July 2020

Bone and Joint Cancer in Ohio, 2012-2016

Incidence and Mortality

Primary bone and joint cancer is cancer that forms in cells of the bone and associated joints and does not include cancers that begin elsewhere and spread (metastasize) to the bone.

Bone and joint cancer is a rare cancer, making up only 0.2% of all newly diagnosed (incidence) cancer cases in Ohio, as reported to the Ohio Cancer Incidence Surveillance System (OCISS) from 2012 through 2016. An average of 116 cases of bone and joint cancer were diagnosed annually in Ohio during this time period (Table 1). The average annual age-adjusted incidence rate for bone and joint cancer in Ohio was 1.0 per 100,000, the same as the national incidence rate. The incidence rate among males diagnosed with bone and joint cancer (1.1 per 100,000) was higher than the rate among females (0.8 per 100,000) in Ohio. Whites had a higher rate of bone and joint cancer (1.0 per 100,000) than Blacks (0.7 per 100,000) in Ohio in 2012-2016.

An average of 43 deaths from bone and joint cancer occurred each year in Ohio in 2012-2016 (Table 1). The average annual age-adjusted mortality rate for bone and joint cancer in Ohio was 0.3 per 100,000, compared with the U.S. mortality rate of 0.4 per 100,000. The mortality rate was higher for males (0.4 per 100,000) than females (0.3 per 100,000) in Ohio during this time period.

Key Findings and Populations at High Risk

- An average of 116 new cases of bone and joint cancer were diagnosed and an average of 43 deaths from bone and joint cancer occurred each year in Ohio during 2012-2016.
- The bone and joint cancer incidence rate in Ohio was 1.0 per 100,000, the same as the U.S. rate in 2012-2016.
- Bone and joint cancer occurs more often in males than in females in Ohio and the United States.
- Whites have higher incidence rates of bone and joint cancer than Blacks in Ohio and the United States.
- Bone and joint cancer was most frequently diagnosed among children and young adults (ages 0 to 34).
- Rates of new cases of bone and joint cancer increased slightly in the last 10 years, while deaths decreased.
- In Ohio, county-level bone and joint cancer incidence rates ranged from 0.5 to 1.8 per 100,000 in 1996-2016.
- Half of bone and joint cancers in Ohio were diagnosed at a local (early) stage in Ohio in 2012-2016.
- Overall, 70% of Ohioans diagnosed with bone and joint cancer survive five years after diagnosis.

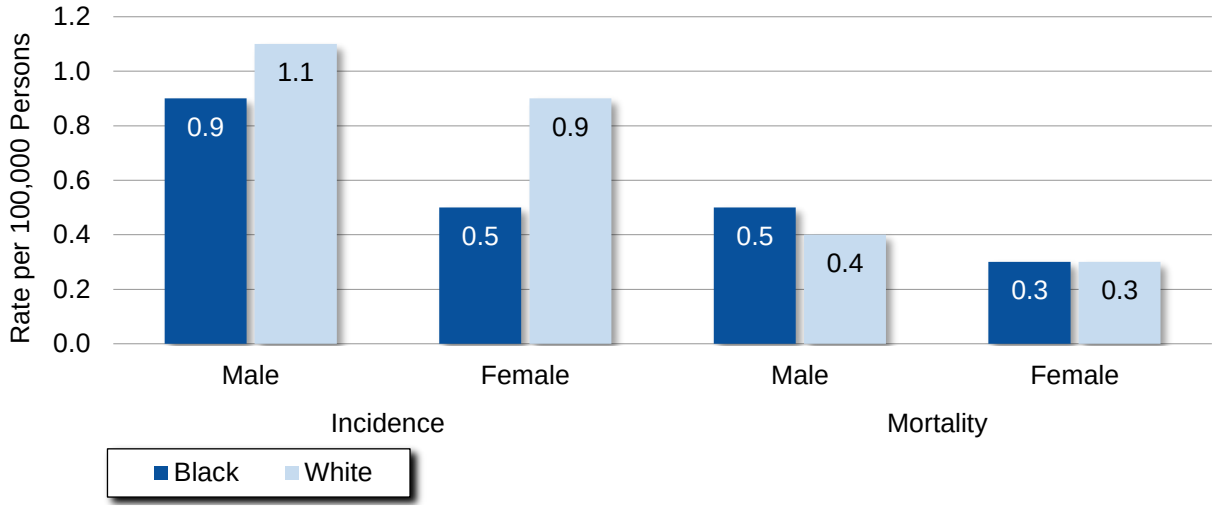
Table 1. Average Annual Number and Age-adjusted Rates of Bone and Joint Cancer Cases and Deaths per 100,000 Persons by Sex, Race, and Age Group, Ohio and the United States, 2012-2016

		Incidence			Mortality		
		Ohio Cases	Ohio Rate	U.S. Rate	Ohio Deaths	Ohio Rate	U.S. Rate
Total		116	1.0	1.0	43	0.3	0.4
Sex	Male	65	1.1	1.1	24	0.4	0.5
	Female	52	0.8	0.8	18	0.3	0.3
Race	White	102	1.0	1.0	37	0.3	0.5
	Black	10	0.7	0.8	5	0.3	0.4

Sources: Ohio Cancer Incidence Surveillance System, Bureau of Vital Statistics, Ohio Department of Health, 2019; Surveillance, Epidemiology and End Results (SEER) Program, National Cancer Institute, 2019.

Incidence and Mortality by Sex and Race

Figure 1. Average Annual Age-adjusted Incidence and Mortality Rates of Bone and Joint Cancer per 100,000 Persons by Sex and Race, Ohio, 2012-2016

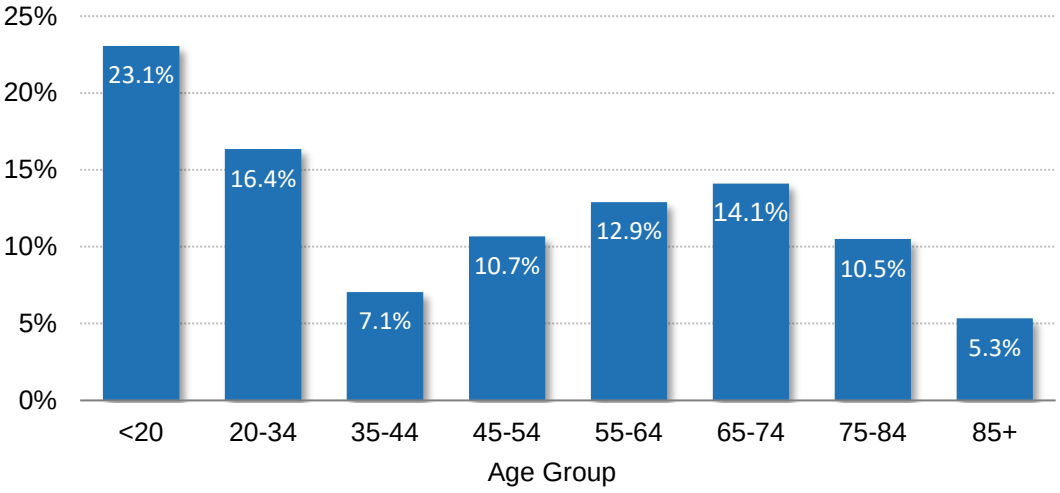


Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020; Bureau of Vital Statistics, Ohio Department of Health, 2020.

White males had the highest bone and joint cancer incidence rate in Ohio, based on data from 2012 to 2016 (Figure 1). Black men were slightly more likely than white men to die from bone and joint cancer. Both white and black females had the lowest incidence and mortality rates for bone and joint cancer in Ohio in 2012-2016.

Incidence by Age Group

Figure 2. Percent of New Cases of Bone and Joint Cancer by Age Group, Ohio, 2012-2016

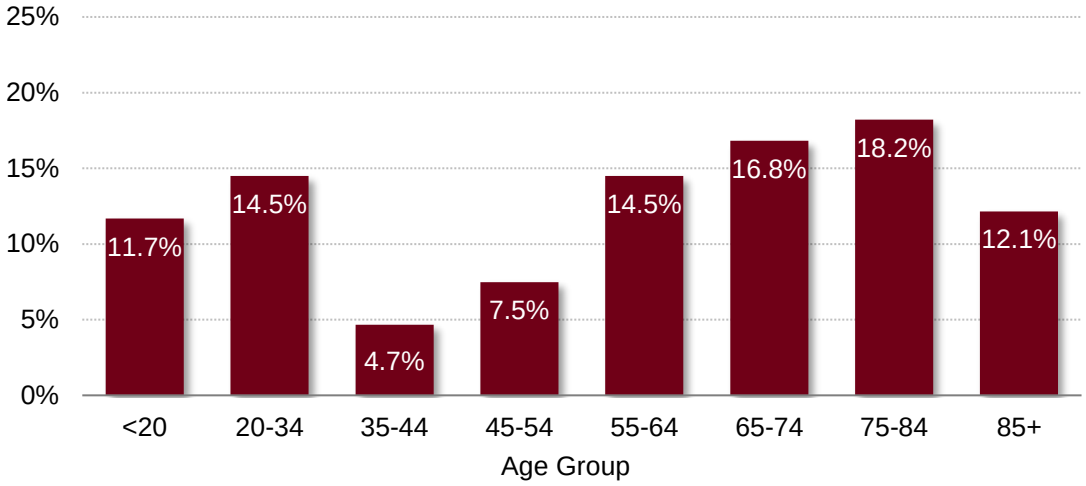


Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

Figure 2 shows the distribution of bone and joint cancer in Ohio from 2012-2016. Nearly 40% of bone and joint cancers in Ohio were diagnosed among people younger than 35 years of age. In Ohio, bone and joint cancer was most frequently diagnosed among those younger than 20 years of age (Figure 2).

Mortality by Age Group

Figure 3. Percent of Deaths of Bone and Joint Cancer by Age Group, Ohio, 2012-2016



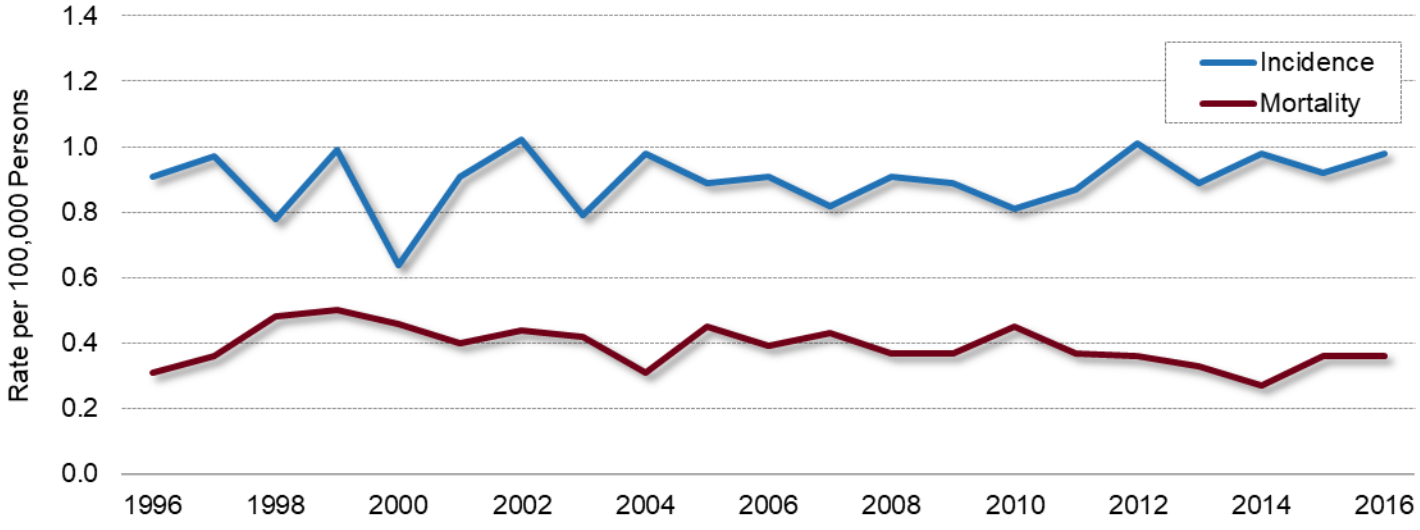
Source: Bureau of Vital Statistics, Ohio Department of Health, 2020.

The distribution of deaths due to bone and joint cancer by age group from 2012 to 2016 in Ohio are shown in Figure 3. Nearly 50% of deaths due to bone and joint cancer occurred in people 65 and older, with the highest percentage among those ages 75 to 84 (18.2%) (Figure 3).

Trends in Incidence and Mortality

Figure 4 shows incidence and mortality rates of bone and joint cancer by year from 1996 through 2016 in Ohio. Incidence rates of bone and joint cancer were slightly variable in Ohio from 1996 to 2016; whereas, death rates were relatively stable during this time period.

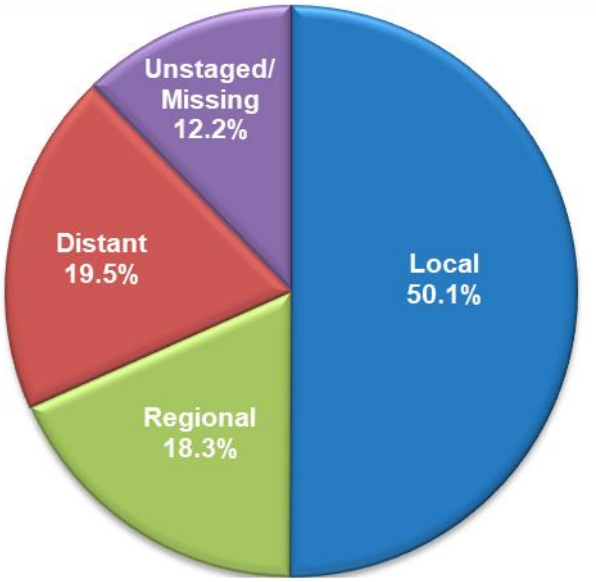
Figure 4. Trends in Age-adjusted Incidence and Mortality Rates of Bone and Joint Cancer per 100,000 Persons, Ohio, 1996-2016



Source: Ohio Cancer Incidence Surveillance System, Bureau of Vital Statistics, Ohio Department of Health, 2020.

Stage at Diagnosis

Figure 5. Proportion of Bone and Joint Cancer Cases (%) by Stage at Diagnosis, Ohio, 2012-2016



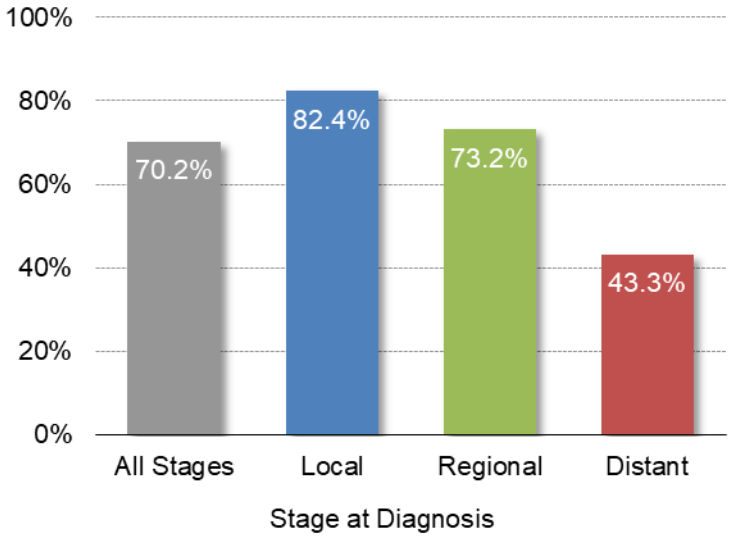
Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

Cancer stage at diagnosis, which refers to the extent or spread of a cancer in the body, is one factor that is used to select appropriate treatment and is an important determinant of survival. If cancer cells have penetrated beyond the original layer of tissue, the cancer has become invasive and is categorized as local, regional or distant based on the extent of spread.

In Ohio in 2012-2016, 50.1% of bone and joint cancer cases were diagnosed at a local stage, 18.3% were regional stage, 19.5% were distant stage, and 12.2% were unstaged or had missing stage information (Figure 5). There were no *in situ* (non-invasive) cases of bone and joint cancer.

Survival

Figure 6: Five-Year Relative Survival (%) for Bone and Joint Cancer by Stage at Diagnosis, Ohio, 2009-2015



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

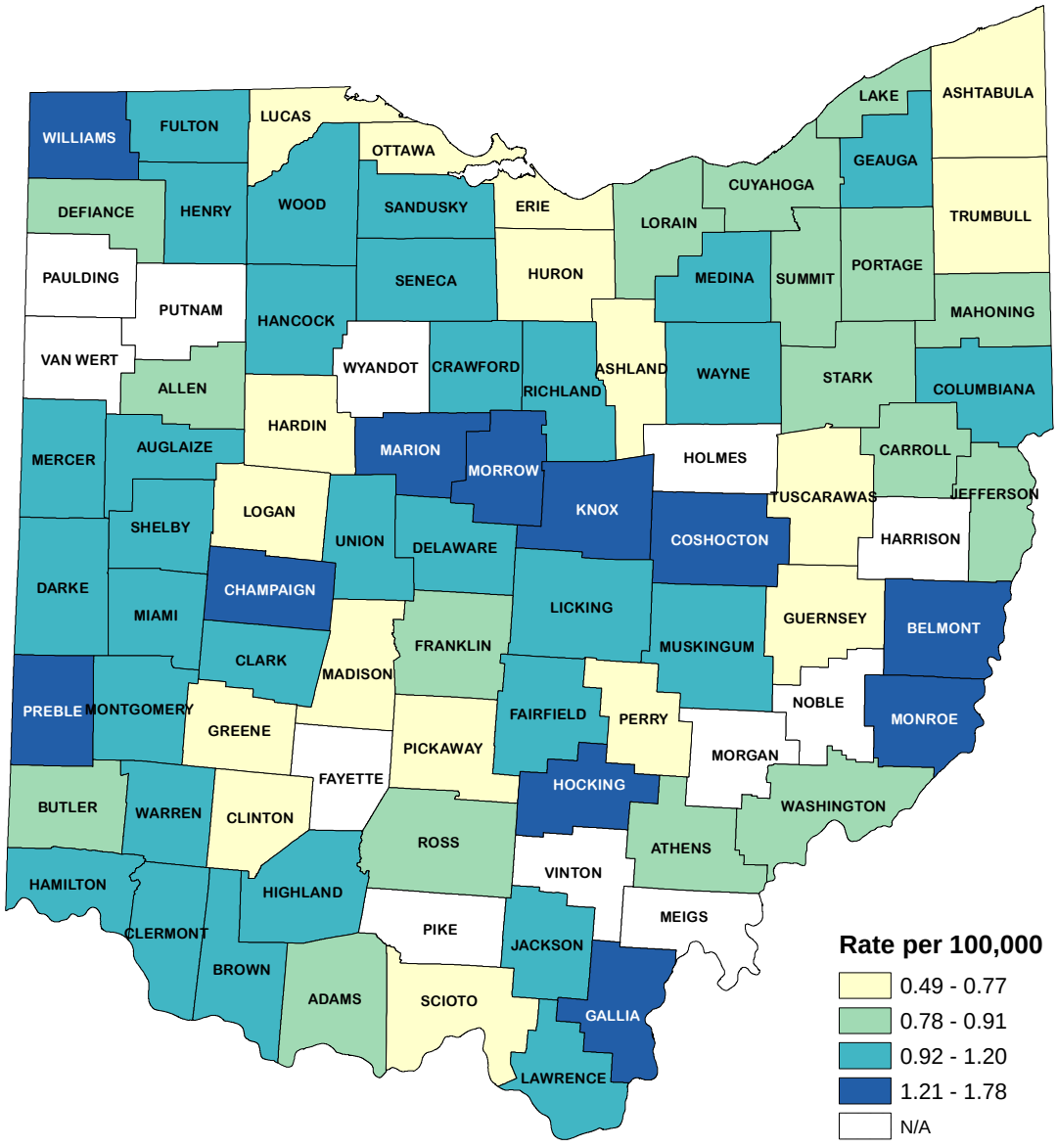
Relative survival is the percentage of people who are alive at a designated time period (usually five years) after a diagnosis divided by the percentage expected to be alive in the absence of a diagnosis based on normal life expectancy.

The overall five-year relative survival for bone and joint cancer in Ohio was 70.2% in 2009-2015. Five-year relative survival was 82.4% when bone and joint cancer was diagnosed at the local stage, 73.2% when diagnosed at the regional stage and 43.3% for tumors diagnosed at the distant stage (Figure 6).

Bone and Joint Cancer by County

Figure 7 shows 1996-2016 average annual age-adjusted bone and joint cancer incidence rates by county of residence. Because bone and joint cancer is rare, 21 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. Rates were not calculated or presented when the total case count was less than five, which was the case for 12 counties in Ohio. County-specific bone and joint cancer incidence rates in Ohio ranged from 0.49 to 1.78 per 100,000 persons, compared with Ohio's rate of 0.9 per 100,000 during that time period. The following six counties had the highest incidence rates, in decreasing order: Monroe, Morrow, Champaign, Marion, Williams, and Gallia. The data used to generate this map are presented in Table 4.

Figure 7. Average Annual Age-adjusted Incidence Rates of Bone and Joint Cancer per 100,000 Persons by County of Residence, Ohio, 1996-2016



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

N/A: Rate not calculated when the case count for 1996-2016 is less than five.

Types of Bone and Joint Cancer

The most common types (histologies) of primary bone cancer are osteosarcoma, chondrosarcoma, Ewing sarcoma and chordoma. Cancers that began in other parts of the body and spread to the bone (metastases) are not included.

- **Osteosarcoma**, also called osteogenic sarcoma, is the most common type of bone cancer. This tumor typically occurs in the arm near the shoulder and in the leg near the knee in children, adolescents, and young adults, but can occur in any bone, especially in older adults. It often grows quickly and spreads to other parts of the body, including the lungs. Risk of osteosarcoma is highest among children and adolescents ages 10 to 19. Osteosarcomas accounted for 29% of bone and joint cancers in Ohio in 2012-2016 (Table 2).
- **Chondrosarcoma** is cancer of the cartilage and is the second most common type of bone cancer. Chondrosarcoma occurs mainly in older adults over age 40. Chondrosarcomas usually occur in cartilage around the pelvis, knee, shoulder, or upper part of the leg. Chondrosarcomas accounted for 28% of bone and joint cancers in 2012-2016.
- **Ewing sarcoma** is the third most common type of bone cancer. The risk of Ewing sarcoma is highest in children and adolescents younger than 19 years of age. Ewing sarcomas typically form in the pelvis, legs, or ribs, but can form in any bone. Boys are more likely to develop Ewing sarcoma than girls. Ewing sarcoma is much more common in whites than in Blacks or Asians. Ewing sarcoma accounted for 14% of bone and joint cancers in Ohio in 2012-2016.
- **Chordoma** is a very rare tumor that forms in bones of the spine. These tumors usually occur in older adults and typically form at the base of the spine (sacrum) and at the base of the skull. Chordoma accounted for 8% of bone and joint cancers in Ohio in 2012-2016.

Table 2. Average Annual Number and Percent of Common Bone and Joint Cancers by Histology, Ohio, 2012-2016

Type of Bone & Joint Cancer	Cases	Percent
Osteosarcoma	33	29%
Chondrosarcoma	32	28%
Ewing sarcoma	16	14%
Chordoma	9	8%

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

Bone and Joint Cancer by Site

Table 3. Percent of Bone and Joint Cancers by Site, Ohio, 2012-2016

Site of Bone and Joint Cancer	Percent
Long bones of the leg and associated joints	31%
Pelvic bones, sacrum, coccyx, and associated joints	16%
Bones of the skull and face and associated joints	12%
Long bones of the arm, scapula, and associated joints	9%
Spinal column	8%
Rib, sternum, clavicle, and associated joints	7%
Lower jaw	4%
Short bones of the leg and associated joints	3%
Short bones of the arm and associated joints	1%

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2020.

Table 3 shows the locations where bone and joint cancers were found in the body in Ohio in 2012-2016. Long bones of the leg and associated joints comprised the highest percentage of cases (31%) in Ohio in 2012-2016.

Risk Factors

Anything that increases the chance of getting a disease is called a risk factor. Having one or more risk factors does not mean that a person will develop the disease. At this time, the causes of bone cancer are not well understood. However, scientists agree that certain factors increase a person's risk of developing this disease. These risk factors include:

Previous radiation therapy, chemotherapy, or stem cell transplantation: Bone cancer occurs more frequently in people who have had radiation therapy, chemotherapy (particularly with alkylating agents), or stem cell transplantation.

Certain inherited conditions: Individuals with retinoblastoma (a rare type of eye cancer), Li-Fraumeni syndrome, tuberous sclerosis complex, or hereditary bone defects are at increased risk.

Bone conditions: Paget's disease of the bone and other benign bone conditions increase the risk of bone cancer.

Bone and Joint Cancer Signs and Symptoms

Pain is the most common symptom of bone and joint cancer, but not all bone and joint cancers cause pain. This and other common symptoms of bone and joint cancer include:

- Persistent or unusual pain or swelling in or near a bone.
- A lump or mass in the arms, legs, chest, or pelvis.
- Unexplained fever.
- A bone that breaks for no reason.

It is possible that one or more of these signs and symptoms may be the result of other health problems. If you have any of these symptoms, you should consult with your healthcare provider.

Bone and Joint Cancer in Children and Adolescents

In Ohio, children and adolescents (ages 0 to 19) represented 23% of all cases of bone and joint cancer diagnosed in 2012-2016 (Figure 2) and about 12% of the deaths from this cancer (Figure 3).

There was an average of 27 cases (15 males, 12 females) of bone and joint cancer diagnosed each year among children and adolescents in Ohio in 2012-2016. The rate was 0.9 per 100,000 compared with the national (Surveillance, Epidemiology and End Results (SEER) Program 21 Areas) rate of 1.0 per 100,000. The most common types of bone and joint cancer in children in Ohio were osteosarcoma (51% of cases) and Ewing sarcoma (39% of cases) in 2012-2016.

An average of five deaths occurred each year among children and adolescents from malignant bone and joint cancer in Ohio in 2012-2016, at a rate of 0.2 per 100,000, similar to the national rate. There were twice as many boys dying of this cancer than girls in Ohio during this time period.

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., 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.

Census Data: The 1996-2016 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 Oct. 26, 2012); revised bridged-race intercensal population estimates for July 1, 2005-July 1, 2009 (released June 26, 2014); and vintage 2017 bridged-race postcensal population estimates for July 1, 2010-July 1, 2017 (released June 27, 2018).

Incidence: The number of cases diagnosed during a specified time period (e.g., 2012-2016). Bone and joint cancer cases were defined by the International Classification of Diseases for Oncology, Third Edition (ICD-O-3), and categorized by site codes C400-C419, excluding types 9050-9055, 9140, and 9590-9992, in accordance with the 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., 2012-2016). Bone and joint cancer deaths were defined as follows: International Statistical Classification of Diseases and Related Health Problems, Ninth Edition (ICD-9), code 170 for 1996-1998 and International Statistical Classification of Diseases and Related Health Problems, Tenth Edition (ICD-10), codes C40-C41 for 1999-2016.

Rate: The number of cases or deaths per unit of population (e.g., per 100,000 persons) during a specified time period (e.g., 2012-2016). 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.

Stage at Diagnosis: The degree to which a tumor has spread from its site of origin at the time of diagnosis. A system of summary staging is often used to group cases into the following stages:

in situ — Noninvasive cancer that has not penetrated surrounding tissue.

Local — A malignant tumor confined entirely to the organ of origin.

Regional — A malignant tumor that has extended beyond the organ of origin directly into surrounding organs or tissues or into regional lymph nodes.

Distant — A malignant tumor that has spread to parts of the body (distant organs, tissues and/or lymph nodes) remote from the primary tumor.

Unstaged/Missing — Insufficient information is available to determine the stage or extent of the disease at diagnosis.

Table 4. Total Number of Invasive Bone and Joint Cancer Cases and Age-adjusted Incidence Rates per 100,000 Persons by County of Residence, Ohio and the United States, 1996-2016

	1996-2016		
	Cases	Rate	
Ohio	**2,217**	**0.90**	
U.S.		**0.92**	
Ashland	6	0.49	0.49 - 0.77
Guernsey	5	0.56	
Perry	5	0.62	
Logan	6	0.63	
Erie	12	0.64	
Huron	8	0.64	
Madison	6	0.64	
Trumbull	35	0.66	
Clinton	6	0.67	
Greene	23	0.72	
Ashtabula	17	0.74	
Ottawa	7	0.74	
Pickaway	8	0.74	
Hardin	5	0.76	
Lucas	74	0.77	
Scioto	14	0.77	
Tuscarawas	15	0.77	
Butler	60	0.80	0.78 - 0.91
Defiance	7	0.80	
Jefferson	14	0.80	
Cuyahoga	239	0.82	
Mahoning	48	0.82	
Washington	11	0.83	
Ross	13	0.84	
Athens	9	0.86	
Franklin	199	0.87	
Summit	102	0.88	
Lake	45	0.89	
Portage	30	0.89	
Stark	75	0.89	
Adams	5	0.90	
Allen	22	0.90	
Lorain	57	0.90	
Carroll	5	0.91	
Crawford	9	0.93	0.92 - 1.20
Fairfield	27	0.93	
Licking	32	0.93	
Brown	9	0.95	
Hamilton	167	0.96	
Hancock	15	0.96	
Highland	9	0.97	
Montgomery	115	0.98	
Richland	27	0.98	

	1996-2016		
	Cases	Rate	
Mercer	9	0.99	0.92 - 1.20 continued
Warren	38	0.99	
Lawrence	14	1.00	
Medina	34	1.00	
Shelby	10	1.00	
Henry	6	1.01	
Jackson	7	1.01	
Seneca	13	1.01	
Union	10	1.01	
Sandusky	14	1.03	
Auglaize	11	1.04	
Clermont	39	1.04	
Geauga	19	1.04	
Wood	26	1.06	
Wayne	26	1.07	
Muskingum	21	1.08	
Miami	24	1.09	
Delaware	35	1.11	
Columbiana	27	1.14	
Darke	13	1.14	
Fulton	11	1.17	
Clark	36	1.19	
Coshocton	11	1.20	
Hocking	8	1.21	1.21 - 1.78
Belmont	18	1.23	
Preble	12	1.23	
Knox	16	1.29	
Gallia	9	1.37	
Williams	11	1.38	
Marion	20	1.47	
Champaign	13	1.50	
Morrow	13	1.69	
Monroe	5	1.78	
Fayette	3	N/A	N/A
Harrison	2	N/A	
Holmes	4	N/A	
Meigs	1	N/A	
Morgan	2	N/A	
Noble	3	N/A	
Paulding	3	N/A	
Pike	4	N/A	
Putnam	4	N/A	
Van Wert	2	N/A	
Vinton	3	N/A	
Wyandot	4	N/A	

Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, 2019; Surveillance, Epidemiology and End Results (SEER) Program, National Cancer Institute, 2020.
N/A = Rate not calculated when the case count for 1996-2016 is less than five.

Sources of Data and Additional Information

Ohio Cancer Incidence Surveillance System:
https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/ohio-cancer-incidence-surveillance-system/welcome-to

National Cancer Institute:
https://www.cancer.gov/types/bone

American Cancer Society:
http://www.cancer.org/cancer/bone-cancer.html

To address comments and information requests:

Ohio Cancer Incidence Surveillance System (OCISS)
Ohio Department of Health
246 North High Street
Columbus, OH 43215
Phone: (614) 752-2689
Fax: (614) 644-8028
E-mail: ociss@odh.ohio.gov

Acknowledgements

Ohio Department of Health
Holly L. Sobotka, MS
John Kollman, MS
Emily Bunt, MA

The Ohio State University
James L. Fisher, PhD
Julie A. Stephens, MS
Ryan D. Baltic, MPH

Sincere appreciation to the OCISS, cancer registrars, medical records technicians, and other health professionals who improve the collection and quality of cancer data in Ohio.

Suggested Citation

Bone and Joint Cancer in Ohio, 2012-2016. Ohio Cancer Incidence Surveillance System, Ohio Department of Health, July 2020.

The OCISS is supported in part by the State of Ohio and the Centers for Disease Control and Prevention (CDC), National Program of Cancer Registries, cooperative agreement number NU58DP006284. The contents are the sole responsibility of the authors and do not necessarily represent the official views of the CDC.