

PEDIATRIC CANCER IN IDAHO, 2012–2021

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BACKGROUND

Although relatively rare in comparison with cancer in older adults, from 2012–2021 cancer was the sixth leading cause of death in persons aged 1–19 years.¹ The epidemiology of cancer among children differs markedly from that of adults, both in the patterns of anatomic sites involved and the predominant histologic types. Most notably, cancers diagnosed in children frequently involve the central nervous system or are of hematopoietic or mesenchymal origin. In contrast, malignancies of epithelial tissues, which are predominant in adults, are uncommon in children. Similar to adult cancers, the etiology of many childhood cancers remains unclear.

The Cancer Data Registry of Idaho (CDRI) receives several requests per year from physicians and others for data on pediatric cancer incidence for the state of Idaho. This report describes the incidence of pediatric cancers in Idaho, with comparisons to data from the National Cancer Institute’s Surveillance, Epidemiology, and End Results (SEER) Program and the US Centers for Disease Control and Prevention’s National Program of Cancer Registries (NPCR).^{2,3,4} SEER currently publishes cancer incidence and survival data from population-based cancer registries covering approximately 47.9% of the US population and is considered the standard for quality among cancer registries around the world. NPCR supports central cancer registries in 46 states, the District of Columbia, Puerto Rico, the U.S. Pacific Island Jurisdictions, and the U.S. Virgin Islands. These data represent 97% of the U.S. population. Together, NPCR and SEER collect data for the entire U.S. population.

METHODS

The data analyzed for this report include cancers diagnosed during 2012–2021 among Idaho residents less than 20 years of age. Cases were grouped according to the International Classification of Childhood Cancer (ICCC) based on site and morphology coded according to ICD-O-3.⁵

Health District was assigned from county of residence at time of diagnosis. All incidence and mortality rates presented in this report are calculated per million population and are averages for the period 2012 through 2021; rates per million, rather than per 100,000, are commonly used for pediatric cancers. Malignant cases that are not defined in the ICCC system and in situ cases, which are not included in the ICCC system, were excluded from analyses of malignant cancers. Age-adjustment was performed using the direct method to the 2000 U.S. standard population. Cancer incidence, mortality and survival statistics were calculated using SEER*Stat.⁶ State rankings were obtained from the NPCR and SEER Incidence Public Use Data File.³

RESULTS

A total of 981 cases were diagnosed among Idaho resident children under the age of 20 during 2012–2021. This number includes 858 malignant cancers, 111 benign and

borderline behavior neoplasms, and 12 in situ tumors. Twenty-six malignant cases undefined in ICCC and the 12 in situ cases were excluded from analysis.

A total of 943 cases that met the study criteria were diagnosed among Idaho residents aged less than 20 years between 2012 and 2021, yielding an overall age-adjusted rate of 193.6 cases per million population (Table 1). In comparison, the SEER-12 rate was 212.1 cases per million population during 2012–2021. The distribution of pediatric cancers by ICCC grouping was very similar for Idaho and SEER Regions. For no ICCC major classification category did Idaho show a statistically significantly higher rate of pediatric cancer from SEER-12 data based on the comparisons of 95% confidence intervals.

For all races combined, Idaho ranked 41st highest among states in pediatric (ages 0–19) cancer incidence 2011-2020, with a rate of 190.8 per million population based on USCS data.³ North Dakota ranked lowest with 167.7 cases per million population and New York ranked highest with 241.2 cases per million population. Pediatric cancer incidence is higher among whites in the United States, and Idaho has a higher proportion of white residents than many states, so the distribution of race drives some of the differences in incidence by state. When restricting to non-Hispanic whites alone, Idaho ranked 45th in pediatric cancer incidence.

About 87% of children aged less than 20 years diagnosed with malignant cancer survived at least 5 years after their diagnosis, both in Idaho and SEER-12 Regions (Table 2 and Figure 1). For no ICCC major classification category, nor overall, was there a statistically significant difference in 5-year relative survival between Idaho and SEER cases.

Table 3 and Figure 2 show malignant pediatric cancer incidence in Idaho and SEER Regions by year of diagnosis for 2012 to 2021. Idaho incidence rates are lower than or equivalent to SEER-12 rates for most years and show more year-to-year variability due to smaller numbers of cases. Pediatric cancer incidence increased at a rate of about 0.5% per year in Idaho from 1975 to 2021. This parallels the long-term increase observed in SEER-8 Regions from 1975 to 2021 of about 0.7% per year.⁴

Table 4 shows pediatric cancer incidence in Idaho by public health district by ICCC major classification categories for the period 2012 to 2021. For all sites combined, no health district had a statistically significantly higher or lower rate than the state of Idaho, based on the comparison of 95% confidence intervals. For no ICCC major classification category was there a statistically significant difference between any health district and the state of Idaho.

During 2012 to 2022, 118 of Idaho's children aged 0–19 died from some form of cancer (Table 5).⁷ The leading types of cancer mortality were brain and other central nervous system and leukemia, and accounted for about half of pediatric cancer-related mortality. Cancers of the bones and joints and cancers of the soft tissue (including heart) accounted for about 30% of cancer-related mortality (data not shown). While pediatric

cancer incidence rates have increased over time, pediatric cancer mortality rates have decreased about 2% per year during 1975–2022 in Idaho and the U.S.^{7,8} Figure 3 depicts trends in pediatric cancer mortality rates from 2012 to 2022. The annual rates plotted for Idaho demonstrate large year-to-year variability that is expected due to the relatively small numbers of deaths per year; although there were large increases in pediatric cancer mortality in Idaho during 2018–2019, the overall trend for the period from 2012–2022 did not show a statistically significant increase. Idaho ranked 43rd among states and the District of Columbia in pediatric (ages 0–19) cancer mortality 2012–2022.¹ New Hampshire ranked highest, with 2.7 deaths per 100,000 population, and Delaware ranked lowest, with 1.8 deaths per 100,000 population.

CONCLUSIONS

These data demonstrate strong similarity in pediatric cancer incidence and survival patterns between Idaho and SEER Regions. Compared with cancer in adults,⁸ there is less geographic variability in pediatric cancer incidence, which is likely related to the distribution of hereditary predispositions to cancer in the pediatric population. A 2015 study that tested children and adolescents with cancer revealed that 8.5% had predisposing gene mutations: 16.7% in patients with non-CNS solid tumors, 8.6% in patients with CNS tumors, and 4.4% in patients with leukemia.⁹

A limitation of this study that may affect interpretation of results is the potential incomplete reporting of pediatric cancers from other states in which Idaho residents are diagnosed or treated for cancer. In particular, this may be the reason why pediatric cancer incidence rates are lower in Public Health District 2. Furthermore, disruptions caused by the COVID-19 pandemic greatly impacted cancer healthcare services and may have impacted reporting from other states of Idaho 2020 pediatric cancer diagnoses and treatment.

Largely because of improvements in therapy for pediatric cancers, there has been a decrease in mortality rates over time. Data collected by CDRI for 2021 show that about 40% of pediatric patients participated in clinical trials (not shown), a much higher proportion than adult patients (1.0%). The 40% participation is an increase over recent years; lower participation in prior years was impacted – in part – by an increase in pediatric cancer therapy knowledge and a subsequent specificity in patient eligibility requirements, e.g., a tumor must have specific biomarkers, or a patient must have received specific therapy to be eligible.

While over 85% of children diagnosed with cancer survive at least five years, studies show that adult survivors of childhood cancer have higher prevalence of adverse health outcomes later in life and are at risk for higher health care expenditures and lost productivity, compared to adults without a history of childhood cancer.^{10,11} Childhood cancer survivors continue to have excess risk of late (after 5 years) mortality through 40 years after diagnosis. Compared to the general population, long-term survivors of childhood cancer are at significantly increased risk of death. Beyond 10 years from diagnosis, excess deaths are primarily due to health-related causes including

subsequent cancers, heart disease, and cerebrovascular disease.¹² Education, intervention programs, and ongoing follow-up care are important for improving health and economic outcomes associated with cancer survivorship in this population.

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Table 1. Pediatric (Ages 0-19) Cancer Incidence in Idaho and SEER Regions

Site/Type of Cancer	Idaho 2012-2021			SEER 2012-2021		
	Rate	Cases	Pop	Rate	Cases	Pop
All Sites Combined	193.6	943	4,882,825	212.1	21,562	101,224,062
I Leukemias, myeloproliferative & myelodysplastic diseases	41.9	204	4,882,825	49.6	5,019	101,224,062
I(a) Lymphoid leukemias	33.1	161	4,882,825	36.3	3,661	101,224,062
I(b) Acute myeloid leukemias	5.9	29	4,882,825	8.6	877	101,224,062
I(c) Chronic myeloproliferative diseases	1.0	5	4,882,825	2.1	213	101,224,062
I(d) Myelodysplastic syndrome and other myeloproliferative	1.0	5	4,882,825	1.5	149	101,224,062
I(e) Unspecified and other specified leukemias	0.8	4	4,882,825	1.2	119	101,224,062
II Lymphomas and reticuloendothelial neoplasms	28.8	141	4,882,825	29.6	3,018	101,224,062
II(a) Hodgkin lymphomas	11.4	56	4,882,825	11.1	1,139	101,224,062
II(b) Non-Hodgkin lymphomas (except Burkitt lymphoma)	11.0	54	4,882,825	11.2	1,145	101,224,062
II(c) Burkitt lymphoma	2.2	11	4,882,825	2.3	234	101,224,062
II(d) Miscellaneous lymphoreticular neoplasms	3.9	19	4,882,825	4.7	474	101,224,062
II(e) Unspecified lymphomas	0.2	1	4,882,825	0.3	26	101,224,062
III CNS and misc intracranial and intraspinal neoplasms	45.9	224	4,882,825	48.3	4,897	101,224,062
III(a) Ependymomas and choroid plexus tumor	4.4	21	4,882,825	4.0	400	101,224,062
III(b) Astrocytomas	16.0	78	4,882,825	15.1	1,528	101,224,062
III(c) Intracranial and intraspinal embryonal tumors	4.1	20	4,882,825	5.4	540	101,224,062
III(d) Other gliomas	4.5	22	4,882,825	6.2	624	101,224,062
III(e) Other specified intracranial/intraspinal neoplasms	14.5	71	4,882,825	16.4	1,681	101,224,062
III(f) Unspecified intracranial and intraspinal neoplasms	2.5	12	4,882,825	1.2	124	101,224,062
IV Neuroblastoma and other peripheral nervous cell tumors	8.2	39	4,882,825	8.3	827	101,224,062
IV(a) Neuroblastoma and ganglioneuroblastoma	7.8	37	4,882,825	8.0	796	101,224,062
IV(b) Other peripheral nervous cell tumors	0.4	2	4,882,825	0.3	31	101,224,062
V Retinoblastoma	1.5	7	4,882,825	3.0	299	101,224,062
VI Renal tumors	7.7	37	4,882,825	6.2	622	101,224,062
VI(a) Nephroblastoma and other nonepithelial renal tumors	7.1	34	4,882,825	5.5	556	101,224,062
VI(b) Renal carcinomas	0.6	3	4,882,825	0.6	64	101,224,062
VI(c) Unspecified malignant renal tumors	0.0	0	4,882,825	0.0	2	101,224,062
VII Hepatic tumors	2.3	11	4,882,825	3.1	308	101,224,062
VII(a) Hepatoblastoma	1.9	9	4,882,825	2.4	244	101,224,062
VII(b) Hepatic carcinomas	0.4	2	4,882,825	0.6	62	101,224,062
VII(c) Unspecified malignant hepatic tumors	0.0	0	4,882,825	0.0	2	101,224,062
VIII Malignant bone tumors	7.5	37	4,882,825	9.2	940	101,224,062
VIII(a) Osteosarcomas	4.5	22	4,882,825	5.5	561	101,224,062
VIII(b) Chondrosarcomas	0.2	1	4,882,825	0.3	27	101,224,062
VIII(c) Ewing tumor and related sarcomas of bone	1.6	8	4,882,825	2.9	299	101,224,062
VIII(d) Other specified malignant bone tumors	1.2	6	4,882,825	0.4	38	101,224,062
VIII(e) Unspecified malignant bone tumors	0.0	0	4,882,825	0.1	15	101,224,062
IX Soft tissue and other extrasosseous sarcomas	11.8	57	4,882,825	11.7	1,192	101,224,062
IX(a) Rhabdomyosarcomas	4.3	21	4,882,825	4.1	414	101,224,062
IX(b) Fibrosarcomas, peripheral nerve & other fibrous	0.9	4	4,882,825	1.2	122	101,224,062
IX(c) Kaposi sarcoma	0.0	0	4,882,825	0.0	5	101,224,062
IX(d) Other specified soft tissue sarcomas	4.3	21	4,882,825	4.9	501	101,224,062
IX(e) Unspecified soft tissue sarcomas	2.3	11	4,882,825	1.5	150	101,224,062
X Germ cell & trophoblastic tumors & neoplasms of gonads	12.7	62	4,882,825	12.6	1,291	101,224,062
X(a) Intracranial & intraspinal germ cell tumors	2.4	12	4,882,825	2.5	255	101,224,062
X(b) Extracranial & extragonadal germ cell tumors	1.3	6	4,882,825	1.5	153	101,224,062
X(c) Malignant gonadal germ cell tumors	8.4	41	4,882,825	7.8	810	101,224,062
X(d) Gonadal carcinomas	0.2	1	4,882,825	0.4	40	101,224,062
X(e) Other and unspecified malignant gonadal tumors	0.4	2	4,882,825	0.3	33	101,224,062

Table 1. Pediatric (Ages 0-19) Cancer Incidence in Idaho and SEER Regions - Continued

Site/Type of Cancer	Idaho 2012-2021			SEER 2012-2021		
	Rate	Cases	Pop	Rate	Cases	Pop
XI Other malignant epithelial neoplasms and melanomas	24.9	122	4,882,825	22.6	2,334	101,224,062
XI(a) Adrenocortical carcinomas	0.6	3	4,882,825	0.2	18	101,224,062
XI(b) Thyroid carcinomas	10.6	52	4,882,825	10.3	1,067	101,224,062
XI(c) Nasopharyngeal carcinomas	0.4	2	4,882,825	0.4	41	101,224,062
XI(d) Malignant melanomas	5.5	27	4,882,825	3.5	362	101,224,062
XI(e) Skin carcinomas	0.0	0	4,882,825	0.1	12	101,224,062
XI(f) Other and unspecified carcinomas	7.8	38	4,882,825	8.1	834	101,224,062
XII Other and unspecified malignant neoplasms	0.4	2	4,882,825	0.8	76	101,224,062
XII(a) Other specified malignant tumors	0.2	1	4,882,825	0.5	55	101,224,062
XII(b) Other unspecified malignant tumors	0.2	1	4,882,825	0.2	21	101,224,062
Not classified by ICCC or in situ	7.8	38	4,882,825	7.2	739	101,224,062

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

Cases and rates are for benign, borderline, and malignant behavior.

Statistical Note: Rates based upon 10 or fewer cases (numerator) should be interpreted with caution.

Figure 1. Pediatric Cancer Relative Survival

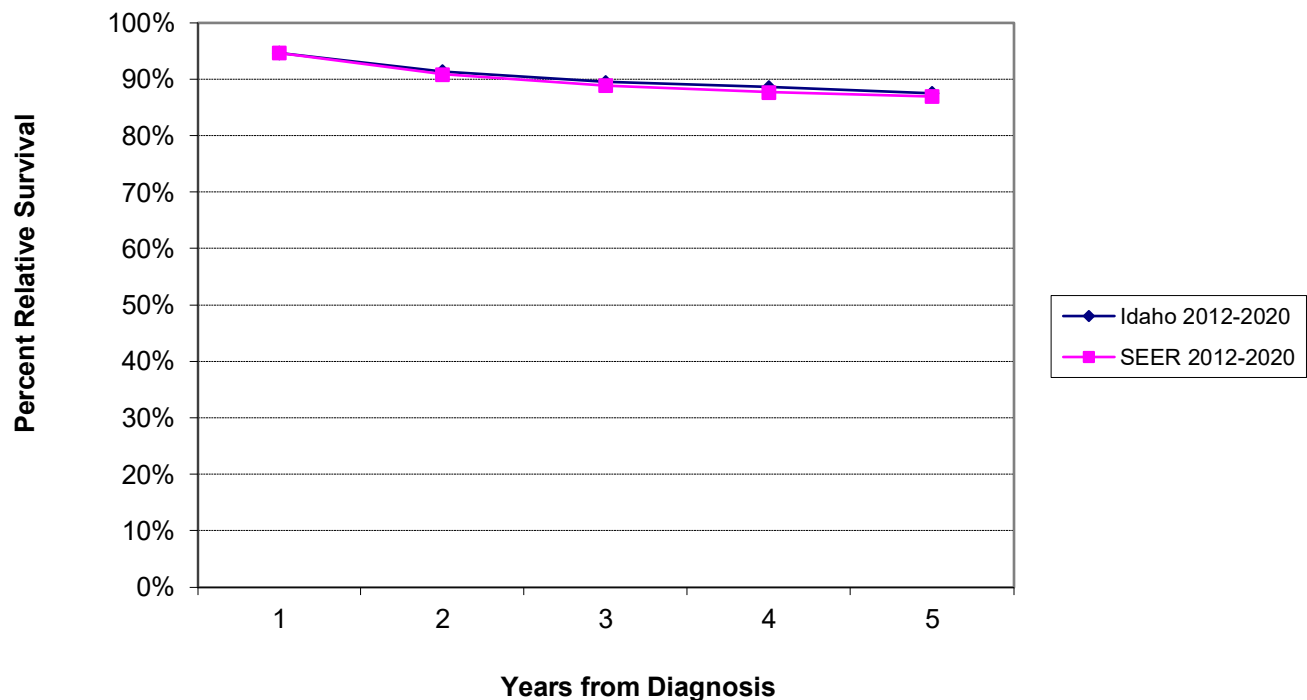


Table 2. Five-Year Relative Cancer Survival by Major ICC Classification Category

Site/Type of Cancer	Idaho 2012-2020			SEER 2012-2020		
	Cases	% Survival	95% CI	Cases	% Survival	95% CI
All Sites Combined	758	87.6%	84.8% - 89.9%	12540	87.0%	86.3% - 87.6%
I Leukemias, myeloproliferative & myelodysplastic diseases	187	89.2%	83.4% - 93.0%	3341	87.0%	85.7% - 88.2%
II Lymphomas and reticuloendothelial neoplasms	128	94.4%	88.4% - 97.3%	1998	95.4%	94.3% - 96.2%
III CNS and misc intracranial and intraspinal neoplasms	118	81.3%	72.7% - 87.5%	1989	75.5%	73.4% - 77.5%
IV Neuroblastoma and other peripheral nervous cell tumors	36	79.2%	59.0% - 90.3%	524	85.4%	81.7% - 88.5%
V Retinoblastoma	6	100.0%	+	187	96.1%	91.0% - 98.3%
VI Renal tumors	34	89.5%	70.1% - 96.6%	407	91.8%	88.3% - 94.3%
VII Hepatic tumors	10	100.0%	+	193	78.8%	71.9% - 84.3%
VIII Malignant bone tumors	28	60.9%	39.3% - 76.9%	628	70.2%	66.0% - 74.1%
IX Soft tissue and other extraosseous sarcomas	51	72.6%	57.2% - 83.3%	770	75.3%	71.7% - 78.5%
X Germ cell & trophoblastic tumors & neoplasms of gonads	56	92.8%	81.6% - 97.3%	842	94.2%	92.2% - 95.7%
XI Other malignant epithelial neoplasms and melanomas	103	95.6%	88.4% - 98.4%	1666	96.4%	95.2% - 97.3%
XII Other and unspecified malignant neoplasms	2	+	+	47	93.3%	80.3% - 97.8%

+ The statistic could not be calculated.

Table 3. Malignant Pediatric (Ages 0-19) Cancer Incidence in Idaho and SEER Regions

Year of Diagnosis	Idaho 2012-2021			SEER 2012-2021		
	Rate	Cases	Pop	Rate	Cases	Pop
Total	176.9	861	4,882,825	184.8	18,767	101,224,062
2012	191.2	90	472,426	180.7	1,857	10,215,553
2013	189.1	89	473,095	182.4	1,871	10,214,735
2014	158.1	75	475,754	190.4	1,952	10,208,341
2015	188.7	90	478,516	200.5	2,056	10,212,861
2016	191.1	92	483,710	191.7	1,966	10,214,965
2017	188.6	92	489,540	185.7	1,901	10,199,139
2018	154.9	76	492,415	184.4	1,877	10,152,025
2019	175.3	87	496,044	173.4	1,758	10,088,788
2020	160.6	80	498,814	178.9	1,788	9,980,192
2021	171.8	90	522,511	178.5	1,741	9,737,463

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

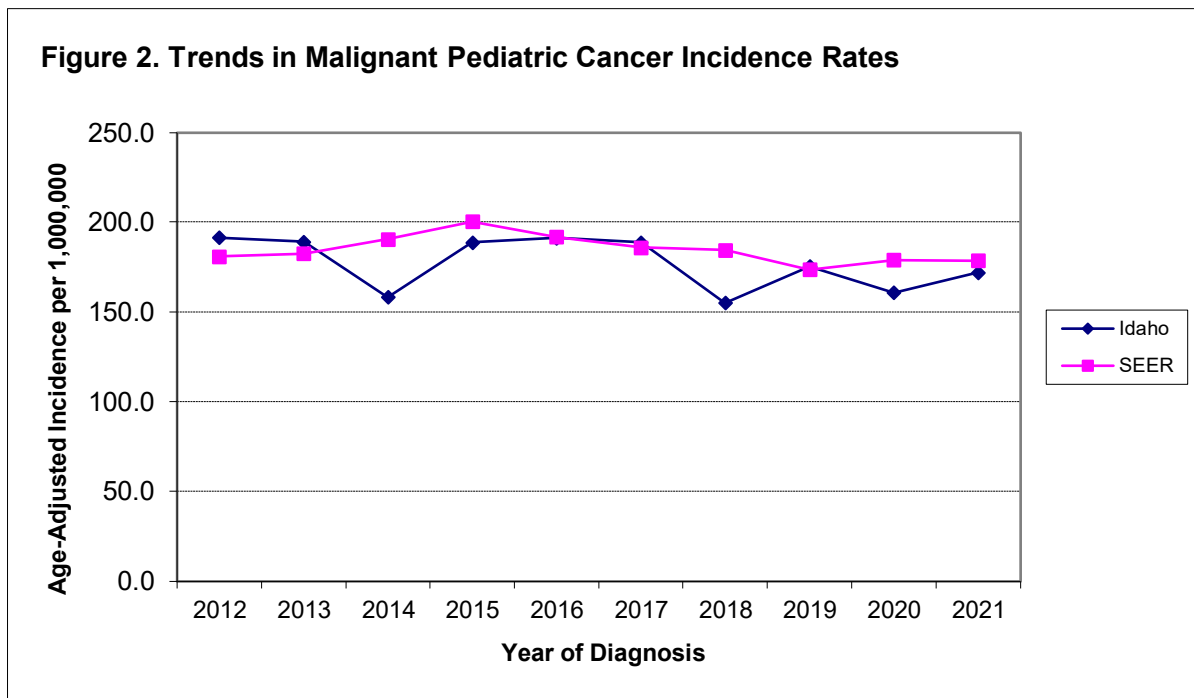


Table 4. Pediatric (Ages 0-19) Cancer Incidence in Idaho by Health District, Major Classification Categories, 2012-2021

Site/Type of Cancer	Health District 1			Health District 2			Health District 3		
	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases
All Sites Combined	187.2	153.4 - 226.3	107	162.8	117.5 - 220.1	43	192.6	164.4 - 224.2	166
I Leukemias, myeloproliferative & myelodysplastic diseases	47.1	31.1 - 68.6	27	28.5	11.4 - 58.7	7	51.6	37.7 - 69.1	45
II Lymphomas and reticuloendothelial neoplasms	24.3	13.3 - 40.8	14	25.3	9.3 - 54.6	6	32.6	21.7 - 47.1	28
III CNS and misc intracranial and intraspinal neoplasms	43.5	28.1 - 64.3	25	42.1	20.9 - 75.9	11	43.7	30.9 - 60.0	38
IV Neuroblastoma and other peripheral nervous cell tumors	5.4	1.1 - 15.7	3	12.6	2.6 - 36.5	3	9.7	4.2 - 19.0	8
V Retinoblastoma	0.0	0.0 - 6.5	0	0.0	0.0 - 14.8	0	2.5	0.3 - 8.9	2
VI Renal tumors	7.1	1.9 - 18.1	4	3.2	0.1 - 20.2	1	2.3	0.3 - 8.4	2
VII Hepatic tumors	5.5	1.1 - 16.0	3	0.0	0.0 - 14.8	0	0.0	0.0 - 4.3	0
VIII Malignant bone tumors	3.5	0.4 - 12.7	2	0.0	0.0 - 14.8	0	9.1	3.9 - 18.0	8
IX Soft tissue and other extrasosseous sarcomas	10.4	3.8 - 22.7	6	11.6	2.3 - 34.3	3	8.1	3.3 - 16.8	7
X Germ cell & trophoblastic tumors & neoplasms of gonads	12.2	4.9 - 25.2	7	9.6	2.0 - 30.0	3	16.5	9.0 - 27.7	14
XI Other malignant epithelial neoplasms and melanomas	28.1	16.1 - 45.7	16	29.9	13.6 - 58.1	9	16.4	9.0 - 27.5	14
XII Other and unspecified malignant neoplasms	0.0	0.0 - 6.5	0	0.0	0.0 - 14.8	0	0.0	0.0 - 4.3	0

Site/Type of Cancer	Health District 4			Health District 5			Health District 6			Health District 7		
	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases
All Sites Combined	215.0	190.6 - 241.6	282	178.1	145.8 - 215.5	106	205.3	168.7 - 247.5	110	175.6	146.6 - 208.7	129
I Leukemias...	44.6	33.9 - 57.7	58	36.2	22.7 - 54.8	22	33.2	19.7 - 52.6	18	37.1	24.5 - 54.0	27
II Lymphomas...	40.6	30.5 - 53.1	54	20.2	10.4 - 35.3	12	29.8	17.0 - 48.4	16	15.0	7.5 - 26.8	11
III CNS and...	49.2	37.9 - 62.7	65	50.1	33.8 - 71.5	30	43.0	27.2 - 64.5	23	43.9	30.0 - 62.0	32
IV Neuroblastoma...	9.8	5.1 - 17.0	12	6.6	1.8 - 16.9	4	13.1	5.3 - 27.0	7	2.8	0.3 - 9.9	2
V Retinoblastoma	1.6	0.2 - 5.8	2	1.8	0.0 - 9.6	1	1.9	0.0 - 10.4	1	1.3	0.0 - 7.5	1
VI Renal tumors	8.7	4.3 - 15.5	11	11.4	4.6 - 23.6	7	11.3	4.1 - 24.5	6	7.9	2.9 - 17.2	6
VII Hepatic tumors	3.9	1.3 - 9.1	5	0.0	0.0 - 6.2	0	3.7	0.4 - 13.3	2	1.4	0.0 - 7.7	1
VIII Malignant bone tumors	6.8	3.1 - 12.9	9	9.9	3.6 - 21.6	6	7.4	2.0 - 19.0	4	10.9	4.7 - 21.5	8
IX Soft tissue...	14.7	8.8 - 23.0	19	6.8	1.8 - 17.4	4	16.9	7.7 - 32.1	9	11.9	5.4 - 22.7	9
X Germ cell...	12.0	6.8 - 19.5	16	10.4	3.8 - 22.6	6	17.0	7.8 - 32.3	9	9.4	3.8 - 19.5	7
XI Other malig epithelial...	23.1	15.7 - 32.9	31	24.8	13.5 - 41.5	14	26.1	14.3 - 43.8	14	32.6	20.9 - 48.5	24
XII Other/unspecified...	0.0	0.0 - 2.9	0	0.0	0.0 - 6.2	0	2.0	0.1 - 10.8	1	1.4	0.0 - 7.7	1

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

Confidence intervals (CIs) are 95% for rates.

Statistical Note: Rates based upon 10 or fewer cases (numerator) should be interpreted with caution.

Table 5. Pediatric (Ages 0-19) Cancer Mortality in Idaho and the U.S.

Year of Death	Idaho 2012-2022			U.S. 2012-2022		
	Rate	Deaths	Pop	Rate	Deaths	Pop
Total	21.8	118	5,407,489	24.2	22,091	908,410,822
2012	16.8	8	472,426	26.8	2,221	82,811,054
2013	12.7	6	473,095	25.5	2,116	82,716,398
2014	18.9	9	475,754	24.6	2,038	82,718,202
2015	14.6	7	478,516	24.7	2,047	82,835,167
2016	26.8	13	483,710	25.5	2,118	83,018,369
2017	18.4	9	489,540	23.7	1,977	83,117,707
2018	30.3	15	492,415	24.1	2,010	83,111,569
2019	40.1	20	496,044	22.7	1,889	82,986,327
2020	14.1	7	498,814	22.5	1,860	82,523,116
2021	27.0	14	522,511	23.0	1,882	81,499,734
2022	17.9	10	524,664	23.7	1,933	81,073,179

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

Figure 3. Trends in Pediatric Cancer Mortality Rates

