

Childhood Cancer in Ohio 2019



Introduction

Cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled, it can result in death. Cancer in children and adolescents is rare, accounting for less than 1 percent of all new cancers in the United States. Cancer is the second leading cause of death among children ages 1 to 14 years in the United States, surpassed only by accidents. In the United States in 2019, an estimated 11,060 new cancer cases and 1,190 cancer deaths are expected to occur among children. Among U.S. adolescents, about 5,000 will be diagnosed with cancer and about 600 will die of the disease.

In this document, cancer among children is defined as cancer diagnosed among persons ages 0-14 and adolescent cancer is among persons ages 15-19. The rates in this document are presented as the number of cases per 1,000,000 persons, whereas rates for adults are typically reported as the number of cases per 100,000 persons.

The types of cancer that develop in children and adolescents differ from those that develop in adults. Overall, among children and adolescents (ages 0 to 19) in the United States, the most common types of cancer are leukemias, brain and central nervous system (CNS) tumors, and lymphomas. Page 2 shows a list of the most common types of cancer in children and adolescents.

Key Findings

- An average of 555 new invasive cancer cases and 60 cancer deaths occurred each year among children and adolescents in Ohio during 2012-2016.
 - Child and adolescent cancer incidence rates were greater for males, whites and those ages 15 to 19 years in both Ohio and the United States. In Ohio, cancer mortality rates were higher for males, blacks and those ages 15-19 years.
 - In Ohio, the leading cancer types among children were leukemias (27 percent), brain and other CNS tumors (23 percent), and lymphomas (12 percent).
 - The leading cancer types among adolescents in Ohio were lymphomas (22 percent), thyroid cancer (14 percent) and leukemias (13 percent).
 - Incidence rates of child and adolescent cancer do not exhibit a clear geographic pattern in Ohio at the county level.
 - Overall, cancer incidence rates increased slightly from 1997-2016 among both children and adolescents in Ohio.
 - Mortality rates of all child and adolescent cancers combined declined 24 percent in Ohio from 1997-2016.
 - The causes of most childhood cancers are largely unknown. Certain chromosomes, genetic syndromes and ionizing radiation are known risk factors, but only explain a small percentage of cases.
 - Signs and symptoms of child and adolescent cancer are similar to other common conditions in this age group; thus, early diagnosis is difficult.
 - The Ohio five-year relative survival for all cancer types combined is 84.3 percent among children and adolescents.
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Common Cancer Types among Children and Adolescents

The common types of cancer that develop in children and adolescents, in alphabetical order, include:

Bone tumors: Cancer that forms in cells of the bone. The most common types of bone cancer in children are osteosarcoma and Ewing sarcoma.

Brain and other CNS tumors: The growth of abnormal cells in the tissues of the brain and other CNS. The most common types of brain and other CNS tumors in children are medulloblastoma, astrocytoma, ependymoma and brain stem glioma.

Germ cell tumors: A diverse group of tumors that arise from either the ovaries in girls or the testicles in boys. These tumors are most common in adolescents.

Hepatic tumors: Cancer that forms in the tissues of the liver.

Leukemias: Cancer that originates in the bone marrow and causes large numbers of abnormal blood cells, particularly white blood cells, to be produced and enter the bloodstream. Two major types of leukemia in children and adolescents include:

Lymphocytic leukemia: Cancer of blood-forming cells arising in the bone marrow that starts from lymphocytes. Lymphocytic leukemia may be acute and develop quickly or chronic and develop slowly. In the United States, acute lymphocytic leukemia (ALL) accounts for about 75 percent of the leukemia cases among children and adolescents.

Acute myeloid leukemia: Cancer of blood-forming cells arising in the bone marrow that starts from myeloid cells and grows quickly. Nationally, acute myeloid leukemia (AML) accounts for about 17 percent of leukemia cases among children and adolescents.

Lymphomas: Cancer that begins in cells of the immune system. There are two basic categories of lymphomas:

Hodgkin lymphoma: Cancer of the lymphatic system that is marked by the presence of a type of cell called the Reed–Sternberg cell. Hodgkin lymphoma often starts in the lymph nodes in the chest, neck or abdomen. Hodgkin lymphoma is rare in children but increases rapidly from age 10 through adolescence.

Non-Hodgkin lymphoma: Cancer of the lymphatic system, excluding Hodgkin lymphoma. The most common types of non-Hodgkin lymphoma in children are Burkitt lymphoma, lymphoblastic lymphoma and large cell lymphoma.

Melanoma of the skin: Cancer that begins in melanocytes (cells that make the pigment melanin) in the skin.

Neuroblastomas: Cancer that arises in immature nerve cells and affects mostly infants and children.

Renal tumors: Cancer of the kidney. The vast majority of kidney tumors in children are Wilms tumor.

Retinoblastomas: Cancer that forms in the tissues of the retina (the light-sensitive layers of nerve tissue at the back of the eye).

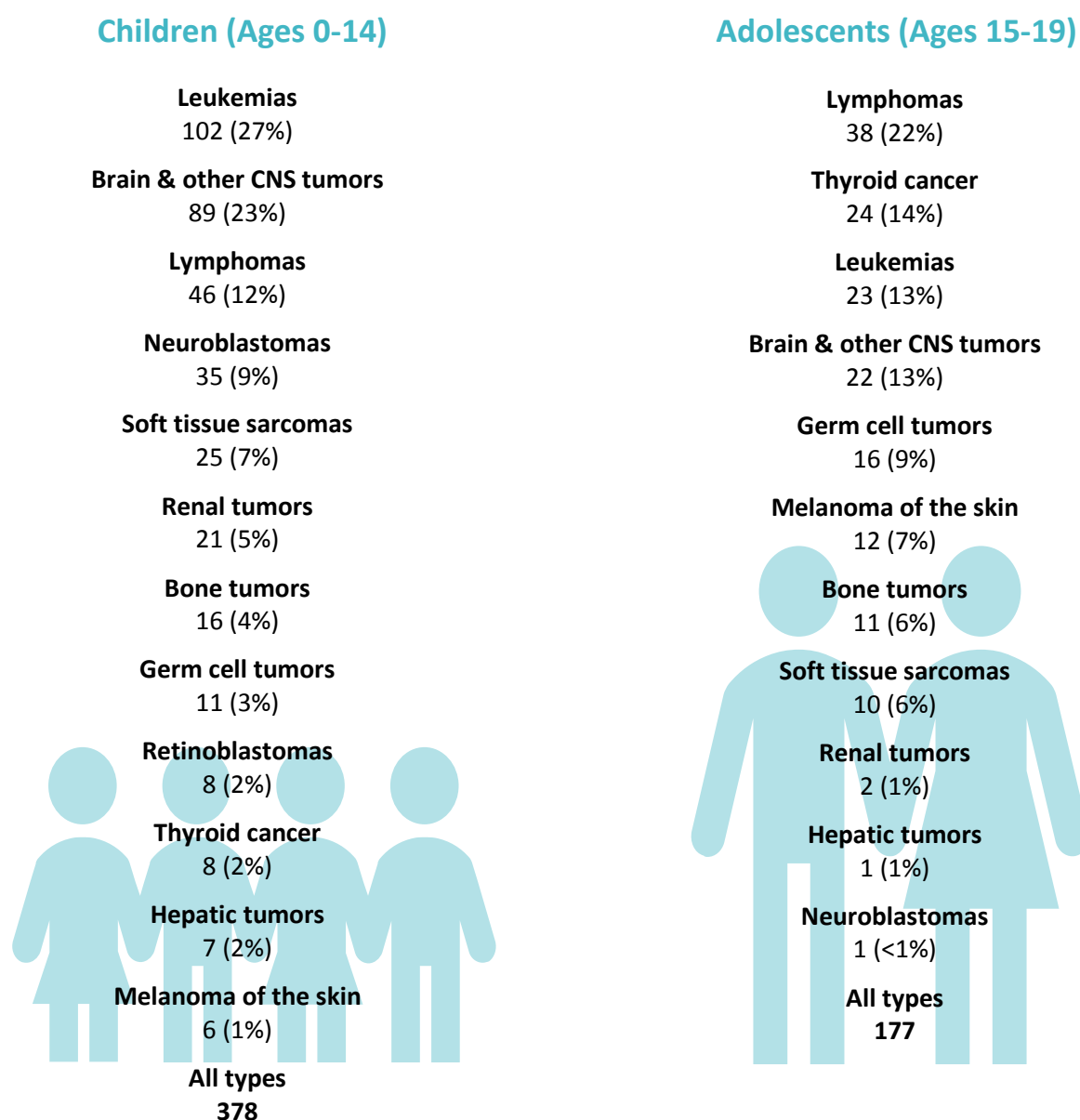
Soft tissue sarcomas: Cancer that begins in the muscle, fat, fibrous tissue, blood vessels or other supporting tissues of the body. The most common soft tissue sarcoma is rhabdomyosarcoma.

Thyroid cancer: Cancer that forms in the thyroid gland.

Leading Cancer Types Among Children and Adolescents in Ohio

Figure 1 shows the average annual number and proportion of new invasive cancer cases among children and adolescents in Ohio from 2012-2016 for the leading types of cancer in these age groups. Leukemias (102 cases per year) and brain and other CNS tumors (89 cases per year) accounted for 27 percent and 23 percent of the newly diagnosed cancers, respectively, among children in this time frame. Lymphomas were the leading cancer in adolescents (38 cases, 22 percent), followed by thyroid cancer (24 cases, 14 percent), leukemias (23 cases, 13 percent) and brain and other CNS tumors (22 cases, 13 percent). In addition to invasive cancers, an average of 26 cases of benign brain tumors were diagnosed annually among children and 12 cases were diagnosed each year among adolescents in Ohio during 2012-2016 (data not shown).

Figure 1. Leading Cancer Types: Average Annual Number and Proportion of New Invasive Cancer Cases in Children (Ages 0-14) and Adolescents (Ages 15-19), Ohio, 2012-2016



Risk of Cancer Among Children and Adolescents

Table 1 shows the risk of being diagnosed with invasive cancer by age 20 for all types of cancer combined and selected types by sex in the United States. One in 257 males and one in 272 females will be diagnosed with invasive cancer by age 20. The risk of being diagnosed with each cancer type in Table 1 is greater among males compared to females and whites compared to blacks (race data not shown).

Table 1. Risk of Being Diagnosed with Cancer by Age 20 for Selected Types by Sex, United States, 2014-2016

	Males	Females
All Malignant Cancers	1 in 257	1 in 272
Brain & Other CNS Tumors	1 in 1,563	1 in 1,695
Hodgkin Lymphoma	1 in 3,846	1 in 4,167
Leukemia (all types)	1 in 1,020	1 in 1,205
Lymphocytic Leukemia	1 in 1,333	1 in 1,639
Non-Hodgkin Lymphoma	1 in 2,778	1 in 5,556

Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.7.7; Statistical Research and Applications Branch, National Cancer Institute, 2019.

Risk of developing cancer by age 20 for those free of cancer at birth, based on cancer cases diagnosed during 2014-2016 in SEER 21 registries. Numbers are rounded to the nearest whole person.

Cancer Incidence and Mortality Among Children and Adolescents

In 2012-2016, an average of 555 new invasive cancer cases and 60 cancer deaths occurred each year among children and adolescents in Ohio (Table 2). The average annual age-adjusted incidence rate in Ohio was 187.5 cases per 1,000,000, compared to the U.S. incidence rate of 186.0 per 1,000,000. The Ohio child and adolescent cancer mortality rate of 20.2 deaths per 1,000,000 in 2012-2016 was 12.6 percent lower than the U.S. mortality rate (23.1 per 1,000,000). In both Ohio and the United States, child and adolescent cancer incidence rates were greater for males, whites and those ages 15 to 19 years. In Ohio, cancer mortality rates were higher for males, blacks and those ages 15-19 years.

Table 2. Average Annual Number of New Invasive Cancer Cases and Incidence Rates and Average Annual Number of Cancer Deaths and Mortality Rates Among Children and Adolescents (Ages 0-19) by Sex, Race and Age Group, Ohio and the United States, 2012-2016

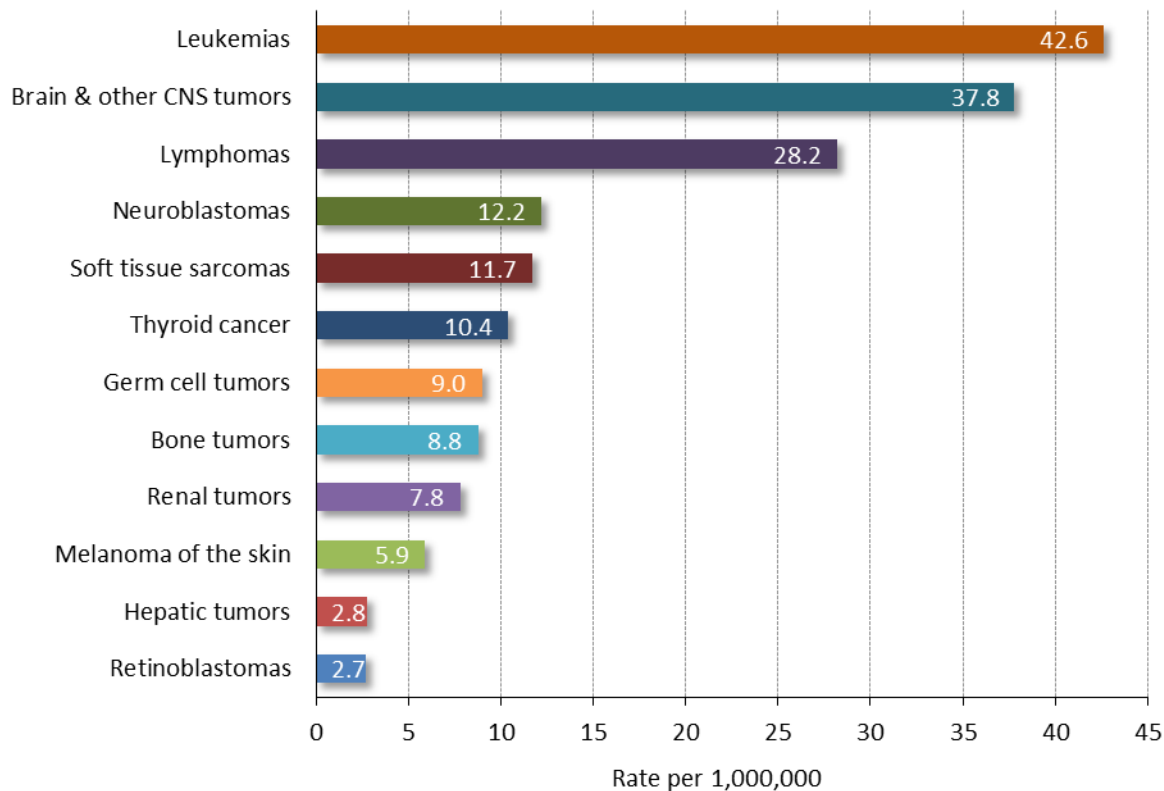
		Incidence			Mortality		
		Ohio		U.S.	Ohio		U.S.
		Cases	Rate	Rate	Deaths	Rate	Rate
Sex	Males	292	192.8	191.9	31	20.7	25.6
	Females	263	181.9	179.8	29	19.8	20.5
Race	White	446	189.2	196.5	46	19.4	23.8
	Black	71	137.0	139.1	13	24.3	22.4
Age Group	0-14	378	173.9	167.2	43	19.6	21.2
	15-19	177	227.6	241.9	17	22.2	28.8
Total		555	187.5	186.0	60	20.2	23.1

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019; Surveillance, Epidemiology and End Results Program, National Cancer Institute, 2019; U.S. Mortality Files, National Center for Health Statistics, Centers for Disease Control and Prevention, 2019.

Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

Overall, leukemias were the most frequently diagnosed cancer among children and adolescents in Ohio during 2012-2016, accounting for an average of 125 cases per year at an age-adjusted rate of 42.6 per 1,000,000 population (Figure 2). During the same years, brain and other CNS tumors (37.8 per 1,000,000) and lymphomas (28.2 per 1,000,000) were the second and third most commonly diagnosed cancers among children and adolescents in Ohio, respectively.

Figure 2. Average Annual Incidence Rates among Children and Adolescents (Ages 0-19) by Site/Type, Ohio, 2012-2016



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.
Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

Cancer Clusters

A cancer cluster is a greater than expected number of cancer cases among a group of people in a geographic area over a defined period of time. True cancer clusters often involve:

- Multiple cases of one type of cancer or related cancers
- Unusual types of cancer in a particular population
- Unusual geographic or time distribution of cases
- Known exposure pathway to a cancer-causing agent

Cancer clusters are often not the result of environmental pollution; rather, clusters most often occur due to shared behaviors and lifestyle factors such as high rates of tobacco use, lack of access to preventive health care, increased rates of screening (which may identify previously undiagnosed cases), low socioeconomic status and chance, among other reasons. Because childhood cancer is rare and has a short latency period, childhood cancer clusters are particularly concerning and often warrant further investigation. However, only a small proportion of childhood cancers have known or preventable causes; thus, it is unlikely that one single factor can be identified as the cause of a childhood cancer cluster.

Childhood Cancer Incidence by County

A map of 1997-2016 average annual age-adjusted incidence rates among children and adolescents by Ohio county of residence is presented in Figure 3. Because child and adolescent cancer is relatively rare, 20 years of data were combined to calculate county-level incidence rates; however, these rates may still be unstable due to small case counts and should be interpreted with caution. As shown in Figure 3, counties in Ohio with the highest and lowest rates of childhood cancer were counties with small populations. This may be because counties with small populations have a high variability in cancer rates and can show high or low incidence of childhood cancer by chance alone. Due to the small number of cases, incidence rates could not be calculated for some counties for childhood leukemia (Figure 4) and brain and other CNS tumors (Figure 5), making it even more difficult to discern any geographic pattern by county for these cancers. Data used to generate these maps can be found in Table 3 in the Appendix.

Figure 3. All Cancer Types: Average Annual Incidence Rates among Children and Adolescents (Ages 0-19) by County of Residence, Ohio, 1997-2016

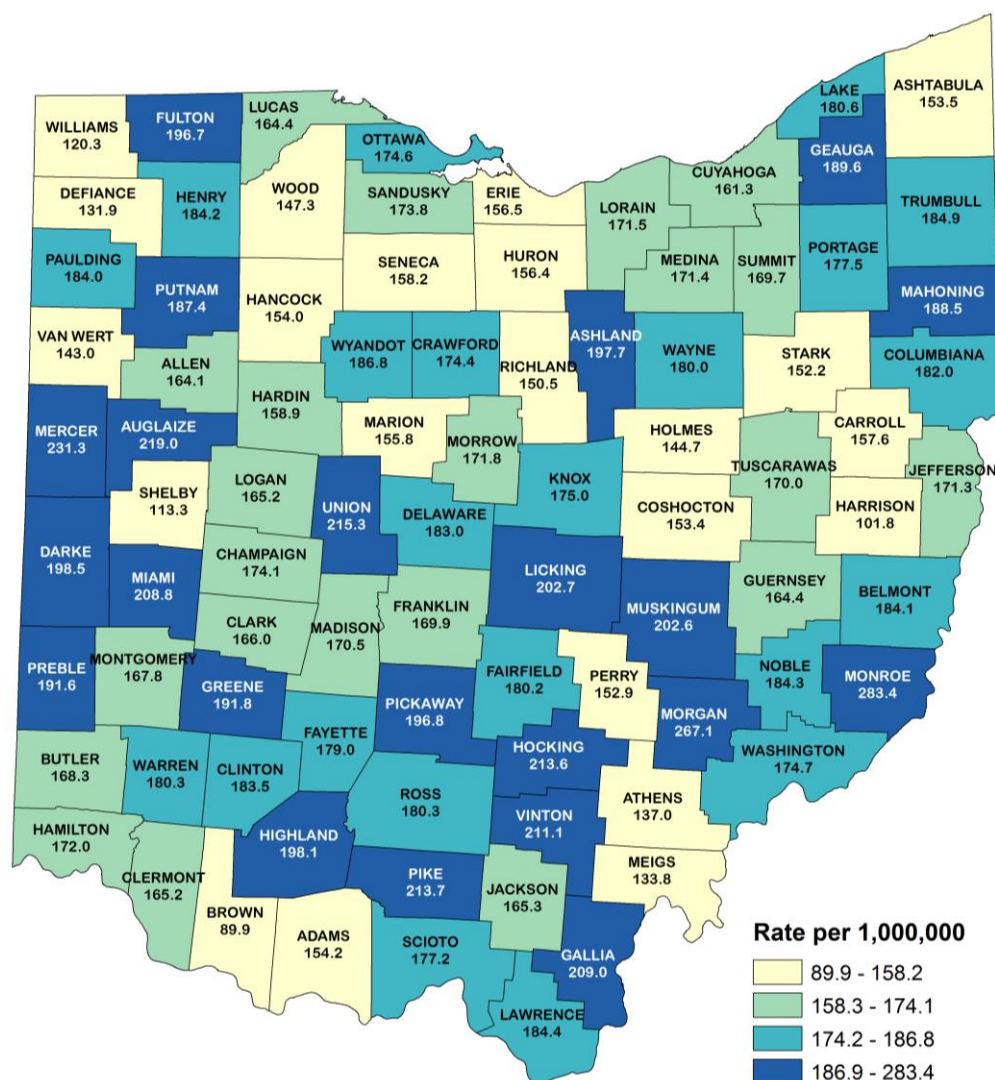
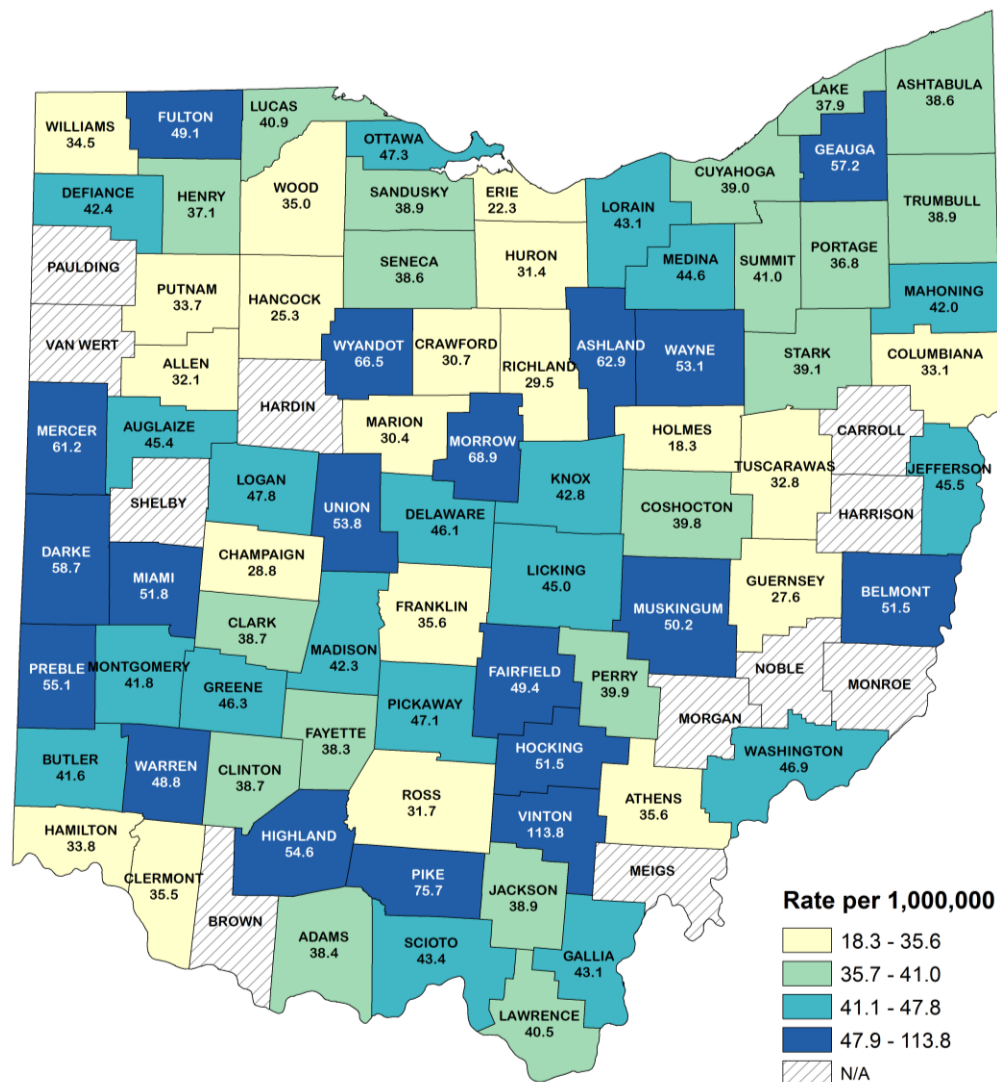


Figure 4. Leukemia: Average Annual Incidence Rates among Children and Adolescents (Ages 0-19) by County of Residence, Ohio, 1997-2016

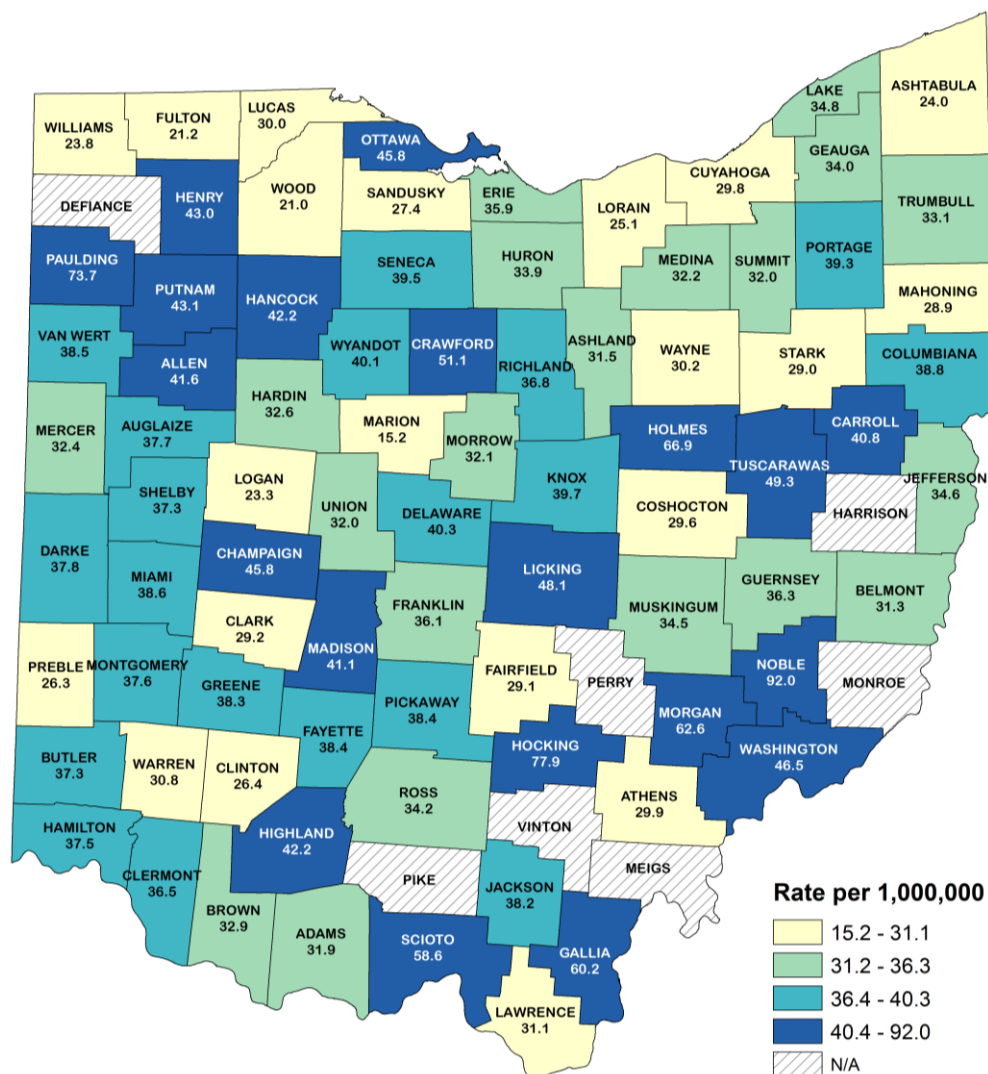


Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.

Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

N/A: Rate not calculated when the case count for 1997-2016 is less than five.

Figure 5. Brain and Other CNS Tumors: Average Annual Incidence Rates among Children and Adolescents (Ages 0-19) by County of Residence, Ohio, 1997-2016



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.

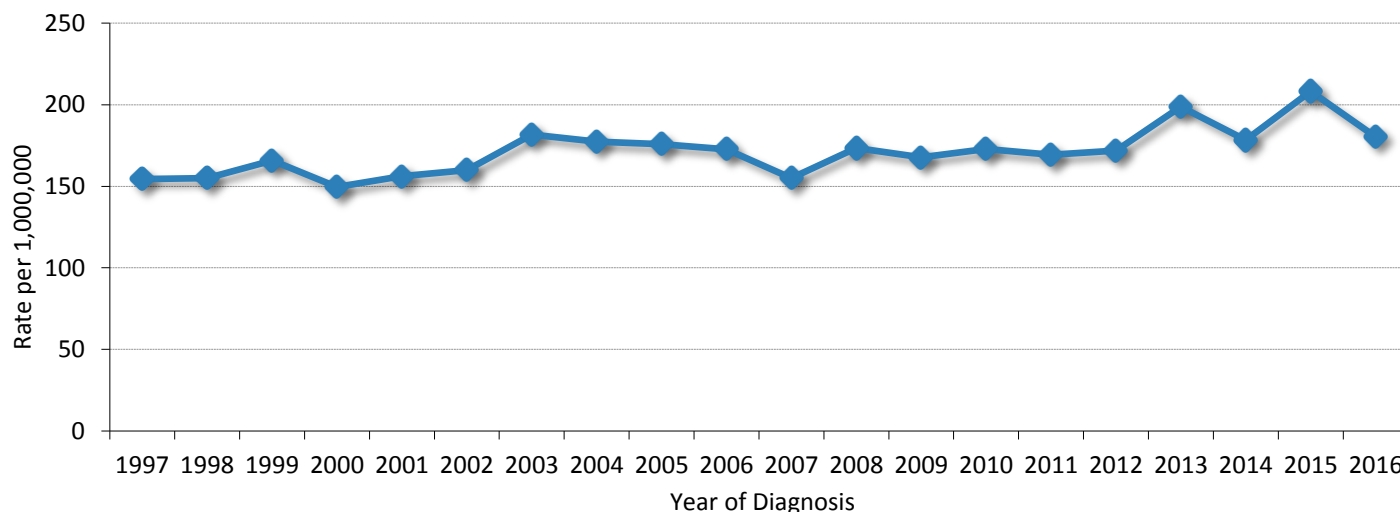
Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

N/A: Rate not calculated when the case count for 1997-2016 is less than five.

Trends in Overall Childhood Cancer Incidence and Mortality

Overall cancer incidence rates increased from 1997-2016 among children and adolescents in Ohio (Figure 6). Adolescents had higher overall cancer incidence rates than children from 1997 to 2016.

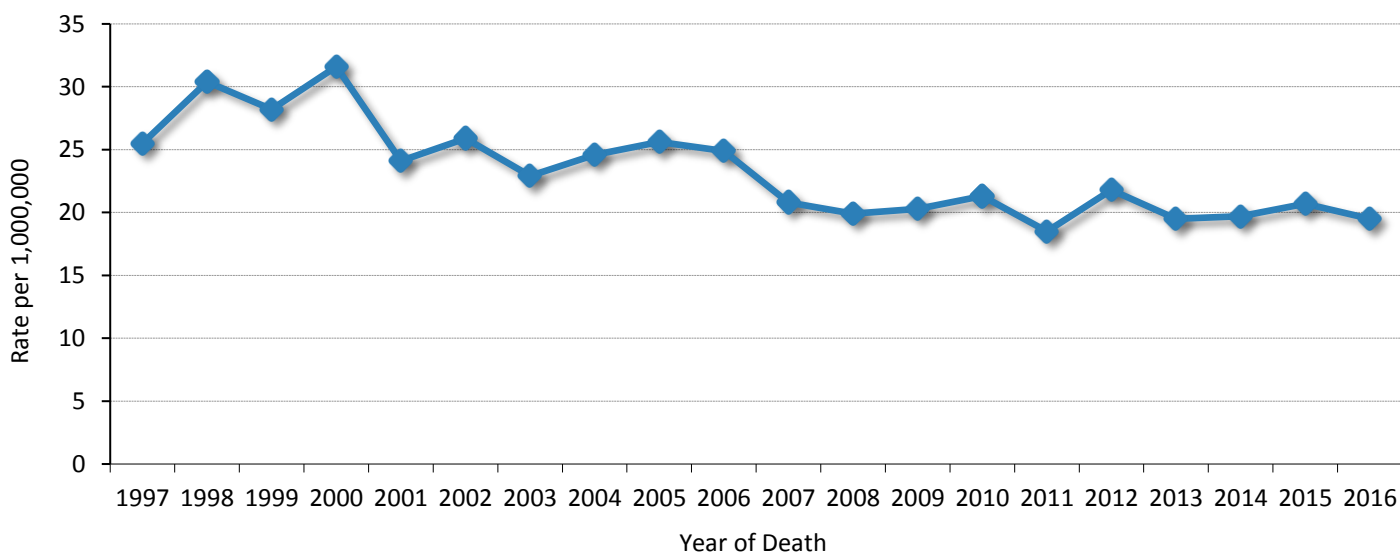
Figure 6. Trends in Overall Childhood Cancer Incidence Rates (Ages 0-19), Ohio, 1997-2016



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.
Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

Mortality rates of all child and adolescent cancers combined declined 24 percent from 1997 to 2016 in Ohio. During this time period, the mortality rate was highest in 2000 (31.6 per 1,000,000) and fell to a low of 18.5 per 1,000,000 in 2011 (Figure 7). Nationally, the largest declines in child and adolescent cancer mortality rates were observed for Hodgkin lymphoma, non-Hodgkin lymphoma and acute lymphocytic leukemia. These declines are largely due to advances in treatment.

Figure 7. Trends in Overall Childhood Cancer Mortality Rates (Ages 0-19), Ohio, 1997-2016



Source: Bureau of Vital Statistics, Ohio Department of Health, as reported in U.S. Mortality Files, National Center for Health Statistics, Centers for Disease Control and Prevention, 2019.
Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

Trends for the Leading Cancers Among Children and Adolescents

Leukemia: Rates for new childhood leukemia cases have been rising on average 0.7 percent each year over the last 10 years in the United States. Childhood leukemia rates were variable in Ohio and increased from 33.9 per 1,000,000 in 1997 to 43.2 per 1,000,000 in 2016. The incidence rates of leukemia among children were consistently higher than the rates among adolescents in Ohio from 1997 to 2016.

Brain and Other CNS Tumors: Nationally, incidence rates for new childhood brain and other CNS tumors have been stable over the last 10 years. Incidence rates for brain and other CNS tumors increased among children and adolescents in Ohio from 1997 to 2016. The rates for brain and other CNS tumors among children were higher than the rates among adolescents each year during that time period.

Lymphoma: Incidence rates of lymphoma (including Hodgkin, non-Hodgkin and other lymphomas) had periods of increase and decrease among Ohio children and adolescents from 1997 to 2016. Lymphoma rates were two to three times higher among adolescents compared to children during this time period.

Thyroid Cancer: The incidence of thyroid cancer is increasing more rapidly than that of any other cancer in the United States. Some, although not all, of this increase can be explained by improved detection methods. Thyroid cancer incidence rates among children and adolescents in Ohio ranged from 4.0 per 1,000,000 in 2000 and 2004 to 13.2 per 1,000,000 in 2015. Thyroid cancer incidence rates in Ohio children were very low (2.1- 4.5 per 1,000,000), while thyroid cancer incidence rates among adolescents in Ohio were about 10 times higher than the rates among children.

Germ Cell Tumors: From 1997 to 2016 in Ohio, incidence rates of germ cell tumors among children and adolescents combined in Ohio were somewhat variable. While incidence rates of germ cell tumors were low and stable among children, incidence rates for this cancer among adolescents were more variable and three to six times higher compared to children.

Child and Adolescent Cancer Clinical Trials

Clinical trials are used to determine the most safe and effective treatment for a disease. Clinical trials aim to improve survival rates or reduce side effects or late effects of treatment. Clinical trials are standard practice in child and adolescent cancer treatment. While less than 5 percent of adults with cancer are enrolled in clinical trials, 60 percent of patients under age 29 diagnosed with cancer are enrolled in clinical trials.

Where to find child and adolescent cancer clinical trials:

National Cancer Institute, Cancer Trials Search: www.cancer.gov/clinicaltrials/search

Clinical Trials.gov: www.clinicaltrials.gov

TrialCheck: <https://eviticlinicaltrials.com/Services/>

The Children's Oncology Group (COG) is the largest pediatric clinical trials group in the world, with more than 200 participating hospitals. For more information about childhood cancer clinical trials, visit: <http://www.childrensoncologygroup.org/index.php/what-is-a-clinical-trial>

Risk Factors for Childhood Cancer

There are few known risk factors for childhood cancer. A risk factor is anything that affects the chance of getting a disease such as cancer. Different cancers have different risk factors. Specific chromosomes, certain genetic syndromes and ionizing radiation explain a small percentage of cases. While environmental causes of child and adolescent cancer are often suspected; so far, most childhood cancers have not been shown to have environmental causes. Risk factors with sufficient evidence to support an increased risk of developing child and adolescent cancer are listed below.

Random mutations: Most cancers in children, like those in adults, are thought to develop as a result of mutations in genes that lead to uncontrolled cell growth and eventually cancer. Many DNA changes that cause most childhood cancers are likely to be caused by random events that sometimes happen inside a cell, without having an outside cause.

Inherited mutations: Up to 10 percent of all cancers in children are caused by a heritable (germline) mutation (a mutation that can be passed from parents to their children). Children who have Down syndrome, a genetic condition caused by the presence of an extra copy of chromosome 21, are 10 to 20 times more likely to develop leukemia than children without Down syndrome. However, only a very small proportion of childhood leukemia is linked to Down syndrome. About 45 percent of children with retinoblastoma, a cancer of the eye that develops mainly in children, inherited a mutation in a gene called RB1 from a parent. Inherited mutations associated with certain familial syndromes, such as Li-Fraumeni syndrome, Beckwith-Wiedemann syndrome, Fanconi anemia syndrome, Noonan syndrome and von Hippel-Lindau syndrome, also increase the risk of childhood cancer.

Radiation: Ionizing radiation can lead to the development of leukemia and other cancers in children and adolescents. Children whose mothers had X-rays during pregnancy and children who were exposed after birth to diagnostic medical radiation from computed tomography (CT) scans have been found to have an increased risk of leukemia and brain tumors, and possibly other cancers.

Infections: Exposure to the Epstein Barr virus (EBV) or having a personal history of mononucleosis increases the risk of lymphomas, including Hodgkin lymphoma and non-Hodgkin lymphoma.

Certain Chemicals: Benzene, found in the chemical industry, cigarette smoke and gasoline, increases the risk of myeloid leukemia. Certain herbicides and insecticides (weed- and insect-killing substances) are linked with an increased risk of non-Hodgkin lymphoma.

Chemotherapy: Cancer patients treated with certain types of cancer treatment drugs such as alkylating agents and topoisomerase II inhibitors, sometimes later get leukemia, including AML or ALL.

Signs and Symptoms of Cancer among Children and Adolescents

Signs and symptoms of child and adolescent cancer often look similar to other more common diseases in children, making early diagnosis difficult. Some common symptoms of child and adolescent cancer include:

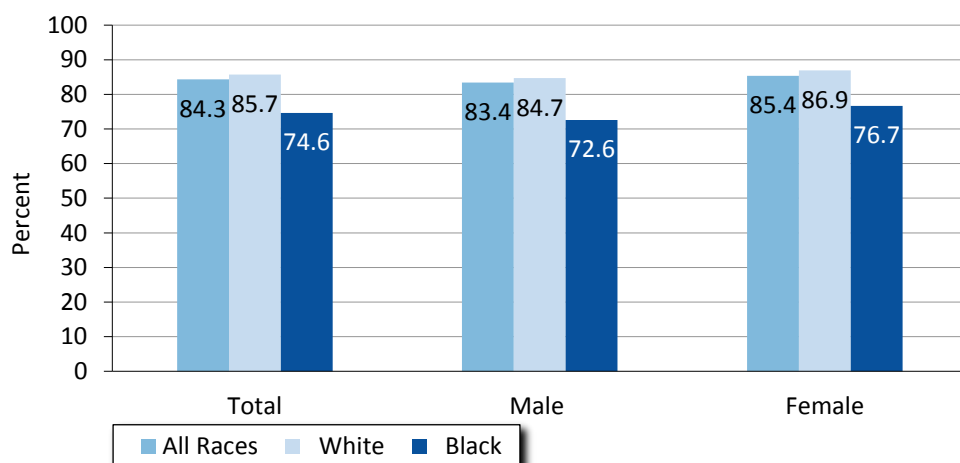
- An unusual mass or swelling
- Unexplained paleness or loss of energy
- Sudden tendency to bruise
- A persistent localized pain or limping
- A prolonged unexplained fever or illness
- Frequent headaches, often with vomiting
- Sudden eye or vision changes
- Excessive, rapid weight loss.

Any of these signs and symptoms may be caused by cancer or by other, less serious health problems. If you have any of these signs or symptoms, see your healthcare provider.

Cancer Survival among Children and Adolescents

Relative survival compares the survival of those diagnosed with cancer with the survival of those who do not have cancer, usually five years after a cancer diagnosis. In Ohio, five-year relative survival for children and adolescents was 84.3 percent for all cancers combined, 84.3 percent for leukemia and 77.4 percent for brain and other CNS tumors, based on data from 2009-2015. Five-year relative survival was 13.0 percent lower among black children and adolescents (74.6 percent), compared to whites (85.7 percent). In addition, five-year relative survival was 2.3 percent lower among boys (83.4 percent), compared to girls (85.4 percent) (Figure 13).

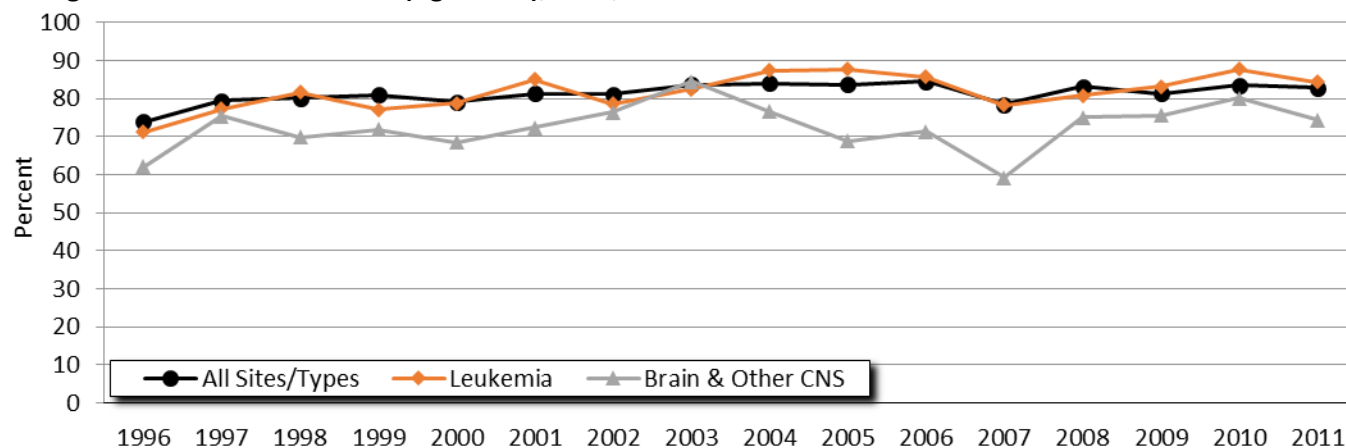
Figure 13. Five-Year Relative Survival among Children and Adolescents (Ages 0-19) by Race and Sex, Ohio, 2009-2015



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.

In Ohio, the overall five-year relative survival among children and adolescents increased from 73.9 percent in 1996 to 82.8 percent in 2011. There was an increase in five-year relative survival for leukemia from 1996 (71.2 percent) to 2011 (84.4 percent), while five-year relative survival for brain and other CNS tumors was variable during this time period (Figure 14).

Figure 14. Trends in Five-Year Relative Survival for All Cancer Sites/Types Combined and the Most Common Cancers among Children and Adolescents (Ages 0-19), Ohio, 1996-2011



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019.

Late Effects of Child and Adolescent Cancer

Many cancer survivors experience late effects, which are health problems that occur months or years after cancer is diagnosed or after treatment has ended. Late effects are related to many factors, including the cancer site/type, treatment received (including dose and location) and characteristics of the survivor (including sex, age at diagnosis, genetics, family history and health-related behaviors). Late effects include:

Emotional/Psychological difficulties: These may include anxiety, depression and fear of recurrence.

Secondary cancers: Cancer treatment can sometimes cause a new cancer many years after treatment is complete. Radiation therapy and some types of chemotherapy have the strongest links to secondary cancers.

Brain changes and learning and memory problems: Some chemotherapy drugs and radiation therapy to the brain can cause memory loss, problems concentrating and processing information, personality changes and movement problems. Children who received radiation therapy to the brain or high doses of certain drugs may be more likely to have these problems.

Bone loss and joint changes: Some chemotherapy drugs, steroid medicines, hormonal therapy and radiation therapy may cause thinning or loss of the bones. These problems can lead to loss of motion in some joints.

Heart problems: Certain chemotherapy drugs and radiation therapy to the chest may cause heart problems, including abnormal heart rhythms, leaky heart valves, congestive heart failure and coronary artery disease.

Lung and breathing problems: Chemotherapy and radiation therapy to the chest may damage the lungs. Children who received cancer treatment at a younger age have a greater risk of lung and breathing problems.

Dental problems: Radiation therapy to the mouth, head or neck may cause dry mouth, gum disease and cavities. Chemotherapy, especially when given to a child whose adult teeth have not formed, may affect tooth development.

Digestive system problems: Abdominal or pelvic surgery and radiation therapy to the neck, chest, abdomen or pelvis can result in gastrointestinal problems.

Hearing loss: Treatment with certain chemotherapy drugs and high doses of radiation to the brain can cause hearing loss. Younger children have a higher risk.

Vision and eye problems: Chemotherapy, hormone therapy, immunotherapy and steroid medicines may increase the risk of cataracts, a clouding of the lens in the eye that affects vision. Some chemotherapy drugs and bone marrow/stem cell transplants increase the risk for dry eyes. Radioiodine treatment for thyroid cancer may cause the overproduction of tears.

Lymphedema: Lymphedema, a problem in which the lymph fluid does not drain properly, builds up in tissues and causes swelling, can result from surgery to remove lymph nodes or by radiation therapy to areas with large numbers of lymph nodes.

Endocrine/Hormone problems: In boys, some chemotherapy drugs and radiation therapy to the lower abdomen, pelvis or testicles may cause infertility. In girls, chemotherapy and radiation therapy to the abdomen, pelvis or lower spine can cause infertility, irregular periods and early menopause. In boys and girls, treatments also change levels of hormones, which can affect puberty and sexual functioning. In addition, radiation therapy to the brain can affect the pituitary glands and the endocrine system, potentially affecting fertility, growth and puberty. Many cancer treatments may cause women to have menopausal symptoms, including hot flashes and changes in mood or sexual desire. Among men, hormone therapy for prostate cancer or surgery to remove testicles may also result in hormone-related changes to sexual desire, hot flashes and osteoporosis.

Peripheral neuropathy: Some chemotherapy drugs can cause nerve damage, resulting in weakness, numbness, tingling or pain, especially in the hands or feet.

Technical Notes

Age-Adjusted Rate: A summary rate that is a weighted average of age-specific rates, where the weights represent the age distribution of a standard population (direct adjustment). The incidence and mortality rates presented in this report were standardized to the age distribution of the 2000 U.S. Standard Population. Under the direct method, the population was first divided into five five-year age groups, i.e., <1, 1-4, 5-9, 10-14, 15-19, and the age-specific rate was calculated for each age group. Each age-specific rate was then multiplied by the standard population proportion for the respective age group. For children, the first four standardized age-specific rates were summed to give an overall age-adjusted rate. For adolescents, the standardized age-specific rate for the 15-19 age group served as the overall rate. Age adjustment allows for the comparison of rates between populations with different age distributions.

Average Annual Number: The number of cases or deaths diagnosed per year, on average, for the time period of interest (e.g., 2012-2016). Average annual numbers are calculated by summing the number of cases or deaths for a given time period, dividing by the number of years that comprise the time period and rounding to the nearest whole number.

International Classification of Childhood Cancer (ICCC): Cancers in children and adolescents are classified by site and histology (tissue type) into 12 major groups using the International Classification of Childhood Cancers (ICCC), available at: <http://seer.cancer.gov/iccc/iccc-who2008.html>.

Cancer Cluster: A greater than expected number of cancer cases among a group of people in a geographic area over a defined period of time.

Census Data: The 1997-2016 rates were calculated using populations estimates from the U.S. Census Bureau and National Center for Health Statistics, including: bridged-race intercensal population estimates for July 1, 1990-July 1, 1999 (2004); revised bridged-race intercensal population estimates for July 1, 2000-July 1, 2004 (2012); July 1, 2005-July 1, 2009 (2014); and vintage 2017 bridged-race postcensal population estimates for July 1, 2010-July 1, 2017 (2018).

Incidence: The number of cases diagnosed during a specified time period (e.g., 2012-2016).

Invasive Cancer: A malignant tumor that has infiltrated the organ in which the tumor originated. Invasive cancers consist of those diagnosed at the localized, regional, distant and unstaged/missing stages. Only invasive cancers were included in the calculation of incidence rates in this document.

Late Effects: Long-term side effects from cancer treatment.

Mortality: The number of deaths during a specified time period (e.g., 2012-2016).

Rate: The number of cases or deaths per unit of population (e.g., per 1,000,000 persons), during a specified time period (e.g., 2012-2016). Child and adolescent cancer rates in this document are presented as the number of cases per 1,000,000 persons per year. Rates may be unstable and are not presented when the case count is less than five.

Relative Survival: The percentage of people alive at a designated time point after a cancer diagnosis (usually five years) divided by the percentage expected to be alive in the absence of cancer based on normal life expectancy. The survival duration in months was calculated with all patients presumed alive if not known to be deceased. Relative survival statistics were calculated using life tables based on county-level socioeconomic status, geography and race. Relative survival data in this report were calculated using SEER*Stat software version 8.3.5. For more information on survival analysis using SEER*Stat, see: <https://seer.cancer.gov/seerstat/tutorials/survival1>.

Appendix

Table 3. Total Number of Invasive Cancer Cases and Average Annual Incidence Rates among Children and Adolescents (Ages 0-19) by County of Residence, Ohio, 1997-2016

	All Types		Leukemia		Brain & Other CNS			All Types		Leukemia		Brain & Other CNS	
	Cases	Rate	Cases	Rate	Cases	Rate		Cases	Rate	Cases	Rate	Cases	Rate
Ohio	10,614	170.9	2,443	39.7	2,120	34.4	Lawrence	60	184.4	13	40.5	10	31.1
SEER		172.6		46.0		29.6	Licking	178	202.7	39	45.0	42	48.1
Adams	24	154.2	6	38.4	5	31.9	Logan	42	165.2	12	47.8	6	23.3
Allen	99	164.1	19	32.1	25	41.6	Lorain	276	171.5	69	43.1	40	25.1
Ashland	58	197.7	18	62.9	9	31.5	Lucas	409	164.4	101	40.9	74	30.0
Ashtabula	84	153.5	21	38.6	13	24.0	Madison	37	170.5	9	42.3	9	41.1
Athens	40	137.0	9	35.6	7	29.9	Mahoning	230	188.5	50	42.0	35	28.9
Auglaize	58	219.0	12	45.4	10	37.7	Marion	52	155.8	10	30.4	5	15.2
Belmont	59	184.1	16	51.5	10	31.3	Medina	157	171.4	40	44.6	30	32.2
Brown	22	89.9	3	*	8	32.9	Meigs	16	133.8	2	*	4	*
Butler	344	168.3	84	41.6	75	37.3	Mercer	57	231.3	15	61.2	8	32.4
Carroll	23	157.6	4	*	6	40.8	Miami	114	208.8	28	51.8	21	38.6
Champaign	38	174.1	6	28.8	10	45.8	Monroe	21	283.4	4	*	4	*
Clark	126	166.0	29	38.7	22	29.2	Montgomery	484	167.8	120	41.8	108	37.6
Clermont	179	165.2	39	35.5	40	36.5	Morgan	21	267.1	4	*	5	62.6
Clinton	43	183.5	9	38.7	6	26.4	Morrow	33	171.8	13	68.9	6	32.1
Columbiana	100	182.0	18	33.1	21	38.8	Muskingum	95	202.6	23	50.2	16	34.5
Coshocton	31	153.4	8	39.8	6	29.6	Noble	12	184.3	3	*	6	92.0
Crawford	41	174.4	7	30.7	12	51.1	Ottawa	34	174.6	9	47.3	9	45.8
Cuyahoga	1110	161.3	266	39.0	203	29.8	Paulding	20	184.0	3	*	8	73.7
Darke	58	198.5	17	58.7	11	37.8	Perry	31	152.9	8	39.9	4	*
Defiance	29	131.9	9	42.4	2	*	Pickaway	56	196.8	13	47.1	11	38.4
Delaware	168	183.0	44	46.1	38	40.3	Pike	34	213.7	12	75.7	3	*
Erie	62	156.5	9	22.3	14	35.9	Portage	147	177.5	29	36.8	30	39.3
Fairfield	141	180.2	39	49.4	23	29.1	Preble	43	191.6	12	55.1	6	26.3
Fayette	28	179.0	6	38.3	6	38.4	Putnam	39	187.4	7	33.7	9	43.1
Franklin	1070	169.9	227	35.6	226	36.1	Richland	98	150.5	19	29.5	24	36.8
Fulton	48	196.7	12	49.1	5	21.2	Ross	69	180.3	12	31.7	13	34.2
Gallia	35	209.0	7	43.1	10	60.2	Sandusky	58	173.8	13	38.9	9	27.4
Geauga	99	189.6	29	57.2	18	34.0	Scioto	73	177.2	18	43.4	24	58.6
Greene	160	191.8	37	46.3	32	38.3	Seneca	51	158.2	12	38.6	12	39.5
Guernsey	36	164.4	6	27.6	8	36.3	Shelby	33	113.3	2	*	11	37.3
Hamilton	774	172.0	151	33.8	167	37.5	Stark	300	152.2	76	39.1	57	29.0
Hancock	62	154.0	10	25.3	17	42.2	Summit	478	169.7	115	41.0	90	32.0
Hardin	29	158.9	3	*	6	32.6	Trumbull	200	184.9	41	38.9	36	33.1
Harrison	8	101.8	0	*	0	*	Tuscarawas	83	170.0	16	32.8	24	49.3
Henry	30	184.2	6	37.1	7	43.0	Union	60	215.3	15	53.8	9	32.0
Highland	47	198.1	13	54.6	10	42.2	Van Wert	23	143.0	4	*	6	38.5
Hocking	33	213.6	8	51.5	12	77.9	Vinton	15	211.1	8	113.8	0	*
Holmes	45	144.7	6	18.3	21	66.9	Warren	204	180.3	56	48.8	35	30.8
Huron	55	156.4	11	31.4	12	33.9	Washington	54	174.7	14	46.9	14	46.5
Jackson	30	165.3	7	38.9	7	38.2	Wayne	120	180.0	35	53.1	20	30.2
Jefferson	57	171.3	15	45.5	11	34.6	Williams	25	120.3	7	34.5	5	23.8
Knox	58	175.0	14	42.8	13	39.7	Wood	102	147.3	22	35.0	13	21.0
Lake	206	180.6	42	37.9	40	34.8	Wyandot	23	186.8	8	66.5	5	40.1

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019; Surveillance, Epidemiology and End Results Program, National Cancer Institute, 2019 (based on cancer cases diagnosed in SEER 13 area registries from 1997-2016 using SEER*Stat version 8.3.5). Total count is for 1997-2016 (20 years) data combined. Rates are per 1,000,000 and age-adjusted to the 2000 U.S. standard population.

* Rate not calculated when the case count for 1997-2016 is less than five.

Sources of Additional Information

American Cancer Society:

- Cancer in Children: <https://www.cancer.org/cancer/cancer-in-children.html>
- Cancer in Adolescents: <https://www.cancer.org/cancer/cancer-in-adolescents.html>

National Cancer Institute:

- Childhood Cancers: <https://www.cancer.gov/types/childhood-cancers>
- Adolescents and Young Adults with Cancer: <https://www.cancer.gov/types/aya>
- Fact sheet: [Cancer in Children and Adolescents](#)

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