

Leukemia in Ohio, 2011-2015

Incidence and Mortality

Leukemia is cancer that originates in the bone marrow and causes the production of abnormal blood cells, particularly white blood cells that help the body to fight infections and other diseases. Leukemia made up 2.5 percent of newly diagnosed (incidence) cancer cases in Ohio reported to the Ohio Cancer Incidence Surveillance System (OCISS) from 2011 to 2015. An average of 1,629 cases of leukemia were diagnosed annually in Ohio during this time period (Table 1). Between 2011 and 2015, the average annual age-adjusted incidence rate for leukemia in Ohio was 12.2 per 100,000, compared to the national incidence rate of 13.8 per 100,000. The incidence rate among males diagnosed with leukemia (15.5 per 100,000) was 1.6 times higher than the rate among females (9.6 per 100,000), and the incidence rate was 1.3 times higher among whites (12.4 per 100,000) compared to blacks (9.3 per 100,000) in Ohio in 2011-2015.

Leukemia made up 3.8 percent of all cancer deaths in Ohio during 2011-2015, where an average of 965 deaths occurred each year (Table 1). The average annual age-adjusted mortality rate for leukemia in Ohio was 7.0 per 100,000, compared to the U.S. mortality rate of 6.7 per 100,000. The mortality rate was 1.8 times higher for males (9.4 per 100,000) than females (5.3 per 100,000), and it was 1.3 times higher among whites (7.2 per 100,000) compared to blacks (5.6 per 100,000) in Ohio in 2011-2015.

Key Findings and Populations at High Risk

- An average of 1,629 cases of leukemia were diagnosed and 965 deaths occurred each year in Ohio during 2011-2015.
- The leukemia incidence rate in Ohio was 12.2 per 100,000, compared to the national rate of 13.8 per 100,000 in 2011-2015.
- Leukemia occurs more often in males than in females.
- Whites have higher incidence and mortality rates of leukemia than blacks in Ohio and the United States.
- Leukemia was most frequently diagnosed among Ohio males ages 65 to 69 and Ohio females ages 85 and older in 2011-2015.
- While there were no clear trends in leukemia incidence rates, mortality rates decreased for males and females in Ohio from 1996 to 2015.
- The incidence of leukemia was highest in southeastern counties in Ohio in 2011-2015.
- The five-year relative survival probability for leukemia was 75.4 percent for those less than 45 years of age and 41.0 percent for those 75 and older, based on national data from 2008-2014.
- Leukemia is the most common type of cancer among children.

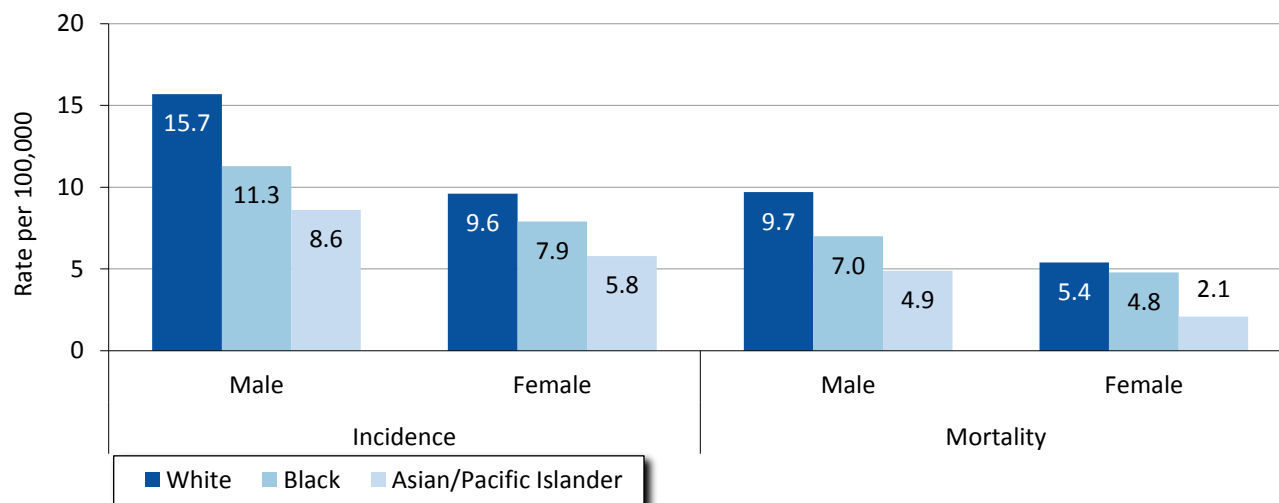
Table 1. Average Annual Number and Age-adjusted Rates of Leukemia Cases and Deaths per 100,000 Persons by Sex and Race, Ohio and the United States, 2011-2015

		Incidence			Mortality		
		Ohio Cases	Ohio Rate	U.S. Rate	Ohio Deaths	Ohio Rate	U.S. Rate
Total		1,629	12.2	13.8	965	7.0	6.7
Sex	Male	936	15.5	17.6	545	9.4	9.0
	Female	693	9.6	10.8	420	5.3	5.0
Race	White	1,449	12.4	14.6	883	7.2	6.9
	Black	131	9.3	11.0	74	5.6	5.6
	Asian/Pacific Islander	15	7.1	7.8	6	3.3	3.7

Sources: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018; Bureau of Vital Statistics, Ohio Department of Health, 2018; Surveillance, Epidemiology and End Results (SEER) Program, National Cancer Institute, 2018.

Incidence and Mortality by Sex and Race

Figure 1. Leukemia: Average Annual Age-adjusted Incidence and Mortality Rates per 100,000 Persons by Sex and Race, Ohio, 2011-2015

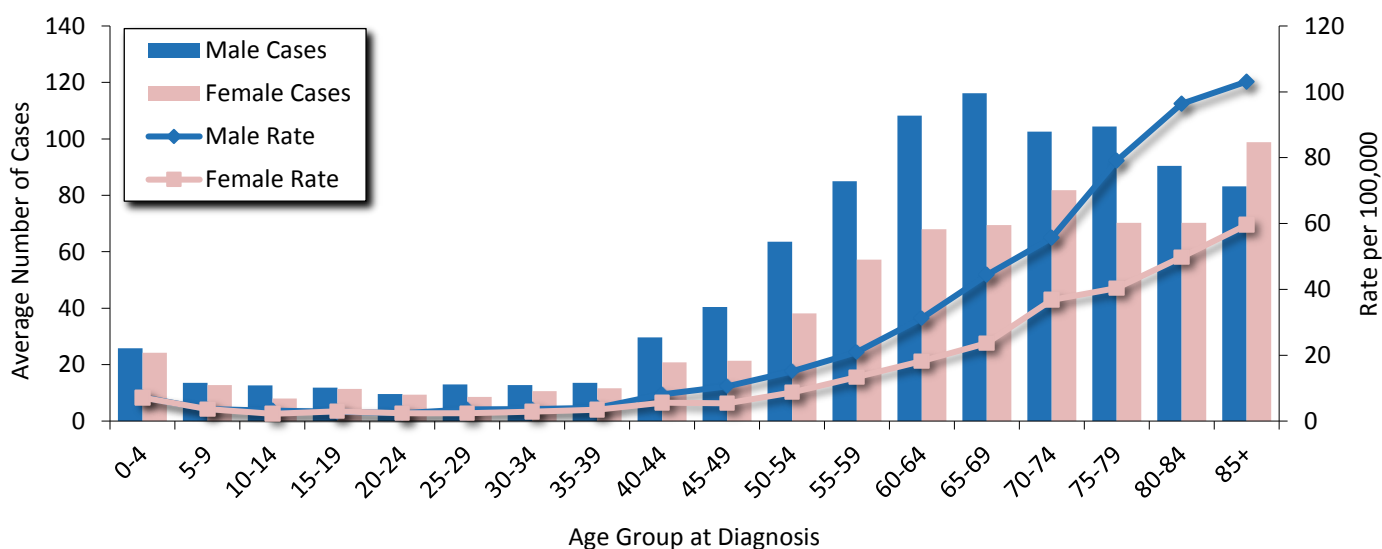


Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018; Bureau of Vital Statistics, Ohio Department of Health, 2018.

White males were more likely to be diagnosed with and die from leukemia in Ohio, based on data from 2011 to 2015, followed by black males and white females (Figure 1). In Ohio, Asian/Pacific Islander males and females had lower incidence and mortality rates for leukemia compared to both blacks and whites in 2011-2015.

Incidence by Age Group and Sex

Figure 2. Leukemia: Average Annual Number and Age-specific Incidence Rates per 100,000 Persons by Age Group and Sex, Ohio, 2011-2015



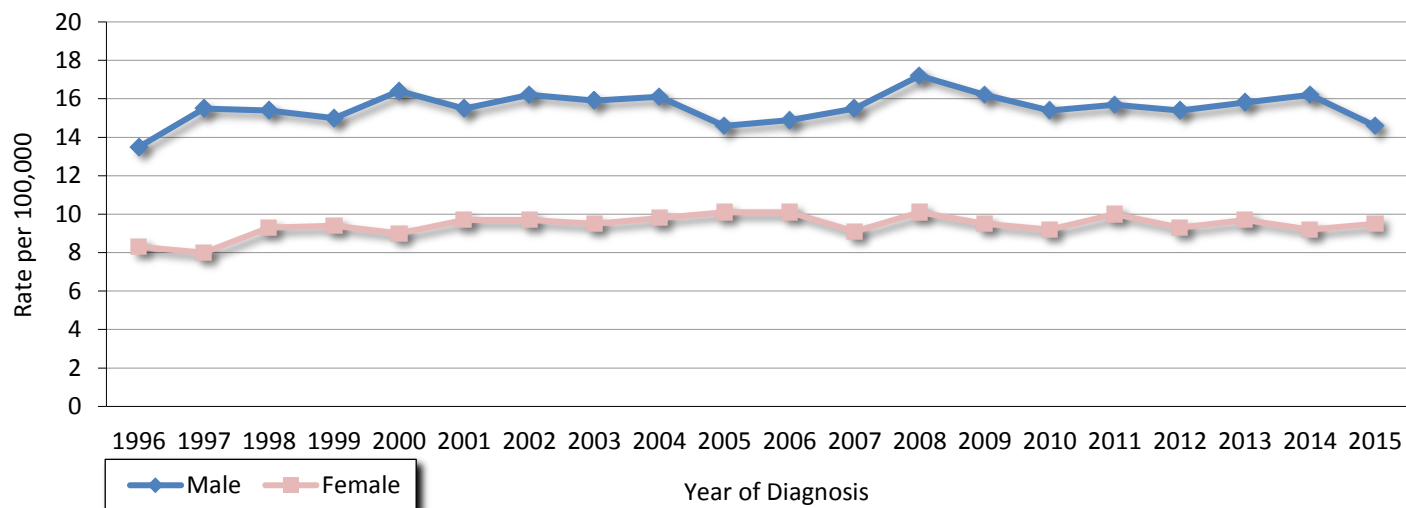
Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

In Ohio between 2011 and 2015, leukemia was most frequently diagnosed among men ages 65 to 69 and among women ages 85 and older (Figure 2). Among children and adolescents (ages 0-19), the incidence of leukemia was highest for those ages 0-4 years. Among adults, incidence rates increased with advancing age, reaching a peak among those 85 and older.

Trends in Incidence and Mortality

Figure 3 shows incidence rates of leukemia according to year of diagnosis (1996 through 2015) for males and females in Ohio. For each year, the incidence rate was higher among Ohio males compared to females. From 1996 to 2015, there was no clear trend in leukemia incidence rates in Ohio among men and women.

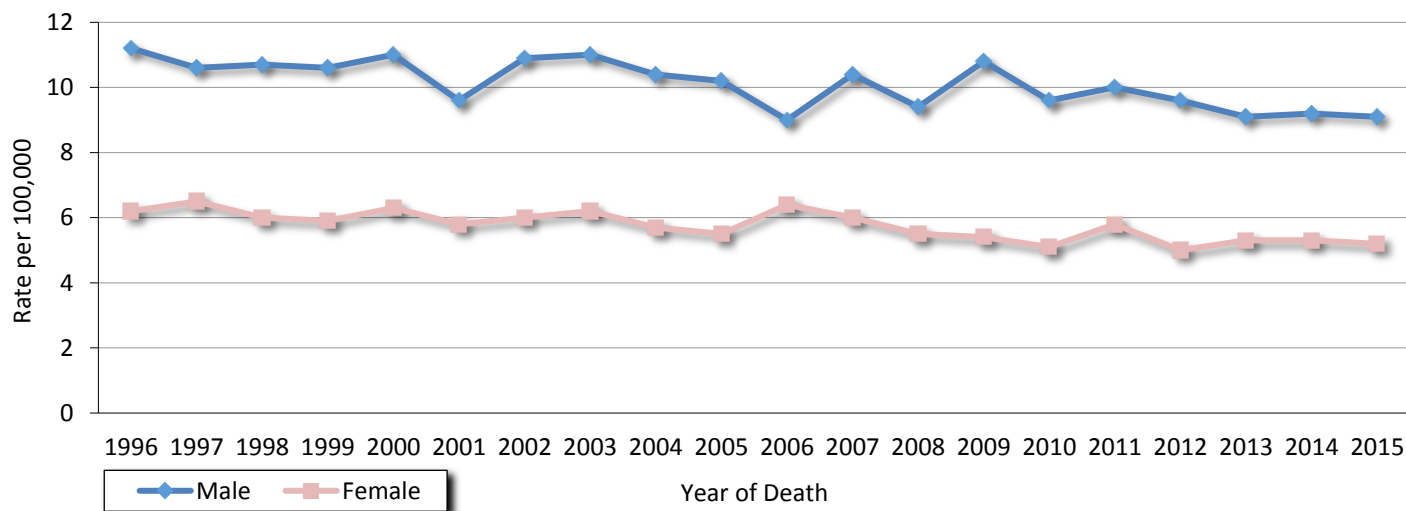
Figure 3. Leukemia: Trends in Age-adjusted Incidence Rates per 100,000 Persons by Sex, Ohio, 1996-2015



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

Figure 4 shows leukemia mortality rates in Ohio according to year of death (1996 through 2015) for males and females. For each year, leukemia mortality rates were higher among males compared to females in Ohio. From 1996 to 2015, leukemia mortality rates decreased 19 percent and 16 percent among Ohio men and women, respectively.

Figure 4. Leukemia: Trends in Age-adjusted Mortality Rates per 100,000 Persons by Sex, Ohio, 1996-2015

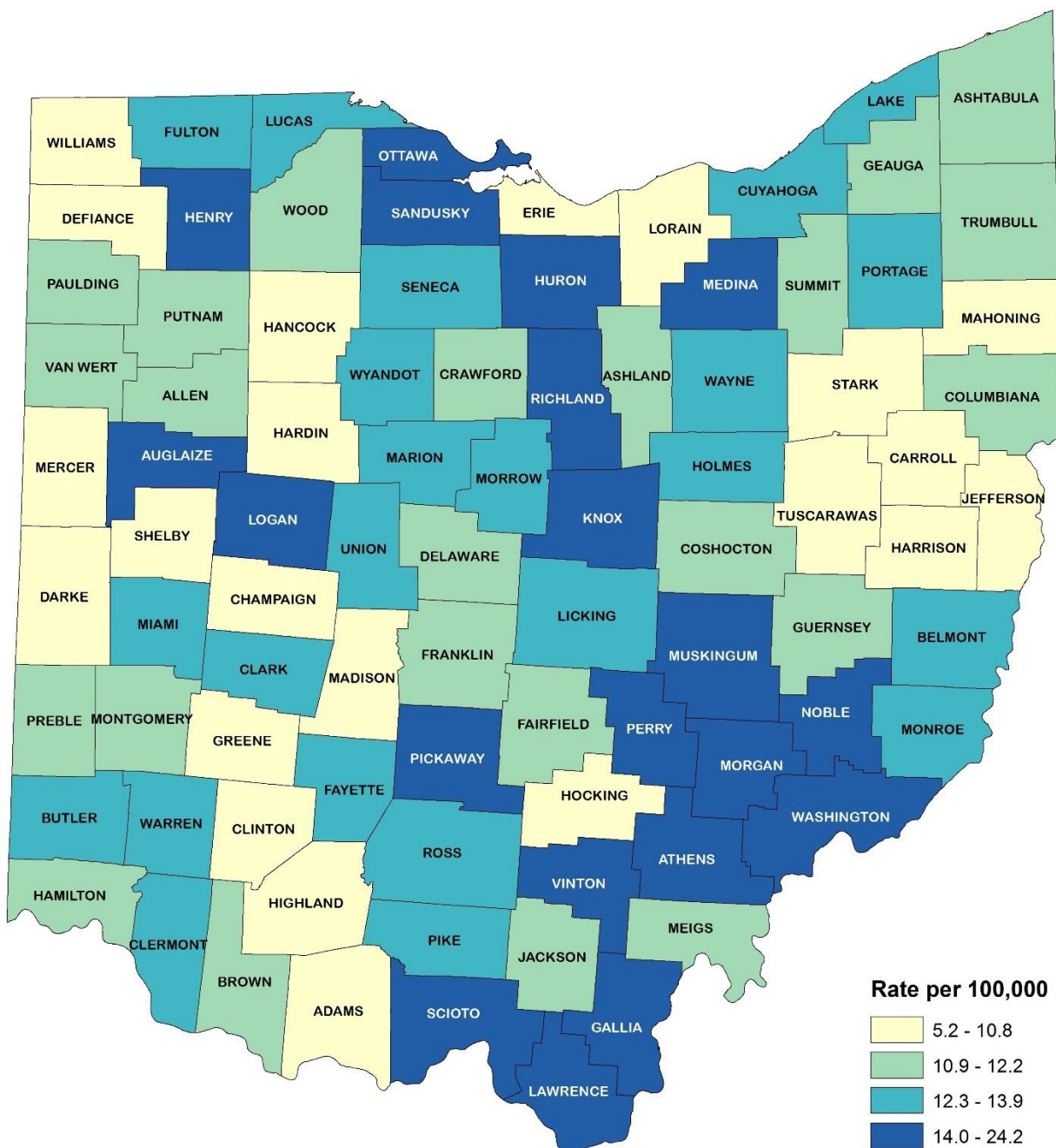


Source: Bureau of Vital Statistics, Ohio Department of Health, 2018.

Incidence by County

Figure 5 shows 2011-2015 average annual age-adjusted leukemia incidence rates by county of residence. County-specific leukemia incidence rates in Ohio ranged from 5.2 to 24.2 per 100,000 persons, compared with Ohio's rate of 12.2 per 100,000. The incidence of leukemia was highest in Ohio's southeastern counties in 2011-2015. The following counties had the highest incidence rates, in decreasing order, for this time period: Vinton, Noble, Perry, Washington and Morgan.

Figure 5. Leukemia: Average Annual Age-adjusted Incidence Rates per 100,000 Persons by County of Residence, Ohio, 2011-2015



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

Each category represents approximately 25 percent of the 88 Ohio counties.

Types of Leukemia

Leukemias are named for how quickly the disease develops and gets worse. Leukemia can be either acute or chronic. In acute leukemia, abnormal blood cells are unable to properly mature and cannot carry out normal functions. These abnormal cells accumulate more rapidly and the disease worsens more quickly. Chronic leukemia usually develops slowly. In chronic leukemia, the cells can mature, but are not completely normal and do not fight infection as well. Leukemias are also named for the type of white blood cell that is affected. Leukemia can arise in either of two main types of white blood cells – lymphoid cells or myeloid cells. The four primary types of leukemia are the following:

Acute Lymphocytic Leukemia (ALL): Occurs when a bone marrow cell develops errors in its DNA, which causes the production of immature white blood cells called lymphoblasts. ALL is the most common type in young children, but also affects adults, mainly those ages 65 and older.

Acute Myeloid Leukemia (AML): Caused by damage to the DNA of developing cells in bone marrow. AML occurs in both adults and children, but it is most common in adults ages 65 and older. AML was the most common type, making up 33.0 percent of all leukemias in Ohio in 2011-2015 (Table 2).

Chronic Lymphocytic Leukemia (CLL): Results from a genetic mutation in the DNA of blood-producing cells, leading to progressive accumulation of small, mature-appearing lymphocytes in blood lymph nodes, the spleen and bone marrow. Most often affects adults ages 55 and older and is rare in children. CLL was the second most common type (30.0 percent) in Ohio in 2011-2015 (Table 2).

Chronic Myeloid Leukemia (CML): Results from injury to the DNA of a stem cell in the bone marrow leading to uncontrolled growth of white cells. Occurs mainly in adults.

Table 2. Leukemia: Average Annual Number and Proportion of Cases (%) by Histology, Ohio, 2011-2015

Histology	Cases	Percent
All Leukemias	1,629	
Acute Lymphocytic Leukemia (ALL)	170	10.4%
Acute Myeloid Leukemia (AML)	538	33.0%
Chronic Lymphocytic Leukemia (CLL)	488	30.0%
Chronic Myeloid Leukemia (CML)	203	12.5%

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

Other types of leukemia not listed above include: other lymphocytic leukemia (3.2 percent); acute monocytic leukemia (1.8 percent); other myeloid/monocytic leukemia (1.8 percent); other acute leukemia (2.4 percent); and aleukemic, subleukemic and not otherwise specified (NOS) leukemia (4.9 percent).

Did You Know?

Although leukemia is often thought of as a childhood cancer, the majority (91 percent) of leukemia cases in the United States are diagnosed in adults 20 years of age and older. Among adults, the most common types are AML and CLL. Among children and adolescents ages 0 to 19 years, ALL is the most common type of leukemia.

Survival

Relative survival probability is the percentage of people who are alive at a designated time period (usually five years) after a diagnosis divided by the percentage expected to be alive in the absence of a diagnosis based on normal life expectancy. Table 3 shows that the U.S. five-year relative survival probability for leukemia in 2008-2014 decreased with advancing age for both males and females. For all races and both sexes combined, the five-year relative survival probability was 75.4 percent among those less than 45 years and 41.0 percent among those 75 years and older. For each age group, the survival probability was greater for whites compared to blacks for both males and females.

Table 3: Five-year Relative Survival Probability (%) by Age at Diagnosis, Sex and Race, United States, 2008-2014

Age at Diagnosis	All Races			White			Black		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Ages <45	75.4	74.9	76.1	76.5	75.5	77.7	67.5	67.3	67.7
Ages 45-54	70.4	71.8	68.4	71.7	72.8	70.1	60.9	63.5	57.5
Ages 55-64	68.6	69.4	67.4	69.7	70.4	68.5	56.7	56.4	56.9
Ages 65-74	59.1	59.1	59.1	59.7	59.3	60.1	52.2	52.1	52.2
Ages 75+	41.0	41.8	40.2	41.8	42.5	41.1	32.7	34.5	30.7

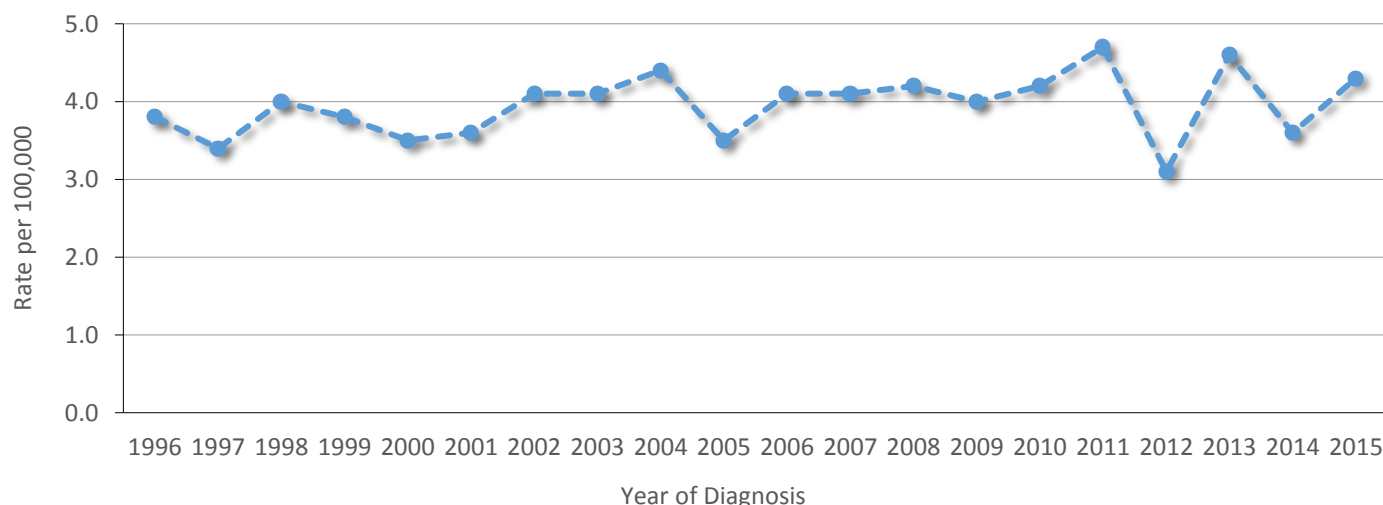
Source: Surveillance, Epidemiology and End Results (SEER) Program, National Cancer Institute, 2018.

Leukemia in Children and Adolescents

Leukemia is the most common type of cancer among children ages 0-14 in the United States, making up about one-third of all childhood cancers. Leukemia occurred most often in the 0-4 age group among children and adolescents (ages 0-19) in Ohio in 2011-2015 (Figure 2).

Figure 6 shows incidence rates of leukemia in Ohio among those ages 19 and younger according to year of diagnosis (1996-2015). Leukemia incidence rates among children and adolescents were variable during this 20-year period.

Figure 6. Leukemia: Trends in Age-adjusted Incidence Rates per 100,000 Children and Adolescents (Ages 0 to 19), Ohio, 1996-2015

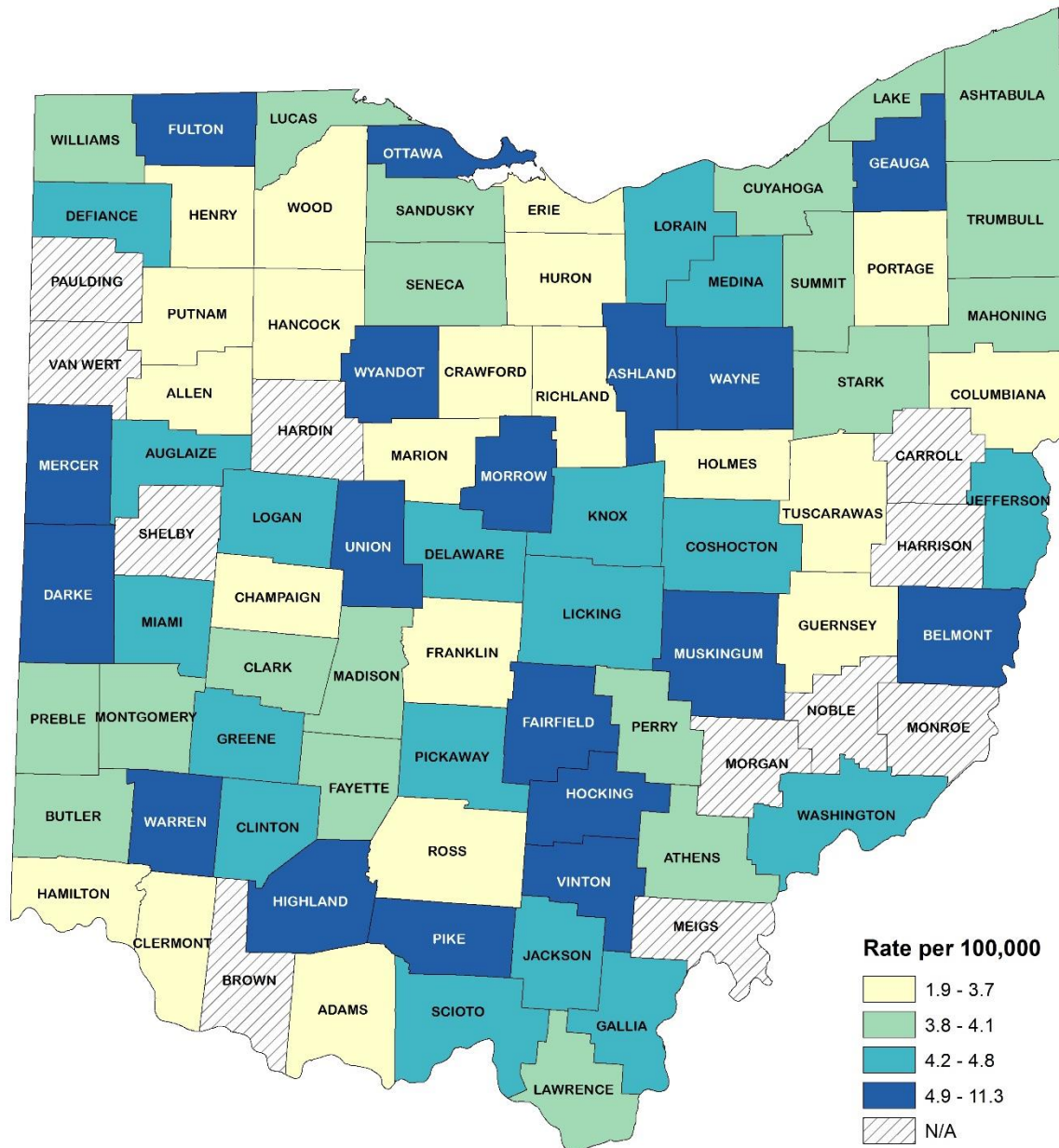


Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

Incidence among Children and Adolescents by County

Figure 7 shows the 1996-2015 average annual age-adjusted leukemia incidence rates among children and adolescents by county of residence. Because pediatric 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. County-specific leukemia incidence rates in Ohio ranged from 1.9 to 11.3 per 100,000 children and adolescents during this time period, compared with Ohio's rate of 4.0 per 100,000. There was no clear geographic pattern of leukemia incidence rates among children and adolescents by county. The following counties had the highest pediatric leukemia incidence rates, in decreasing order: Vinton, Pike, Wyandot, Mercer and Morrow.

Figure 7. Leukemia: Average Annual Age-adjusted Incidence Rates per 100,000 Children and Adolescents (Ages 0-19) by County of Residence, Ohio, 1996-2015



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018.

Each category represents approximately 25 percent of the 77 Ohio counties for which rates were calculated.

N/A: Rate not calculated when the case count for 1996-2015 is less than five.

Risk Factors

Anything that increases your risk of getting a disease is called a risk factor. Having a risk factor does not mean that you will get cancer; not having risk factors doesn't mean that you will not get cancer. The following is a list of risk factors for leukemia:

Non-Modifiable Risk Factors

Age: ALL is most commonly diagnosed among children, whereas AML, CLL and CML occur mainly in adults.

Sex: Leukemia is more common among men than women.

Race: Whites have higher rates of leukemia compared to blacks.

Family history: While it is rare for more than one person in a family to have leukemia, family history does increase risk of CLL.

Down syndrome and other inherited diseases: Down syndrome and certain other inherited diseases increase risk of developing acute leukemia (ALL and AML).

Myelodysplastic syndrome and certain other blood disorders: People with certain blood disorders are at increased risk of AML.

Modifiable Risk Factors

Radiation: People exposed to very high levels of radiation are much more likely than others to get AML, CML or ALL. Radiation exposure resulting from medical treatment for cancer and other conditions can increase risk.

Benzene: Exposure to benzene in the workplace can cause AML. It may also cause CML and ALL. Benzene is found in the chemical industry, cigarette smoke and gasoline.

Chemotherapy: Certain chemotherapy (chemo) drugs, such as alkylating agents, platinum-based drugs or topoisomerase II inhibitors, can increase the risk of leukemia, mainly AML. ALL has also been linked to chemo.

Smoking: Smoking cigarettes increases risk of AML.

Human T-cell leukemia virus type I (HTLV-I): People with HTLV-I infection are at increased risk of a rare type of leukemia known as adult T-cell leukemia.

Signs and Symptoms

In acute leukemia, signs may appear suddenly, while chronic leukemia typically progresses slowly with few symptoms and is often diagnosed during routine blood tests. Symptoms may include:

- Fatigue
- Paleness
- Weight loss
- Repeated infections
- Fever
- Bleeding or bruising easily
- Bone or joint pain
- Swelling in the lymph nodes or abdomen

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

Early Detection

There are no recommended screening tests for the detection of leukemia. However, it is sometimes diagnosed early because of abnormal results on blood tests performed for other indications.

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 19 five-year age groups, i.e., <1, 1-4, 5-9, 10-14, 15-19...85+, 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.

Average Annual Number: The number of cases or deaths diagnosed per year, on average, for the time period of interest (e.g., 2011-2015). 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.

Census Data: The 1996-2015 rates were calculated using population estimates from the U.S. Census Bureau and National Center for Health Statistics. Population data were compiled from bridged-race intercensal population estimates for July 1, 1990-July 1, 1999; revised bridged-race intercensal population estimates for July 1, 2000-July 1, 2004 (released 10/26/2012); revised bridged-race intercensal population estimates for July 1, 2005-July 1, 2009 (released 6/26/2014) and vintage 2017 bridged-race postcensal population estimates for July 1, 2010-July 1, 2017 (released 6/27/2018).

Incidence: The number of cases diagnosed during a specified time period (e.g., 2011-2015). Leukemia cases were defined by the International Classification of Diseases for Oncology, Third Edition (ICD-O-3), and categorized by site and histology codes following the conventions of the Surveillance, Epidemiology and End Results (SEER) Program of the National Cancer Institute.

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

Mortality: The number of deaths during a specified time period (e.g., 2011-2015). Leukemia deaths were defined by the International Statistical Classification of Diseases and Related Health Problems, Ninth Edition (ICD-9) for 1996-1998 and the International Statistical Classification of Diseases and Related Health Problems, Tenth Edition (ICD-10) for 1999-2015, and categorized by site codes following the conventions of the Surveillance, Epidemiology and End Results (SEER) Program of the National Cancer Institute.

Rate: The number of cases or deaths per unit of population (e.g., per 100,000 persons) during a specified time period (e.g., 2011-2015). Rates may be unstable and are not presented when the count is less than five.

Relative Survival: The percentage of people who are alive at a designated time period (usually five years) after a cancer diagnosis divided by the percentage expected to be alive in the absence of cancer based on normal life expectancy. It does not distinguish between patients who have no evidence of cancer and those who have relapsed or are still in treatment.

Table 4. Leukemia: Average Annual Number and Age-adjusted Rates of Cases and Deaths per 100,000 Persons by County of Residence, Ohio and the United States, 2011-2015

	Incidence		Mortality			Incidence		Mortality	
	Cases	Rate	Deaths	Rate		Cases	Rate	Deaths	Rate
Ohio	1,629	12.2	965	7.0	Lawrence	12	16.6	7	9.6
U.S.		13.8		6.7	Licking	25	12.9	13	6.9
Adams	3	10.3	2	6.2	Logan	8	15.0	3	6.3
Allen	14	11.9	9	7.2	Lorain	38	10.6	25	6.9
Ashland	7	11.8	6	7.8	Lucas	62	12.6	38	7.8
Ashtabula	15	12.0	8	6.3	Madison	5	10.2	3	6.5
Athens	8	15.5	3	5.1	Mahoning	31	9.8	21	6.3
Auglaize	8	14.1	5	8.5	Marion	10	12.8	7	8.2
Belmont	11	12.5	7	7.2	Medina	32	16.0	15	7.4
Brown	6	11.5	3	6.6	Meigs	4	11.8	4	11.8
Butler	48	12.5	28	7.5	Mercer	4	7.4	3	4.5
Carroll	3	8.4	3	7.1	Miami	16	12.7	10	8.2
Champaign	4	8.9	4	7.8	Monroe	3	13.5	2	9.4
Clark	21	12.8	13	7.7	Montgomery	73	11.4	53	7.7
Clermont	29	13.7	14	7.0	Morgan	4	18.6	2	9.6
Clinton	4	7.5	3	5.6	Morrow	5	13.8	1	3.0
Columbiana	15	11.4	11	7.3	Muskingum	15	15.1	8	8.1
Coshocton	5	11.7	3	6.7	Noble	3	19.3	2	7.8
Crawford	7	12.1	5	8.1	Ottawa	10	16.5	6	10.2
Cuyahoga	196	12.6	109	6.6	Paulding	3	11.7	2	7.4
Darke	6	8.5	5	7.5	Perry	7	18.7	3	8.8
Defiance	5	10.8	4	8.9	Pickaway	11	17.6	6	9.3
Delaware	22	12.1	10	6.2	Pike	4	12.3	3	8.2
Erie	11	10.6	8	8.3	Portage	24	13.4	12	6.8
Fairfield	20	12.2	11	6.9	Preble	6	11.9	4	7.7
Fayette	4	12.7	3	7.4	Putnam	4	11.0	3	6.8
Franklin	132	11.4	62	5.8	Richland	22	14.4	13	7.8
Fulton	7	13.4	5	9.6	Ross	12	13.8	8	9.4
Gallia	5	14.0	2	5.6	Sandusky	11	14.9	6	8.8
Geauga	15	12.2	8	6.4	Scioto	13	14.6	7	6.6
Greene	18	9.9	15	8.2	Seneca	9	12.9	5	6.7
Guernsey	6	11.8	5	9.7	Shelby	4	6.9	4	6.8
Hamilton	103	11.6	64	6.9	Stark	45	9.9	35	7.0
Hancock	10	10.6	6	6.0	Summit	82	12.2	47	6.9
Hardin	4	10.4	2	6.4	Trumbull	32	11.8	20	7.0
Harrison	1	5.2	1	6.0	Tuscarawas	10	8.8	8	6.3
Henry	5	15.7	3	6.8	Union	7	12.3	3	6.3
Highland	5	9.9	3	6.4	Van Wert	4	12.2	4	10.6
Hocking	4	10.5	2	7.0	Vinton	4	24.2	2	10.6
Holmes	5	12.8	2	5.4	Warren	29	12.8	15	7.1
Huron	10	14.7	7	9.8	Washington	15	18.7	6	7.2
Jackson	4	11.2	3	8.3	Wayne	18	13.6	10	7.1
Jefferson	8	8.6	6	5.4	Williams	3	7.5	3	7.2
Knox	13	16.8	4	5.7	Wood	17	12.2	10	7.6
Lake	42	13.9	21	6.8	Wyandot	4	13.9	2	7.5

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2018; Bureau of Vital Statistics, Ohio Department of Health, 2018; Surveillance, Epidemiology and End Results (SEER) Program, National Cancer Institute, 2018.

Sources of Data and Additional Information

Ohio Cancer Incidence Surveillance System:

http://www.odh.ohio.gov/health/cancer/ocisshs/ci_surv1.aspx

National Cancer Institute:

<https://www.cancer.gov/types/leukemia>

American Cancer Society:

<https://www.cancer.org/cancer/leukemia.html>

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