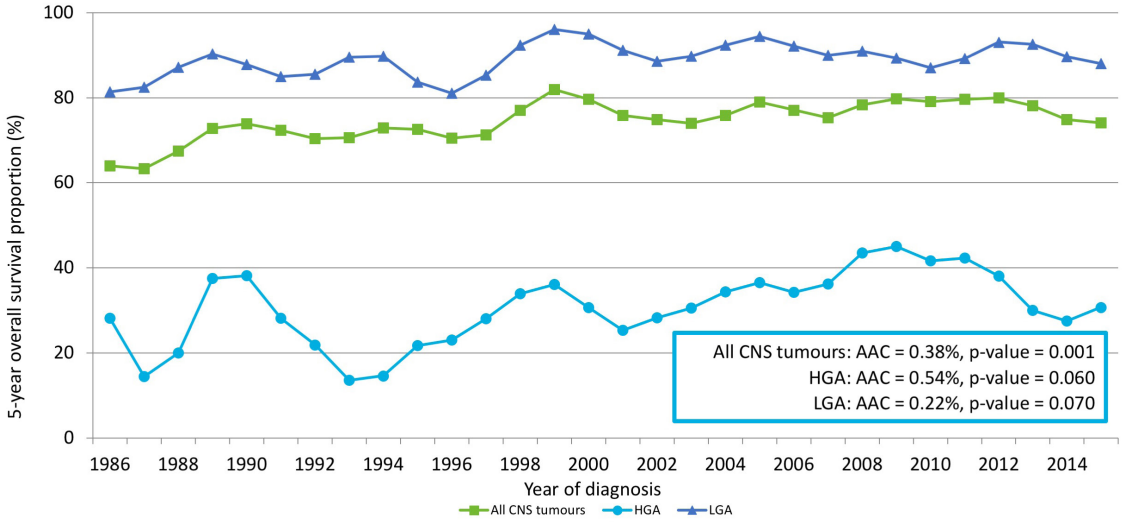
The 5-year OSPs for children diagnosed with malignant bone tumours **(Figure 8.5)** or soft tissue and extraosseous sarcomas **(Figure 8.6)** were generally stable over the 30-year period. Variations in the 5-year OSPs per year were not statistically significant.

All Other and Unspecified Tumours

There were significant improvements in the 5-year OSPs for all other and unspecified tumours, which includes retinoblastoma, renal tumours, hepatic tumours, germ cell tumours and other/unspecified tumours (AAC of 0.34% per year, p<0.001) **(Figure 8.7)**.

FIGURE 8.3.1

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH CENTRAL NERVOUS SYSTEM AND MISCELLANEOUS INTRACRANIAL AND INTRASPINAL NEOPLASMS, OVERALL AND BY DIAGNOSIS SUBGROUP (LOW- AND HIGH-GRADE ASTROCYTOMAS), AGED 0-14 YEARS, ONTARIO, 1986-2015



For Figures 8.3.1-8.3.2

AAC – Average Annual Change; CNS – Central Nervous System Tumours; HGA – High-Grade Astrocytoma; LGA – Low-Grade Astrocytoma

1. *The cohort method was used for cases diagnosed 1986–2011; the period method was used for cases diagnosed 2012–2015; rates are smoothed*
2. *All CNS tumours include CNS and miscellaneous intracranial and intraspinal neoplasms (including malignant, benign and neoplasms of indeterminate behaviour)*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

FIGURE 8.3.2

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH CENTRAL NERVOUS SYSTEM AND MISCELLANEOUS INTRACRANIAL AND INTRASPINAL NEOPLASMS, OVERALL AND BY DIAGNOSIS SUBGROUP (EPENDYMOMAS, MEDULLOBLASTOMA), AGED 0-14 YEARS, ONTARIO, 1986-2015

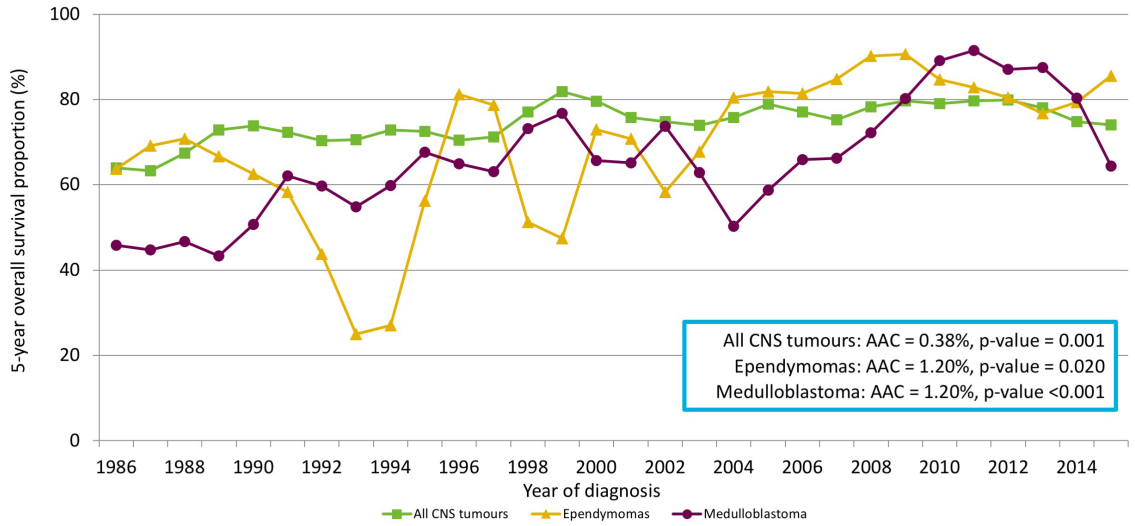
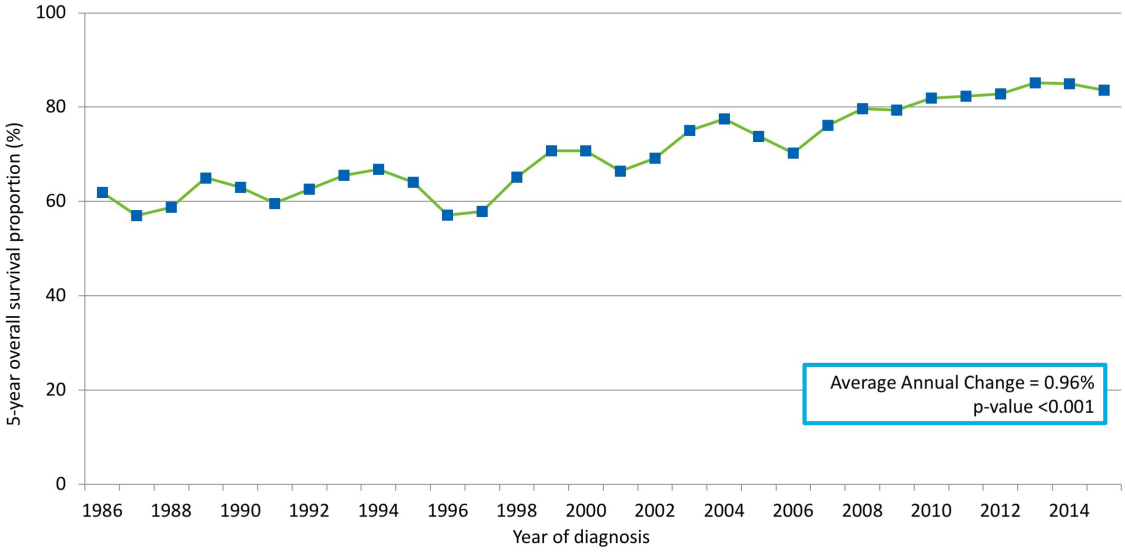


FIGURE 8.4

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH NEUROBLASTOMA AND OTHER PERIPHERAL NERVOUS SYSTEM TUMOURS, AGED 0-14 YEARS, ONTARIO, 1986-2015



For Figures 8.4-8.6

1. *The cohort method was used for cases diagnosed 1986-2011; the period method was used for cases diagnosed 2012-2015; tests of significance are based on non-smoothed data*
2. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

FIGURE 8.5

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH MALIGNANT BONE TUMOURS, AGED 0-14 YEARS, ONTARIO, 1986-2015

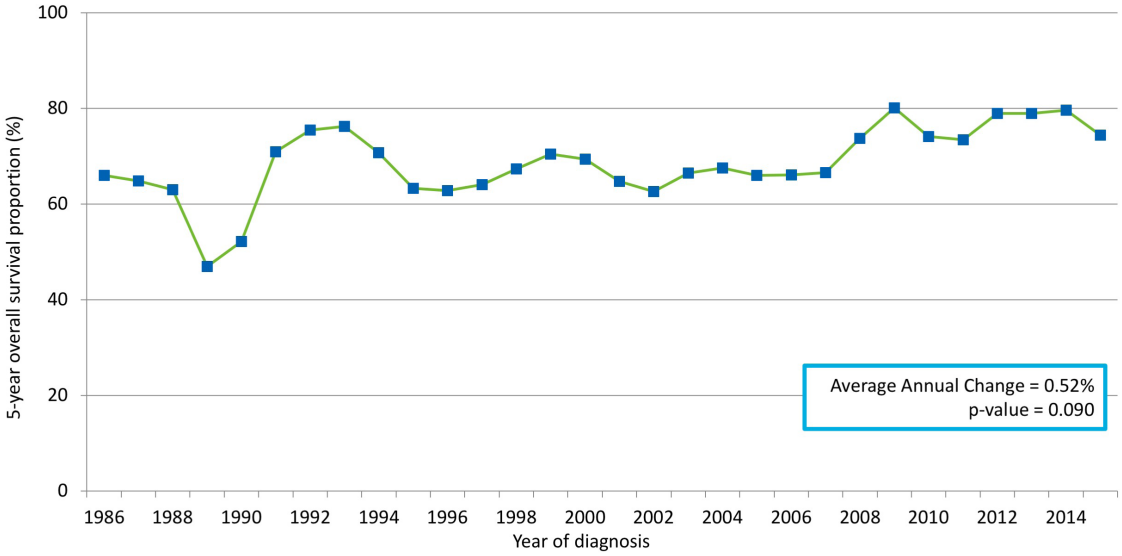


FIGURE 8.6

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH SOFT TISSUE AND OTHER EXTRAOSSEOUS SARCOMAS, AGED 0-14 YEARS, ONTARIO, 1986-2015

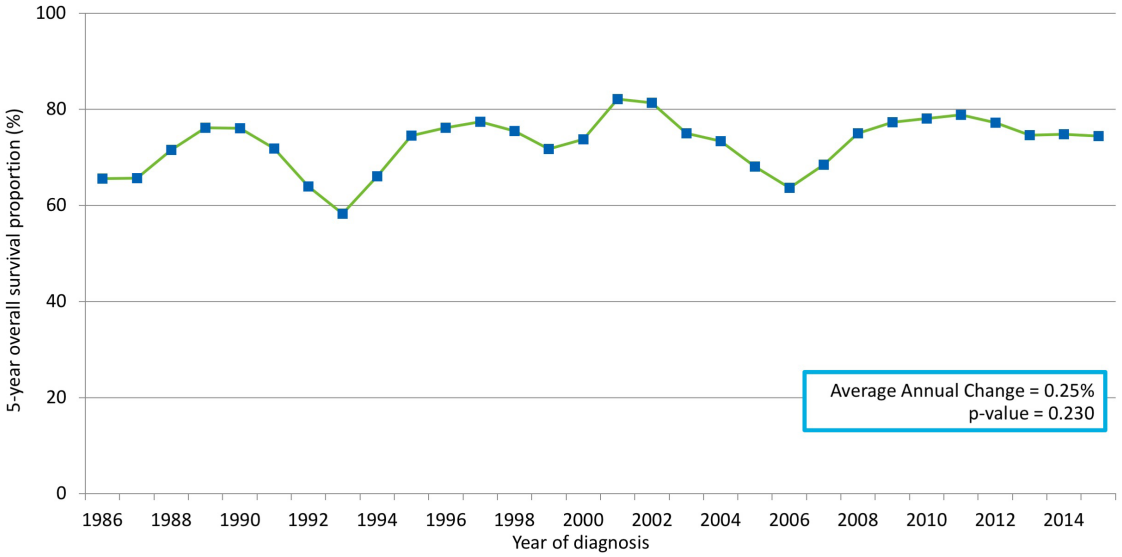
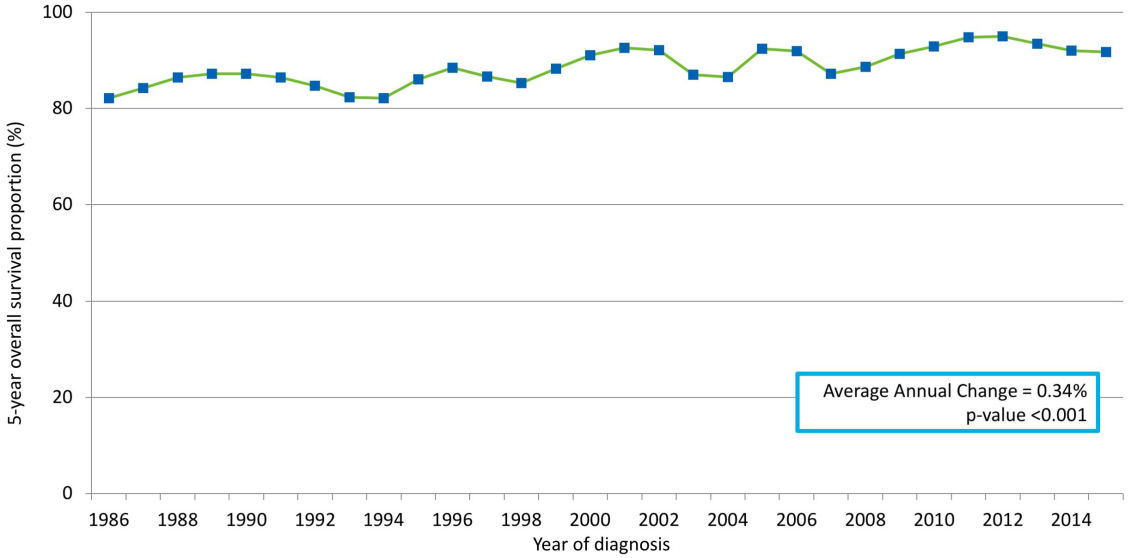


FIGURE 8.7

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH ALL OTHER AND UNSPECIFIED TUMOURS, AGED 0-14 YEARS, ONTARIO, 1986-2015



1. *The cohort method was used for cases diagnosed 1986-2011; the period method was used for cases diagnosed 2012-2015; tests of significance are based on non-smoothed data*
2. *Other and unspecified tumours include retinoblastoma, renal tumours, hepatic tumours, germ cell tumours and other/unspecified tumours*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

TABLE 2

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH CANCER, BY CANCER TYPE AND 5-YEAR PERIOD OF DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015

ICCC DIAGNOSIS GROUP	5-YEAR PERIOD OF DIAGNOSIS											
	1986 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015	
	5-Yr OSP	95% CI	5-Yr OSP	95% CI	5-Yr OSP	95% CI	5-Yr OSP	95% CI	5-Yr OSP	95% CI	5-Yr OSP	95% CI
ALL CANCERS COMBINED	**75.0**	**73.1-77.0**	**75.9**	**74.0-77.8**	**79.6**	**77.9-81.3**	**83.0**	**81.4-84.6**	**84.5**	**83.0-85.9**	**86.2**	**84.8-87.5**
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	77.2	73.9-80.4	78.3	75.2-81.4	81.5	78.8-84.2	88.6	86.2-90.9	89.8	87.7-91.9	89.6	87.6-91.6
II. Lymphomas and reticuloendothelial neoplasms	82.0	75.7-88.3	83.6	78.2-89.0	85.2	79.9-90.5	89.2	85.0-93.4	90.6	86.3-94.8	92.1	88.4-95.9
III. CNS and miscellaneous intracranial and intraspinal neoplasms	68.9	64.0-73.7	71.4	67.3-75.6	76.5	72.5-80.6	75.2	71.2-79.1	78.0	74.3-81.8	78.7	75.1-82.2
IV. Neuroblastoma and other peripheral nervous system tumours	61.7	53.9-69.4	63.5	55.7-71.3	64.6	57.2-72.0	73.0	66.2-79.9	76.1	70.0-82.2	85.7	80.4-91.0
V. Retinoblastoma	97.4	93.3-99.8	97.6	93.6-99.8	97.9	94.4-99.8	95.8	91.1-99.8	93.2	86.9-99.5	95.5	90.3-99.9
VI. Renal tumours	92.1	87.4-96.8	88.3	82.8-93.8	88.9	83.7-94.1	88.9	82.8-95.0	90.6	85.4-95.8	97.7	95.1-100.0
VII. Hepatic tumours	68.2	51.8-84.6	59.1	41.8-76.4	61.5	45.8-77.3	80.8	68.0-93.5	69.7	56.5-82.9	88.0	77.3-98.7
VIII. Malignant bone tumours	61.6	52.3-71.0	72.1	62.7-81.6	68.4	59.6-77.2	65.1	55.2-75.0	70.5	60.9-80.1	67.9	59.2-76.7
IX. Soft tissue and other extraosseous sarcomas	73.9	66.1-81.6	66.1	58.6-73.5	73.5	66.3-80.7	76.5	69.5-83.4	72.0	65.4-78.6	77.6	71.4-83.8
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	76.9	65.8-88.1	84.6	75.1-94.1	92.9	87.2-98.5	88.5	81.2-95.8	94.9	90.2-99.6	93.2	88.3-98.0
XI. & XII. Other and unspecified malignant neoplasms	75.7	64.0-87.3	70.8	55.5-86.1	84.0	75.4-92.6	90.6	84.6-96.6	95.1	91.2-99.0	90.4	84.7-96.1

CI – Confidence Interval; CNS – Central Nervous System; ICCC – International Classification of Childhood Cancer; OSP – Overall Survival Proportion

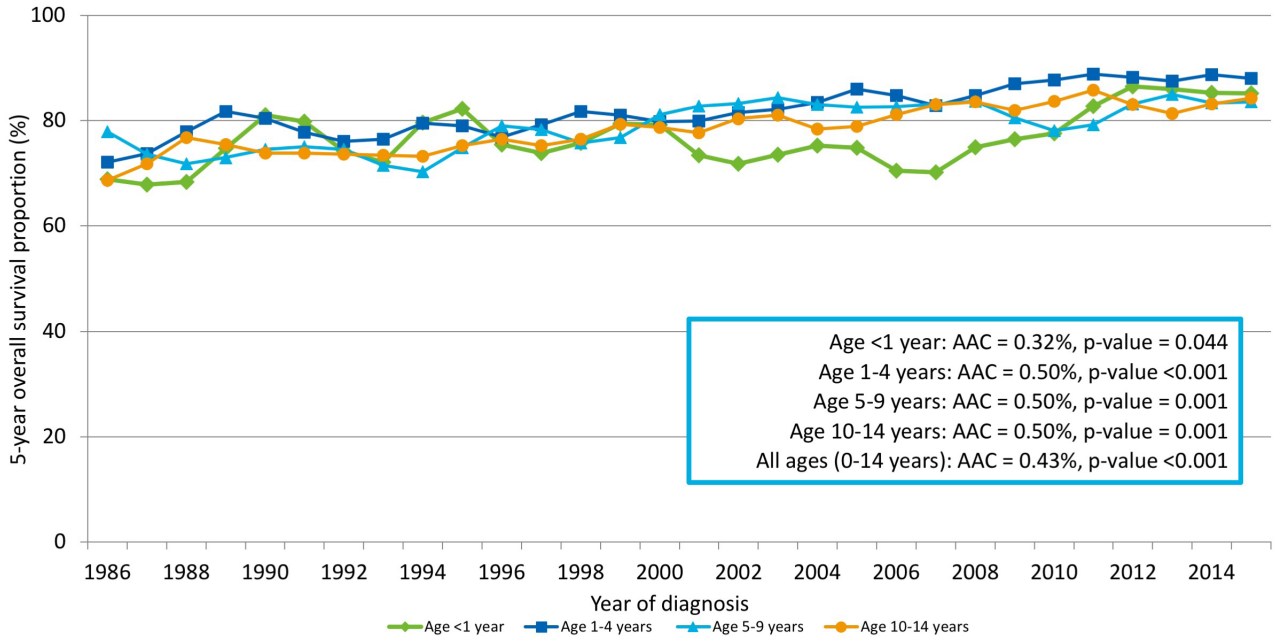
1. *The cohort survival analysis method was used for cases diagnosed between 1986–2011; the period method was used for cases diagnosed between 2012–2015*
2. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and incorporates specific changes to the International Classification of Disease for Oncology (ICD-O) system that were made for cases diagnosed from January 1, 2012 forward that are not reflected in the ICCC-3*
3. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

Survival by Age at Diagnosis

Improvements in 5-year OSPs were not limited to a specific age group (**Figure 9**). Children diagnosed at all ages experienced a 0.3% to 0.5% average annual increase in their survival rates between 1986–2015. Over the most recent 10-year period (2006–2015), infants diagnosed under the age of 1 year had the lowest 5-year OSP among all age groups (79.5%), while children aged 1–4 years at diagnosis had the highest 5-year OSP among all age groups (86.8%).

FIGURE 9

5-YEAR OVERALL SURVIVAL PROPORTIONS AMONG CHILDREN WITH CANCER, BY AGE GROUP AT DIAGNOSIS, AGED 0-14 YEARS, ONTARIO, 1986-2015



AAC – Average Annual Change

1. *The cohort method was used for cases diagnosed 1986–2011; the period method was used for cases diagnosed 2012–2015; rates are smoothed; tests of significance are based on non-smoothed data*
2. *Data Sources: Pediatric Oncology Group of Ontario Networked Information System (POGONIS), December 2017, POGO; and linkage with Ontario Cancer Registry and the Ontario Registrar General Death File*

CHAPTER 3

ESTIMATED CHILDHOOD CANCER PREVALENCE

Prevalence is defined as the number or percent of people alive on a certain date in a population, who previously had a diagnosis of childhood cancer. It includes new (incidence) and pre-existing cases, alive on a certain date, and is a function of both past incidence of the disease and survival.[33] Prevalence is a statistic of primary interest in public health as it identifies the level of the burden of disease or health-related events on the population and healthcare system.[33]

Given that POGONIS began capturing data on incident childhood cancers in Ontario in 1985, Ontario registry-based estimates of complete prevalence in Ontario were not feasible for the purposes of this work. In this report, complete prevalence estimates for Ontario were generated for the period 2007–2014, based on complete prevalence counts of childhood cancer survivors in the United States (US) as of January 1 of each year (2007–2014), generated by the Surveillance, Epidemiology, and End Results Program (SEER), adjusted for the size and composition of the Ontario population.[34-41] Specifically, childhood cancer prevalence was defined as the prevalence of people who were diagnosed with cancer 0–19 years of age, as prevalence estimates are not reported by SEER for ages 0–14 years. The SEER methodology for determining complete prevalence and further details regarding the methodology used to generate these figures are further described in the **Technical Appendix**.

Trend in Prevalence of Childhood Cancer Survivors

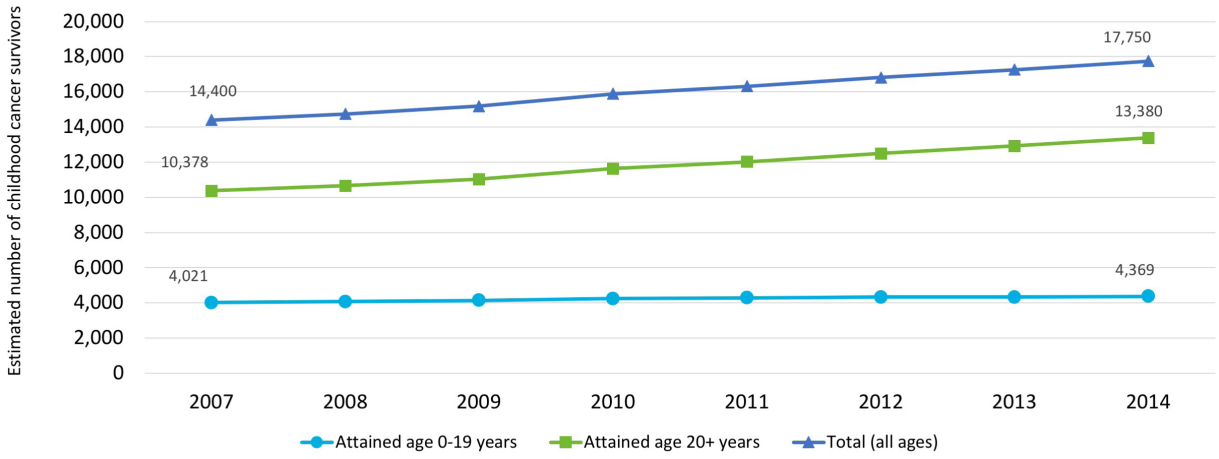
The prevalence of childhood cancer has risen steadily due to the increasing incidence of childhood cancer, combined with marked improvements in survival over the last few decades.

As of January 1, 2014, it was estimated that there were approximately 420,000 childhood cancer survivors in the US who were diagnosed with cancer, per the International Classification of Childhood Cancer, third edition (ICCC-3), between the ages of 0 and 19 years.[42] This translates into approximately 46,000 childhood cancer survivors in Canada and an estimated complete prevalence of 17,750 childhood cancer survivors in Ontario as of January 1, 2014.

Figure 10 provides the estimated number of childhood cancer survivors per year in Ontario, 2007–2014, and by attained age (for pediatric survivors of childhood cancer, attained age of 0-19 years, and adult survivors of childhood cancer, attained age of 20+ years). The estimated number of childhood cancer survivors increased by over 20% over the 8-year period, from 14,400 in 2007 to 17,750 in 2014. These increases are attributable primarily to the increasing number of adult survivors of childhood cancer, which increased by 28.9% over the 8-year period, compared with the number of pediatric survivors of childhood cancer, which increased by 1.1% per year. Over time, an increasing proportion of childhood cancer survivors will be adults, accounting for 75% of the total estimated prevalence in 2014.

FIGURE 10

ESTIMATED COMPLETE PREVALENCE COUNTS OF CHILDHOOD CANCER SURVIVORS IN ONTARIO, DIAGNOSED BETWEEN AGES 0-19 YEARS, BY ATTAINED AGE, 2007-2014



1. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and diagnosed 0–19 years of age*
2. *Data Sources: Surveillance, Epidemiology, and End Results (SEER) program (for prevalence data in the United States); intercensal estimates of resident population of the United States (April 1, 2000 to July 1, 2010); Statistics Canada (intercensal population estimates for the Ontario population)*

Prevalence of Childhood Cancer Survivors by Attained Age

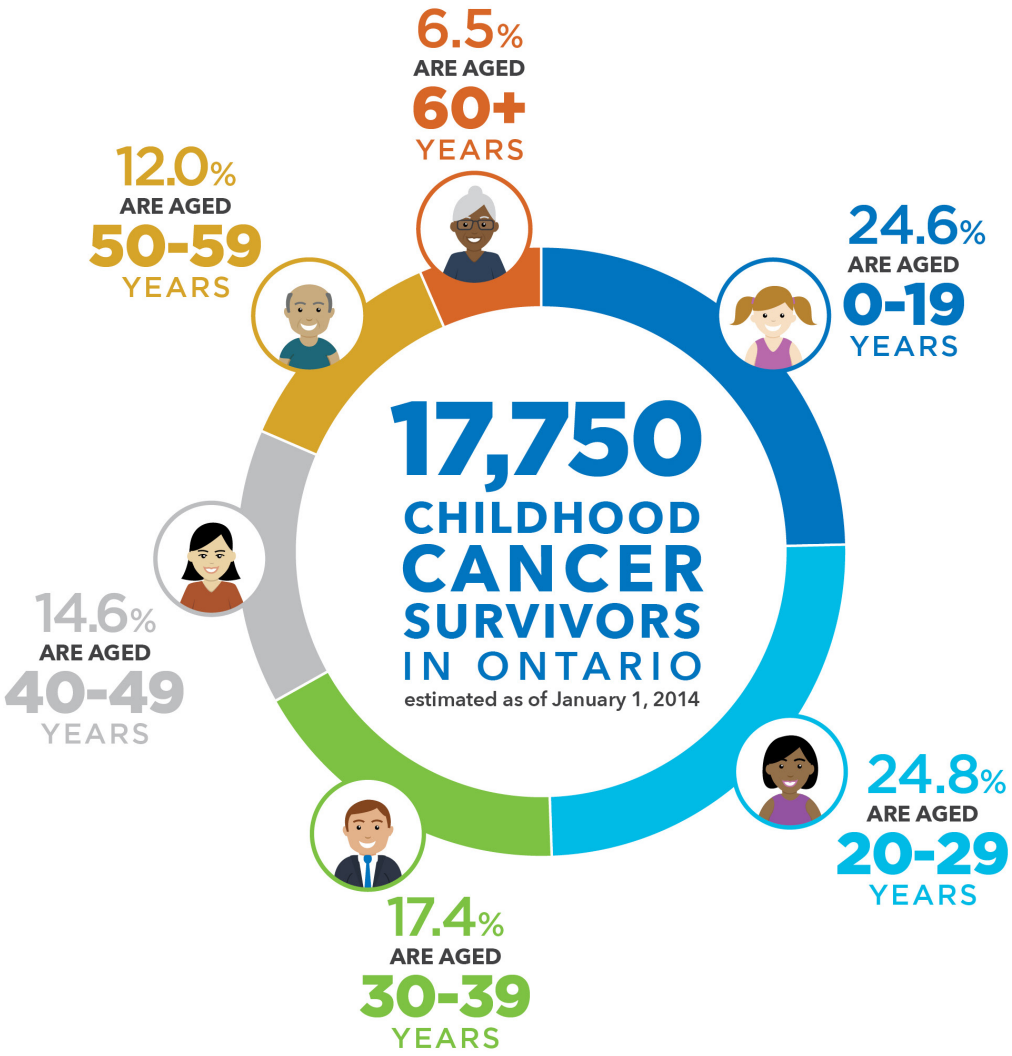
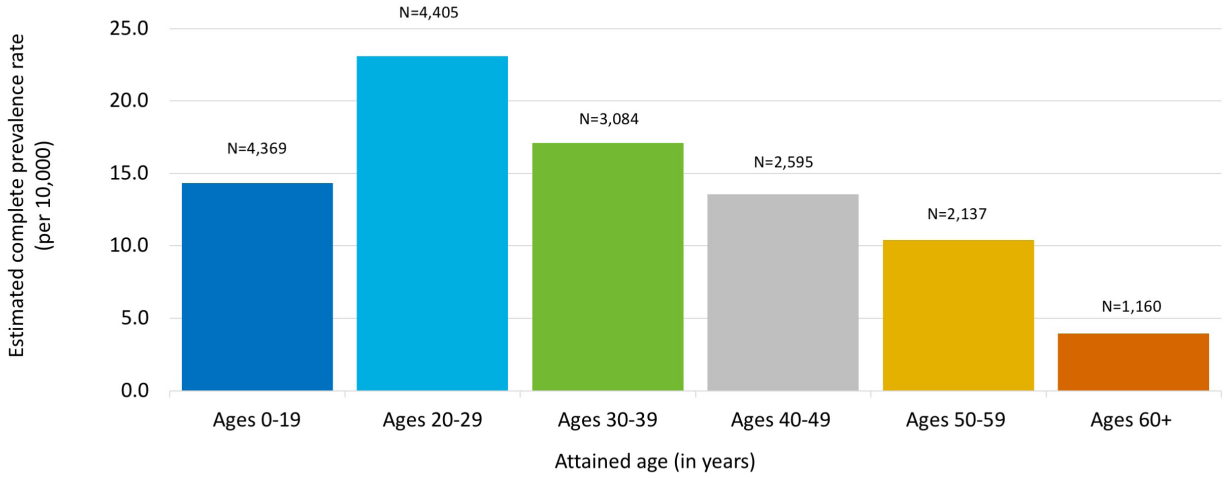


Figure 11 presents the estimated, age-specific complete prevalence rate of childhood cancer survivors in Ontario, per 10,000 population, as of January 1, 2014. It is estimated that 1 in 500 adults between the ages of 20 and 39 years is a childhood cancer survivor. In addition, approximately 40% of childhood cancer survivors in Ontario are estimated to be 20–39 years of age, and nearly 50% of childhood cancer survivors in Ontario were <30 years of age (24.6% aged <20 years and 24.8% aged 20–29). For childhood cancer survivors over the age of 30, it is estimated that the prevalence in Ontario decreases with increasing age group. Specifically, in 2014, 17.4% of survivors were 30–39 years of age, 14.6% were 40–49 years of age, 12.0% were 50–59 years of age, and 6.5% of survivors were 60+ years of age (**Figure 11**).

FIGURE 11

ESTIMATED AGE-SPECIFIC PREVALENCE RATES OF CHILDHOOD CANCER SURVIVORS IN ONTARIO, DIAGNOSED BETWEEN AGES 0-19 YEARS, BY ATTAINED AGE, AS OF JANUARY 1, 2014



1. *Includes cases classified as cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3), and diagnosed 0–19 years of age*
2. *Data Sources: Surveillance, Epidemiology, and End Results (SEER) program (for prevalence data in the United States); intercensal estimates of resident population of the United States (April 1, 2000 to July 1, 2010); Statistics Canada (intercensal population estimates for the Ontario population)*

TECHNICAL APPENDIX

Data Sources

Childhood Cancer Data

Data in this report regarding incidence, mortality and survival come from the Pediatric Oncology Group of Ontario Networked Information System (POGONIS), maintained by POGO and funded by the Ontario Ministry of Health and Long-Term Care.

Mortality Data

To systematically capture deaths in the entire cohort (from 1986 to 2015), regardless of location and age at death, death information in POGONIS is validated and supplemented via annual record linkage to the Ontario Cancer Registry and the Ontario Registrar General Death File under a data sharing agreement with Cancer Care Ontario.

Complete Prevalence Estimates

Complete prevalence counts for Ontario were estimated for the population of childhood cancer survivors, diagnosed 0–19 years of age, in Ontario for the period 2007-2014, based on the following sources of data:

- complete prevalence counts of childhood cancer survivors in the United States as of January 1 of each year (2007-2014) from the Surveillance, Epidemiology, and End Results Program (SEER) [34-41];
- intercensal estimates of the resident population by sex and age for the United States (April 1, 2000 to July 1, 2010) [43,44]; and
- intercensal population estimates from Statistics Canada for Ontario and Canada.[30]

Interpretation of these Statistics

Interpretation of the trends presented in this report should focus on the overall trends up to 2015, rather than the statistics in a particular year. Childhood cancer is relatively uncommon, and therefore, year-by-year fluctuations and variability in the incidence and survival estimates arise due to the relatively small number of childhood cancer diagnoses and deaths each year.

Analysis Methods

Classification of Childhood Cancer

The POGONIS database classifies childhood cancer according to the International Classification of Childhood Cancer, third edition (ICCC-3).[31] The ICCC-3 classification divides childhood cancer into 12 main diagnostic groups, with 47 subgroups for additional refinement. Shifts in classification at the subgroup level and refining of specificity of diagnoses occur over time as a result of the advent of ever more sophisticated diagnostic tools, including immunohistochemistry and molecular diagnostics. These advances permit finer identification of clinical disease subsets and therefore re-assignment to other diagnostic categories. Some disease entities had not been identified at the time of diagnosis for a proportion of cases in the database. If these cases were diagnosed today, they would be assigned to a different classification category, most frequently within the same major ICCC-3 group but occasionally to a completely different group.

The classification of each case applied in this analysis is true to the timing of the diagnosis and the associated International Classification of Diseases for Oncology (ICD-O) morphology code for that period. An updated version of the ICD-O-3 system was published (2013) and incorporates coding changes from the World Health Organization (WHO) Blue Books, published between 2007 and 2010. These coding changes are not reflected in the ICCC-3 (published in 2005), but have been integrated into POGONIS for cases diagnosed as of January 1, 2012. Therefore, POGO has developed an updated ICCC classification based on:

- incorporation of the changes to the ICD-O-3.1 codes based on Ontario clinical and epidemiological expertise; and
- comparison with the SEER ICCC Recode ICD-O-3/WHO 2008.[45]

The supplementary table summarizes the differences between POGO's assignment of specific ICD-O codes to the ICCC-3 diagnostic categories, compared to those listed in ICCC-3.[31] The majority of the codes included in the POGO classification table are not found in the ICCC-3. In addition, some codes included in the Supplementary Table reflect those that have been reclassified by POGO to different classification subgroups (based on Ontario clinical expertise).

SUPPLEMENTARY TABLE

DIFFERENCES BETWEEN POGO UPDATE OF ICCC-3 CLASSIFICATION COMPARED WITH ICCC-3 CLASSIFICATION

TIME PERIOD(S) OF ICD-O CODING REVISIONS*	ICD-O CODE(S) ‡	ICD-O DESCRIPTION	ICCC CATEGORY	
			PER POGONIS	PER ICCC [31]
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases				
1985–1999	9801/3	Acute biphenotypic leukemia NOS	I.a. Lymphoid leukemias	I.e. Unspecified and other specified leukemias
2000–2011, 2012–2015	9805/3	Acute biphenotypic leukemia NOS	I.a. Lymphoid leukemias	I.e. Unspecified and other specified leukemias
2012–2015	9806/3	Mixed phenotype acute leukemia with t(9;22) (q34;q11.2); BCR-ABL1	I.a. Lymphoid leukemias	N/A
2012–2015	9807/3	Mixed phenotype acute leukemia with t(v;11q23); MLL rearranged	I.a. Lymphoid leukemias	N/A
2012–2015	9808/3	Mixed phenotype acute leukemia, B/myeloid, NOS	I.a. Lymphoid leukemias	N/A
2012–2015	9809/3	Mixed phenotype acute leukemia, T/myeloid, NOS	I.a. Lymphoid leukemias	N/A
2000–2011, 2012–2015	9940/3	Leukemic reticuloendotheliosis	I.b. Acute myeloid leukemia	I.a. Lymphoid leukemias
2012–2015	9898/3	Myeloid leukemia associated with Down Syndrome	I.b. Acute myeloid leukemia	N/A
II. Lymphomas and reticuloendothelial neoplasms				
2012–2015	9597/3	Primary cutaneous follicle centre lymphoma	II.b. Non-Hodgkin lymphomas (except Burkitt lymphoma)	N/A
2012–2015	9688/3	T-cell rich large B-cell lymphoma	II.b. Non-Hodgkin lymphomas (except Burkitt lymphoma)	N/A
2012–2015	9737/3	ALK positive large B-cell lymphoma	II.b. Non-Hodgkin lymphomas (except Burkitt lymphoma)	N/A
1985–1999	9722/3	Langerhans cell histiocytosis, NOS	II.d. Miscellaneous lymphoreticular neoplasms	N/A
2012–2015	9751/3	Langerhans cell histiocytosis, NOS	II.d. Miscellaneous lymphoreticular neoplasms	N/A
2000–2011, 2012–2015	9971/3	Polymorphic post transplant lymphoproliferative disorder (PTLD)	II.d. Miscellaneous lymphoreticular neoplasms	N/A

SUPPLEMENTARY TABLE (CONTINUED)

DIFFERENCES BETWEEN POGO UPDATE OF ICCC-3 CLASSIFICATION COMPARED WITH ICCC-3 CLASSIFICATION

TIME PERIOD(S) OF ICD-O CODING REVISIONS*	ICD-O CODE(S) ‡	ICD-O DESCRIPTION	ICCC CATEGORY	
			PER POGONIS	PER ICCC [31]
III. CNS and miscellaneous intracranial and intraspinal neoplasms				
2012–2015	9425/3	Pilomyxoid astrocytoma	III.b. Astrocytomas	N/A
1985–1999	9490/0	Gangliocytoma (B)	III.e. Other specified intracranial and intraspinal neoplasms	N/A
2012–2015	9395/3	Papillary tumour of the pineal region	III.e. Other specified intracranial and intraspinal neoplasms	N/A
VIII. Malignant bone tumours				
1985–1999, 2000–2011, 2012–2015	9231/3 (C40.0–C41.9, C76.0–C76.8, C80.9)	Myxoid chondrosarcoma	VIII.b. Chondrosarcomas	N/A
IX. Soft tissue and other extraosseous sarcomas				
1985–1999, 2000–2011, 2012–2015	8800/3	Soft tissue sarcomas, NOS	IX.d. Other specified soft tissue sarcomas	IX.e. Unspecified soft tissue sarcomas
1985–1999	8803/3 (C34.0–34.9, C39.0–39.9, C44.0–47.9)	Askin's tumour	IX.d. Other specified soft tissue sarcomas	IX.e. Unspecified soft tissue sarcomas
1985–1999, 2000–2011, 2012–2015	8804/3	Epithelioid sarcoma	IX.d. Other specified soft tissue sarcomas	IX.e. Unspecified soft tissue sarcomas
1985–1999	8900/3	Ectomesenchymoma	IX.d. Other specified soft tissue sarcomas	IX.a. Rhabdomyosarcomas
1985–1999, 2000–2011, 2012–2015	8991/3	Embryonal sarcoma	IX.d. Other specified soft tissue sarcomas	IX.a. Rhabdomyosarcomas
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads				
1985–1999, 2000–2011, 2012–2015	8000/3 (C70.0–C72.9, C75.1–C75.3)	Neoplasm, malignant	X.a. Intracranial and intraspinal germ cell tumours	N/A
1985–1999, 2000–2011, 2012–2015	8000/3 (C56.9, C62.0–C62.9)	Neoplasm, malignant	X.c. Malignant gonadal germ cell tumours	X.e. Other and unspecified malignant gonadal tumours

CNS–Central Nervous System; ICCC – International Classification of Childhood Cancer; ICD-O – International Classification of Diseases for Oncology; N/A – Not applicable; NOS – Not Otherwise Specified

**Each Time Period reflects the time frame corresponding to a specific edition of the World Health Organization (WHO) International Classification of Disease for Oncology, Morphology (ICD-O-M) listing, i.e., ICD-O 2 (for Time Period 1: 1985–1999); ICD-O 3 (for Time Period 2: 2000–2011); and ICD-O 3.1 (for Time Period 3: 2012–2015).*

‡ ICD-O codes include ICD-O-2, ICD-O-3 or ICD-O-3.1 codes (corresponding to the ICD-O code in the given time period) and represent the "morphology code/behaviour codes." Where applicable, topography (site) codes are also specified.

Coding Rules For Multiple Primary Cancers

Incidence rates are based on all childhood cancer patients, aged 0–14 years at time of diagnosis between 1986 and 2015, and registered in POGONIS. Every occurrence of childhood cancer is considered an incident (or new) case. For subjects diagnosed with a subsequent, morphologically different primary cancer during follow up, each cancer is considered an incident case.

Significance Testing

Throughout this report, "significant" refers to statistical significance at an alpha level of 0.05 for changes in trend or when comparing differences in rates. Non-significant changes in trend are described in this report as "stable." All tests for significance are based on unsmoothed rates. In this report, all p-values were estimated using linear regression. This statistical test assesses if the average annual change is different from zero.

Cancer Incidence And Mortality

Counts

Incidence counts are the number of new cancer cases diagnosed in a population during a specified time period. In this report, this refers to the number of new cancer diagnoses in children, diagnosed between 0 and 14 years of age, between 1986 and 2015, resident of Ontario and registered in POGONIS. Currently, complete death-cleared incidence data are available up to December 31, 2016.

Mortality counts describe the number of deaths attributed to cancer during a specific period of time in a specific population. In this report, mortality refers to the number of deaths amongst children with cancer in a calendar year in Ontario. For consistency, this report includes cases diagnosed during the same range of years for incidence and mortality (i.e., 1986 to 2015).

Rates

Incidence and mortality rates are the number of new cancer cases or deaths per 1,000,000 people in a population during a specific time period. This is sometimes called the "crude rate" since it does not adjust for the age distribution of the population.

In this report, rates were calculated regardless of the number of aggregated cases unless otherwise specified. Given the relative rarity of some cancers, the rates presented in this report should be interpreted with caution, as it can be difficult to distinguish differences based on random variation from true differences in the rate when the number of cases is small.

Age-Standardized Incidence Rate (ASIR)

The age-specific incidence rate is the number of new cases found in a given age group divided by the number of children in that age group in the general population in the same time period, expressed as rate per million.

The age standardized incidence rate (ASIR) is a weighted average of age-specific incidence rate, where the weights are the proportions of persons in the corresponding age groups in a standard population. This statistical adjustment reduces the potential confounding effect of age. The standard population used in the calculations was the Canadian population in 2011. Direct standardization was used in estimating ASIRs in this report to allow for comparability with other jurisdictions.

Age-standardized rates are adjusted for differences in the age structure of different populations, which

permits comparisons of cancer incidence or mortality among populations that differ in size, structure, time period or all three factors. Age-standardized rates give the rate that would have occurred if the population of Ontario had the same age distribution as the standard population.

Disease-specific ASIRs per year are provided for each main category of the ICCC-3 classification system. Included with each figure is the average annual change in ASIR and associated p-value, estimated using linear regression. This statistical test assesses if the average annual change is different from zero. P-values equal to or less than 0.05 indicate the change is statistically significant.

Age-Standardized Mortality Rate (ASMR)

The age-standardized mortality rate (ASMR) is a weighted average of age-specific mortality rate, where the weights are the proportions of persons in the corresponding age groups in a standard population. This statistical adjustment reduces the potential confounding effect of age. The standard population used in the calculations was the Canadian population in 2011. Direct standardization was used in estimating ASMRs.

ASMRs were calculated stratifying by ICCC diagnostic groups, death year and age at time of death (grouped into a four-category age variable: less than 1 year, 1–4 years, 5–9 years and 10–14 years). The year-specific counts represent the number of deaths registered among childhood cancer patients aged 0–14 years in each given year.

Disease-specific ASMRs per year are provided for each main category of the ICCC-3 classification system and selected subgroups. Included with each figure is the average annual change in ASMR (per 1 million population) and associated p-value, estimated using linear regression. Included with each figure is the average annual change in ASMR and associated p-value, estimated using linear regression. This statistical test assesses if the average annual change is different from zero. P-values equal to or less than 0.05 indicate the change is statistically significant.

Survival

Survival analyses were based on first primary cancers. Overall survival proportions (OSPs) are provided for children with a diagnosis that is included in the POGO updated ICCC-3, diagnosed between 0 and 14 years of age and from 1986 to 2015. For overall survival calculations, person-time was calculated in months from the date of a subject's first diagnosis to the date of death, or if the subject survived, to December 31, 2016. Subjects were censored at the earlier of the time of death or the end of the follow-up period (December 31, 2016).

In this report, OSPs were estimated using the cohort method when complete follow-up data after diagnosis (e.g., at least five years of follow up to estimate the 5-year OSP) were available (e.g., for cases diagnosed between January 1, 1986 and December 1, 2011). For recently diagnosed cases whose complete follow-up data were not available (i.e., diagnosed since January 1, 2012), the estimates were calculated using the period survival methodology.[46,47] Period analysis uses the survival experience of people in a recent time interval to estimate survival.

The period survival method, modelled after period life tables, allows for a more up-to-date representation of the survival probability at the time the latest mortality information was available.[48-51]. With the period survival method, analyses do not have to wait for complete data on the full follow-

up period (e.g., five years after diagnosis). This methodology has been employed by many provincial and national cancer publications and hence permits the estimates in this report to be compared with other published data.[52] Comparisons of 5-year OSPs between cohort and period analyses should be interpreted with caution due to the two different methods used to derive the respective estimates.

Prevalence

Data regarding the childhood population diagnosed with cancer since 1985 in a POGO partner centre have been collected in POGONIS since 1985 and in the Ontario Cancer Registry since 1964. Since people diagnosed with cancer in their childhood can live for a very long time following their diagnosis, prevalence counts based on incidence and survival data captured in Ontario's registries would underestimate the number of childhood cancer survivors in the population. For example, in considering childhood cancers diagnosed since 1985 between 0 and 19 years of age, limited duration prevalence (i.e., 30-year prevalence as of January 1, 2015) would include only patients who are 49 years of age or younger.[33] Survivors older than 49 years at the prevalence date would not be included and, therefore, the 30-year prevalence would be underestimated. Given that POGONIS began capturing data on incident childhood cancers in Ontario in 1985, Ontario registry-based estimates of complete prevalence in Ontario were not feasible for the purposes of this work.

Complete prevalence estimates for Ontario were generated for the period 2007–2014, based on complete prevalence counts of childhood cancer survivors in the United States (US) as of January 1 of each year (2007–2014), generated by SEER.[34-41]

SEER prevalence estimates are derived based on the counting method to estimate prevalence from incidence and follow-up data from the SEER cancer registries.[33] The counting method estimates prevalence by counting the number of persons who are known to be alive as of a specific date and adjusting for those lost to follow up. Prevalence estimates obtained using the counting method are limited-duration prevalence due to the length of registration time. For example, incidence data collected from 1975 through 2013 yields a maximum of 39-years prevalence, in other words, prevalence of people diagnosed in the previous 39 years. In addition, SEER uses a method similar to the completeness index method [53] to estimate the long-term survivors of childhood cancers and the complete (unlimited) prevalence from limited-duration prevalence.[54,55]

Age-specific prevalence rates were calculated for the US population of children diagnosed with cancer, 0–19 years of age, based on estimates of the resident population by sex and age for the US (April 1, 2000 to July 1, 2010).[43,44] Age-specific prevalence rates in the US were then adjusted for the size and age distribution of the Ontario population, based on population estimates from Statistics Canada,[30] to estimate the complete prevalence of childhood cancer survivors in Ontario. SEER estimates of childhood cancer prevalence prior to 2007 were not available at the time of this analysis.

GLOSSARY OF TERMS

A

Age-Specific Rate of incidence or mortality is the number of new cases or deaths found in a given age group divided by the number of children in that age group in the general population in the same time period, expressed as rate per million.

Age-Standardized (Incidence/Mortality) Rate is a weighted average of the age-specific incidence (or mortality) rate, where the weights are the proportions of persons in the corresponding age groups in a standard population. This statistical adjustment reduces the potential confounding effects of age. Age-standardized rates are adjusted for differences in the age structure of different populations, which permits comparisons of cancer incidence or mortality among populations that differ in size, structure, time period or any combination of these factors. Age-standardized rates represent the rate that would have occurred if the population of Ontario had the same age distribution as the standard population.

B

Benign (also called **non-malignant** or not cancerous) tumours may grow larger but do not spread to other parts of the body.[56] The International Classification of Childhood Cancer (ICCC) includes all malignant cancers in children, as well as benign tumours and neoplasms of indeterminate behaviour in the central nervous system.[31]

C

Childhood Cancer (or **pediatric cancer**) describes cancer diagnosed and cancer deaths in children up to and including the age of 14 years, and are classified according to the International Classification of Childhood Cancer, 3rd edition (ICCC-3).

Confidence Interval is an estimated range of values with a given probability, e.g., 95% (p-value = 0.05), that the true value of a variable, such as a mean, proportion or rate, is contained within the specified interval.[57] An indication of the precision of an estimate. A wide confidence interval indicates less precision, while a narrow confidence interval indicates more precision in the estimate. For example, if the 5-year overall survival proportion (OSP) is estimated as 73%, with a 95% confidence interval of 61.7–84.3%, then we are 95% confident that the actual 5-year OSP would be between 61.7–84.3%. However, there is still a 5% chance that the actual 5-year OSP is not within the confidence interval (between the upper and lower confidence limits).[58]

Count is the number of cases (incidence or new cancer cases), deaths, or prevalence cases in a given time period or at a particular point in time (see **Incidence Count** and **Mortality Count**).

Crude Rate of incidence or mortality is the number of new cancer cases or deaths per 1,000,000 people in a population during a specific time period. This is called the "crude rate" since it does not adjust for the age distribution of the population.

F

5-Year Overall Survival Proportion is the percentage of people in a population, study or treatment group who are alive five years after they were diagnosed with a disease, such as cancer. The disease may or may not have come back (or relapsed).

I

ICCC is a diagnostic classification scheme for childhood cancer. At the time the World Health Organization's (WHO) International Agency for Research on Cancer (IARC) published their first monograph on childhood cancer in 1988, Dr. R. Marsden published a supplement that classified childhood cancer into 12 groups based chiefly on histologic type. The classification by Marsden has been modified and is now called the International Classification of Childhood Cancers (ICCC).[58]

Incidence Count is the number of new cancer cases diagnosed in a population during a specified time period. One patient may have multiple primary cancer diagnoses. Every occurrence of childhood cancer is considered an incident (or new) case. In subjects diagnosed with a subsequent, different primary cancer during follow up, each cancer is considered a new case.

Incidence Rate is the ratio of the number of new cancers of a specific site/type occurring in a specified population during a year to the number of individuals who were at risk for the given cancer, generally expressed as the number of cancers per 1,000,000 persons.

L

Linear Regression is a statistical test that assesses if the average annual change in a continuous value is different from zero. P-values less than or equal to 0.05 indicate that the change is statistically significant.

M

Malignant (or cancerous) cells can invade and destroy nearby tissue and spread to other parts of the body.[56] The ICCC includes all malignant cancers in children, as well as benign tumours and neoplasms of indeterminate behaviour in the central nervous system.[31]

Mortality Count is the number of deaths attributed to cancer during a specific period of time in a specific population. In this report, mortality refers to the number of deaths among children with cancer in a calendar year in Ontario.

N

Neoplasm is an abnormal mass of tissue that results when cells divide more than they should or do not die when they should. Neoplasms may be benign (not cancer), of indeterminate behaviour (NIB) or malignant (cancer).[56] The ICCC includes all malignant cancers in children, as well as benign tumours and neoplasms of indeterminate behaviour in the central nervous system.[31]

Non-Malignant (see **Benign**)

O

Overall Survival is an estimate of the probability of surviving all causes of death for a specified time interval following diagnosis of cancer from a cohort of cancer cases. An overall survival proportion does not consider cause of death. It simply looks at who is alive and who is not. Sometimes, overall survival proportions are referred to as observed survival proportions, overall survival rates or survival rate, in relation to the number of years following a diagnosis of cancer.

P

Pediatric Cancer (see **Childhood Cancer**)

Percent Change is a statistic calculated over a given time interval and is based on the following formula: *Percent Change = (Final Value – Initial Value) / Initial Value * 100*. A positive percent change corresponds to an increasing trend, while a negative percent change represents a decreasing trend. [58]

Prevalence is defined as the number or percent of people alive on a certain date in a population who previously had a diagnosis of the disease. It includes new (incidence) and pre-existing cases and is a function of both past incidence and survival. Prevalence is a statistic of primary interest in public health because it identifies the level of burden of disease or health-related events on the population and healthcare system. Information on prevalence can be used for health planning, resource allocation and an estimate of cancer survivorship.

Prevalence, Complete is the number of people alive on a certain day who have been diagnosed with cancer at any time in their lives, regardless of how long ago the diagnosis was, or if the patient is still under treatment or is considered cured. This differs from incidence in that it considers both newly diagnosed and previously diagnosed people.[58]

Primary Cancer is used to describe the original, or first, cancer in the body. Cancer cells from a primary cancer may spread to other parts of the body and form new, or secondary tumours. This is called metastasis. These secondary tumours are the same type of cancer as the primary cancer. A patient may have more than one primary cancer diagnosis (i.e., more than one type of cancer, known as **Subsequent Malignant Neoplasm[s]**).

Probability is the chance that an event will occur. It is usually expressed as a percentage. Zero percent denotes impossibility, while 100% denotes certainty.[58]

P-value is a term used in statistics to help show whether a difference found between groups being compared is due to chance. A small p-value (e.g., ≤ 0.05) usually means that the difference between groups is not due to chance alone but is due to some other factor, such as the treatment one of the groups received. A large p-value (>0.05) usually means that the difference between groups is probably due to chance alone.[58]

S

Standard Population is a table providing the proportions of the population falling into standard age groups (0, 1–4, 5–9, 10–14 years of age) for a geographic area, such as Ontario, Canada, or the world. The standard population used in this report is the 2011 Canadian census population.

Statistical Significance describes a mathematical measure of difference between groups. The difference is said to be statistically significant if it is greater than what might be expected to happen by chance alone, 95% of the time.[58]

Surveillance includes the systematic, ongoing collection, collation, review, analysis and interpretation of health data, essential to planning, implementation and evaluation of public health practice, closely integrated with the timely dissemination of these data and information to relevant stakeholders. Cancer surveillance data are used to monitor changes in cancer in a population and can be used to evaluate cancer control programs and efforts. Included are measures of cancer incidence (new cases), prevalence, morbidity, survival and mortality.[57,58]

Survival is a statistical analysis that examines how long after diagnosis people live. Cancer survival is measured in a number of different ways, depending on the intended purposes. Specific types of survival statistics are defined under **Overall Survival**.[58]

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