LEUKEMIA IN IDAHO — 2000–2020

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Table of Contents

Index of Figures

Index of Tables

Executive Summary

This report reviews incidence, mortality, and survival among adult (aged 20+ years at time of diagnosis) Idaho residents diagnosed with leukemia for diagnosis years 2000 through 2020 (although a small number of analyses include diagnosis years 1995–1999). It also compares incidence, mortality, and survival among Idaho residents to those statistics for other areas of the United States, and briefly discusses risk factors for leukemia. Highlights from the results of these analyses are as follows:

1. Incidence of leukemia is higher among Idahoans than most other U.S. registries, even when stratifying analyses on race and ethnicity. The reasons for this are unknown, and could be related to reporting, underlying population demographics and/or genetics, health behaviors, or environmental exposures.
2. Rates of leukemia among adults Idahoans have been increasing during 2001–2020, whereas in other areas of the United States, rates have remained constant over time.
3. There was no difference in leukemia mortality in Idaho relative to other U.S. states after adjusting for race and ethnicity. Although rates of leukemia mortality were higher in more rural areas of Idaho.
4. Five-year survival after diagnosis among Idahoans was better among patients living in urban areas or areas near urban areas (“urban commuting areas”) than patients living in non-urban commuting areas.
5. Five-year survival post-diagnosis was also lower among Idahoans diagnosed with leukemia who lived in areas of higher poverty at the time of their diagnosis. Among patients diagnosed during 2000–2019, survival was lower among patients living in areas with higher levels of poverty at their time of diagnosis with either lymphocytic leukemia, chronic lymphocytic leukemia, or acute myeloid leukemia.
6. Analysis of five-year survival post-diagnosis by Public Health District indicates that among adults diagnosed during 2000–2019, survival was lower among residents of Public Health District 2 (Idaho North Central District Public Health) and Public Health District 6 (Southeastern Idaho Public Health) than the statewide survival rate for all leukemias combined, and survival is higher among residents of Public Health District 4 (Central District Health) than the statewide survival rate for all leukemias combined.

These results merit further investigation into potential opportunities for public health and clinical interventions that would address prevention of new leukemia cases and ensure that all Idahoans are receiving the highest standard of care post-leukemia diagnosis.

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Introduction

Leukemia is a term describing cancers that arise in blood-forming tissues; more specifically, leukemias are caused by a rapid increase in the creation of abnormal white blood cells that typically begin in the bone marrow. There are three major types of leukemia: lymphocytic, myeloid, and monocytic, which are further characterized as acute or chronic depending on how quickly the disease develops and progresses. More common forms of leukemia include acute lymphocytic leukemia (ALL), chronic lymphocytic leukemia (CLL), acute myeloid leukemia (AML), and chronic myeloid leukemia (CML).[1] Other, less common forms include acute monocytic leukemia (AML-M5), and chronic myelomonocytic leukemia (CMML).

Acute lymphocytic leukemia is a cancer resulting from the uncontrolled proliferation of abnormal and immature B or T lymphocytes, and the most common type of childhood cancer.[2,3] Chronic lymphocytic leukemia is the chronic disordered proliferation of monoclonal B cells, and a common adult leukemia for which incidence increases with age (an average age of diagnosis of 70).[4] Chronic lymphocytic leukemia is very rarely seen in adults under the age of 40 and is extremely rare in children.[5] Acute myeloid leukemia alters the production of stem cell precursors of the myeloid lineage (red blood cells, platelets and white blood cells besides B and T cells), and is the most common form of acute leukemia in adults.[6,7] Chronic myeloid leukemia is characterized by the uncontrolled growth of myeloid cells and typically has a two or three stage natural history, starting with an indolent chronic phase, and followed by an accelerated or blast phase or both.[8] These different phases are associated with rapid increases in abnormal granulocytes, basophils, and eosinophils.[9,10] Chronic myeloid leukemia is another form of leukemia that is rarely seen in the pediatric population,[9,10] with a median age at diagnosis of 66 years in the United States.[11]

This report describes leukemia in Idaho and compares the cancer experience of Idahoans to residents of other U.S. states, chiefly through an evaluation of leukemia incidence, leukemia mortality, and survival among persons diagnosed with leukemia. This report describes leukemia in adult patients (aged 20+ years at time of diagnosis). Information on leukemia in pediatric and adolescent patients (aged < 20 years at time of diagnosis) may be found in Idaho's "Pediatric Cancer in Idaho, 2011– 2020" report.[12] In this report, adult cancers were classified using the SEER site recode ICD-O-3/WHO 2008 definition.[13] Other methods used in this report have been published elsewhere.[14]

Cancer data for the 2020 diagnosis year, which are included in this report, which were impacted by the COVID-19 pandemic. For example, incidence and mortality rates for certain cancers were lower in 2020 than prior diagnosis years due to disruptions to the healthcare system and increased mortality related to COVID-19. In Idaho, however, leukemia incidence among adults in 2020 was similar to prior years, as were rates of leukemia mortality. Thus, we feel comfortable including 2020 data in this report as they are representative of the population-based leukemia experience among Idahoans and unlikely to bias statistics. Other states, however, may have had a different experience regarding leukemia and COVID-19, therefore comparisons to other states' data may need to be interpreted in light of the COVID-19 pandemic.

Factors Associated with Increased Risk for Leukemia

Similar to other cancers, risk factors for leukemia include those that are modifiable and non-modifiable. Modifiable risk factors are those behaviors or exposures that may impact a person's risk of cancer, but which are able to be changed. Non-modifiable risk factors are those that may impact a person's risk of cancer but are immutable, e.g. a person's age.

Modifiable Risk Factors

Exposure to ionizing radiation. Exposure to high levels of high-frequency – or ionizing – radiation is associated with an increased risk of leukemia, specifically acute lymphocytic leukemia, and acute myeloid leukemia. These exposures can occur in occupational settings, and during therapy for cancer. The relationship between low dose x-ray exposure, i.e. that which is typically present during medical imaging, and leukemia is less clear.

Exposure to benzene and other chemicals. Excessive benzene exposure is known to cause bone marrow damage and is associated with increased leukemia risk – specifically acute myeloid leukemia.[15] Benzene is found ubiquitously in commercial products, including in plastics, fuels, lubricants, rubbers, dyes, and pesticides. Excessive exposure to benzene may be more common in an occupational setting where these products are produced or prevalent. Recent research has demonstrated that natural gas stoves and ovens may also emit benzene – even when not in use – increasing concentrations of ambient benzene in the domestic setting.[16,17] Other chemicals or agents linked to the development of acute myeloid leukemia include vinyl chlorides, "soot, creosote, inks, dyes and tanning solutions and coal dust."[18]

Tobacco Smoking. Smoking tobacco has a well-established relationship with increased risk of acute myeloid leukemia in adults.[19-21] Other observational research studies have shown that tobacco use and cigarette smoking are associated with increased odds of acute lymphocytic leukemia, chronic lymphocytic leukemia and chronic myelogenous leukemia.[22-24]

Viral infections. In the United States, viral infections are not commonly linked to increased risk of leukemia. In other areas of the world, however, certain viral infections are linked to increased leukemia risk. Human T-cell lymphoma/leukemia virus-1 (HTLV-1) is associated with increased risk of a specific type of adult T-cell leukemia/lymphoma, primarily in Japan and the Caribbean.[25] Infection with Epstein-Barr virus (EBV) is associated with increased risk for a type of natural killer-cell leukemia, primarily in Africa.[26]

Non-modifiable Risk Factors

Risk for all types of leukemia among adults increases with age, and is higher among males than females. Race and ethnicity also confer risk for leukemia.[27] SEER-22 data show that among

adults, risk for acute lymphocytic leukemia is highest among whites (including Hispanics) and lowest among non-Hispanic Blacks; non-Hispanic Asians and Pacific Islanders and non-Hispanic whites have similar incidence rates.[28] (Few cases were reported among non-Hispanic American Indian/Alaska Natives and rates for persons aged 40 years or older were suppressed in SEER-22 data.) For chronic lymphocytic leukemia, non-Hispanic whites have the highest risk, followed by whites (including Hispanics), non-Hispanic Blacks, non-Hispanic American Indian/Alaska Native people, and non-Hispanic Asians and Pacific Islanders. Risk for acute and chronic myeloid leukemia was more similar across racial and ethnic groups, although rates for non-Hispanic and white including Hispanic were higher than other race-ethnicity categories.[29]

Genetic disorders. Certain genetic disorders, such as down syndrome or Li-Fraumeni syndrome, can greatly increase the risk of developing leukemia. Increased risk for acute lymphocytic leukemia has been linked to Down syndrome, Klinefelter syndrome, Fanconi anemia, Bloom syndrome, ataxia-telangiectasia, neurofibromatosis, and Li-Fraumeni syndrome.[30] Increased risk for acute myeloid leukemia has been linked to Fanconi anemia, Bloom syndrome, ataxia-telangiectasia, Diamond-Blackfan anemia, Shwachman-Diamond syndrome, Li-Fraumeni syndrome, neurofibromatosis type 1, and Kostmann syndrome.[31]

Family history of leukemia. Although most cases of adult leukemia are thought to be caused by modifiable risk factors, research has shown that having a close relative with leukemia may confer higher risk. This has been shown for acute myeloid leukemia,[31] and chronic lymphocytic leukemia.[32] Similarly, having an identical twin who has been diagnosed with acute lymphocytic leukemia increases risk of that form of leukemia.[30]

Leukemia Incidence (Aged 20+ Years at Diagnosis)

During 2016–2020, the age-adjusted incidence rate for leukemia among adult Idaho residents was 21.4 cases per 100,000 population (95% CI: 20.3, 22.5) compared to 17.7 per 100,000 population (95% CI: 17.6, 17.8) in 47 other U.S. states* and the District of Columbia ("the remainder of the U.S.") (rate ratio [RR] of the U.S. to Idaho 1.21, 95% CI: 1.15, 1.27).[33] A similar but slightly attenuated pattern was noted among non-Hispanic whites only (RR = 1.14, 95% CI: 1.08, 1.20).[12]

During 2001–2020, incidence rates of leukemia were 1.17 times higher (95% CI: 1.14, 1.21) in Idaho than other U.S. states, including when stratifying by race/ethnicity. Elevated incidence rates of leukemia in Idaho relative to other U.S. states were driven by higher incidence rates of chronic lymphocytic leukemia (RR = 1.30, 95% CI: 1.24, 1.36), chronic myeloid leukemia (RR = 1.26, 95% CI: 1.17, 1.36), and other acute leukemias (RR = 1.28, 95% CI: 1.04, 1.56) among males and females. Incidence rates of other myeloid/monocytic leukemia were lower among Idahoans than other U.S. residents (RR = 0.69, 95% CI: 0.49, 0.96), although only 38 cases

* States included in comparison data include all other U.S. states deemed "fit-for-use" for CiNA 2020 incidence data. States that were excluded include Arkansas, Indiana, and Nevada.

were diagnosed among Idahoans during 2001–2020. Within Idaho, adults in Bonneville County had higher incidence rates of leukemia than Idaho overall, at 27.0 cases per 100,000 population (95% CI: 22.1, 32.7). Incidence rates of leukemia by Idaho county are described in greater detail in the Cancer Data Registry of Idaho annual report.[14]

In Idaho, males have 1.67 times higher (95% CI: 1.51, 1.86) incidence rates of leukemia than females (27.2 cases per 100,000 [95% CI: 25.4, 29.0] versus 16.2 cases per 100,000 [95% CI: 14.9, 17.6]), similar to elsewhere in the United States (RR = 1.67, 95% CI: 1.66, 1.69). Incidence rates of leukemia overall by sex and time for diagnosis years 2001–2020 are shown in **Figure 1** for Idaho and other U.S. states as noted above. Incidence rates of specific forms of leukemia by males and females in Idaho and compared to other states in the U.S. are presented in **Table 1**. Incidence rates of leukemia during 2001–2020 were higher in males than in females in Idaho and the United States for every type of leukemia, with the exception of acute monocytic leukemia in Idaho (RR = 1.22, 95% CI: 0.73, 2.04); data not shown).

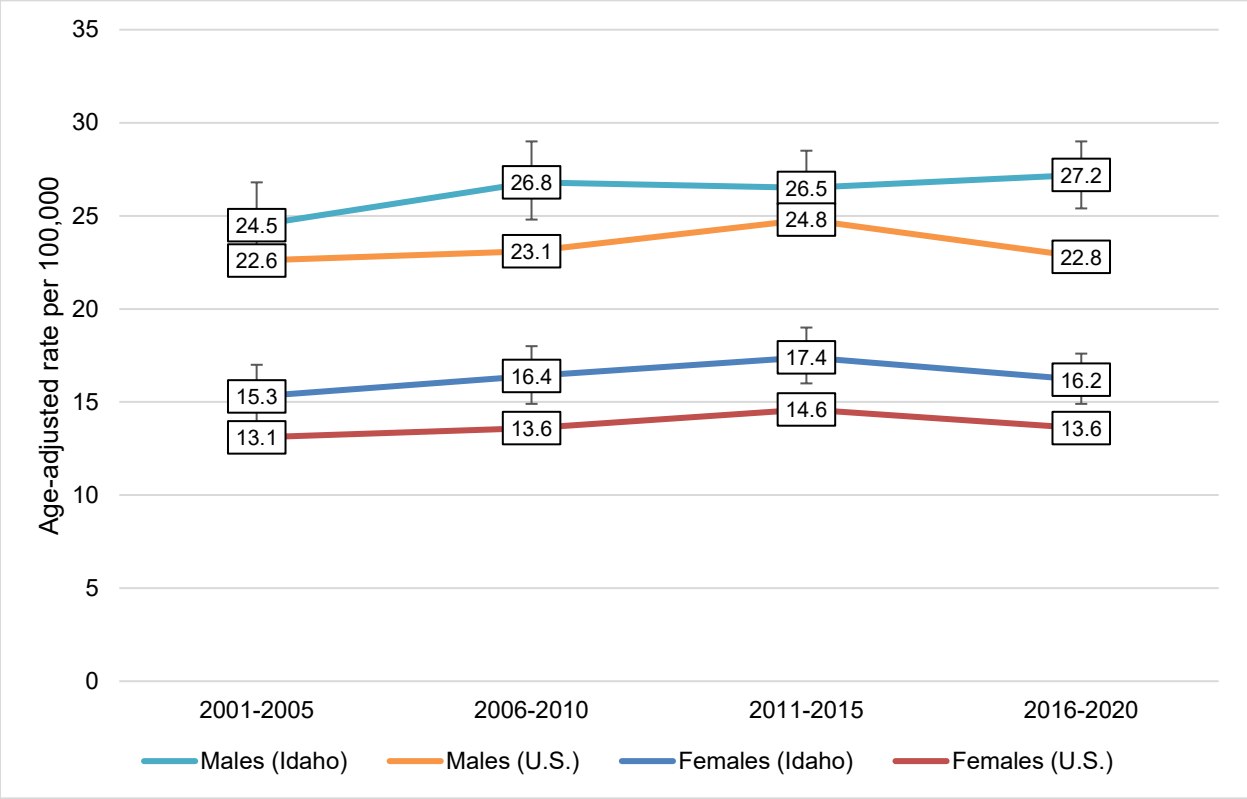

Figure 1: Age-adjusted incidence rates (with 95% CI) of Leukemia by Sex in Idaho versus other U.S. states — 2001–2020.

Table 1: Incidence rates of Leukemia for Idaho versus 47 other U.S. States and the District of Columbia, 2016–2020.

	Idaho				Other U.S. States*			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Male and female								
Leukemia	21.4	20.3	22.5	1,533	17.7	17.6	17.8	235,565
Lymphocytic Leukemia	10.0	9.2	10.7	727	8.0	17.6	17.8	108,288
Acute Lymphocytic Leukemia	1.0	0.8	1.3	68	1.0	7.9	8.0	12,614
Chronic Lymphocytic Leukemia	8.5	7.8	9.2	627	6.4	1.0	1.1	88,424
Other Lymphocytic Leukemia	0.5	0.3	0.7	32	0.6	6.3	6.4	7,250
Myeloid and Monocytic Leukemia	10.1	9.3	10.9	709	8.7	0.5	0.6	113,557
Acute Myeloid Leukemia	6.5	5.9	7.1	457	5.6	8.6	8.7	73,675
Acute Monocytic Leukemia	0.3	0.2	0.4	20	0.2	5.5	5.6	2,885
Chronic Myeloid Leukemia	3.1	2.7	3.6	221	2.7	0.2	0.2	34,289
Other Myeloid/Monocytic Leukemia	0.2	0.1	0.3	11	0.2	2.6	2.7	2,708
Other Leukemia	1.3	1.1	1.6	97	1.0	0.2	0.2	13,720
Other Acute Leukemia	0.4	0.2	0.5	26	0.3	1.0	1.1	3,607
Aleukemic, Subleukemic and NOS	1.0	0.8	1.2	71	0.8	0.3	0.3	10,113
Male								
Leukemia	27.2	25.4	29	926	22.8	22.6	22.9	137,932
Lymphocytic Leukemia	13.0	11.8	14.3	449	10.7	10.7	10.8	66,315
Acute Lymphocytic Leukemia	1.3	1	1.8	45	1.2	1.2	1.2	6,902
Chronic Lymphocytic Leukemia	10.8	9.7	12	376	8.7	8.6	8.8	54,140
Other Lymphocytic Leukemia	0.9	0.6	1.3	28	0.9	0.8	0.9	5,273
Myeloid and Monocytic Leukemia	12.7	11.5	14	428	10.8	10.7	10.9	64,207
Acute Myeloid Leukemia	8.1	7.2	9.2	271	6.8	6.8	6.9	41,015
Acute Monocytic Leukemia	0.3	0.2	0.6	13	0.3	0.3	0.3	1,704
Chronic Myeloid Leukemia	4.0	3.4	4.8	138	3.4	3.3	3.4	19,887
Other Myeloid/Monocytic Leukemia	0.2	0.1	0.4	6	0.3	0.3	0.3	1,601
Other Leukemia	1.4	1.1	1.9	49	1.3	1.2	1.3	7,410
Other Acute Leukemia	0.3	0.1	0.6	10	0.3	0.3	0.4	2,004
Aleukemic, Subleukemic and NOS	1.1	0.8	1.6	39	0.9	0.9	0.9	5,406
Female								
Leukemia	16.2	14.9	17.6	607	13.6	13.5	13.7	97,633
Lymphocytic Leukemia	7.2	6.4	8.2	278	5.7	5.6	5.7	41,973
Acute Lymphocytic Leukemia	0.7	0.4	1	23	0.9	0.9	0.9	5,712
Chronic Lymphocytic Leukemia	6.4	5.7	7.3	251	4.5	4.5	4.6	34,284
Other Lymphocytic Leukemia	0.1	0	0.3	4	0.3	0.3	0.3	1,977
Myeloid and Monocytic Leukemia	7.7	6.8	8.7	281	7.1	7	7.1	49,350
Acute Myeloid Leukemia	5.0	4.3	5.8	186	4.6	4.6	4.7	32,660
Acute Monocytic Leukemia	0.2	0.1	0.4	7	0.2	0.2	0.2	1,181

	Idaho				Other U.S. States*			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Chronic Myeloid Leukemia	2.4	1.9	2.9	83	2.1	2.1	2.1	14,402
Other Myeloid/Monocytic Leukemia	0.1	0	0.3	5	0.2	0.1	0.2	1,107
Other Leukemia	1.3	0.9	1.7	48	0.9	0.8	0.9	6,310
Other Acute Leukemia	0.4	0.2	0.7	16	0.2	0.2	0.2	1,603
Aleukemic, Subleukemic and NOS	0.8	0.6	1.2	32	0.7	0.6	0.7	4,707

Rates are per 100,000 and age-adjusted to the 2000 US Std Population (19 age groups - Census P25-1130) standard; Confidence intervals (Tiwari mod) are 95% for rates and ratios.
* States included in comparison data include all other U.S. states deemed “fit-for-use” for CiNA 2020 incidence data. States that were excluded include Arkansas, Indiana, and Nevada.

Incidence rates of leukemia increased in Idaho during 2001–2020 at an average annual percentage change of 0.6% (95% CI: 0.1, 1.2), from 17.4 cases per 100,000 population in 2001 to 21.5 per 100,000 population in 2020. Incidence rates of leukemia in other U.S. states as a whole have remained steady, with an average annual percentage change of 0.3% (95% CI: -0.1, 0.7). Increases in leukemia incidence in Idaho were also seen in the sub-categories of myeloid and monocytic leukemia (APC 1.1%, 95% CI: 0.3, 1.8) and more specifically acute myeloid leukemia (APC 1.4%, 95% CI: 0.1, 2.7). Increases in these categories were also noted in other U.S. states.

As demonstrated elsewhere,[14] leukemia is diagnosed more frequently with increasing age (data for patients aged < 20 years at diagnosis included below). Incidence rates among pediatric cases are uniformly lower than incidence rates among adults, with the exception of the 01–04 years, when incidence rates of leukemia are 10.5 per 100,000 population (95% CI: 7.8, 13.9) in Idaho and 8.8 per 100,000 population (95% CI: 8.6, 8.9) in other U.S. states. During 2016–2020, incidence rates of leukemia were similar among Idahoans versus other U.S. residents until ages 70+, when incidence rates were higher among Idahoans (**Figure 2**). This pattern is consistent for males and females. For most types of leukemia, incidence rates increase with age and plateau in the 80+ age categories (data not shown).

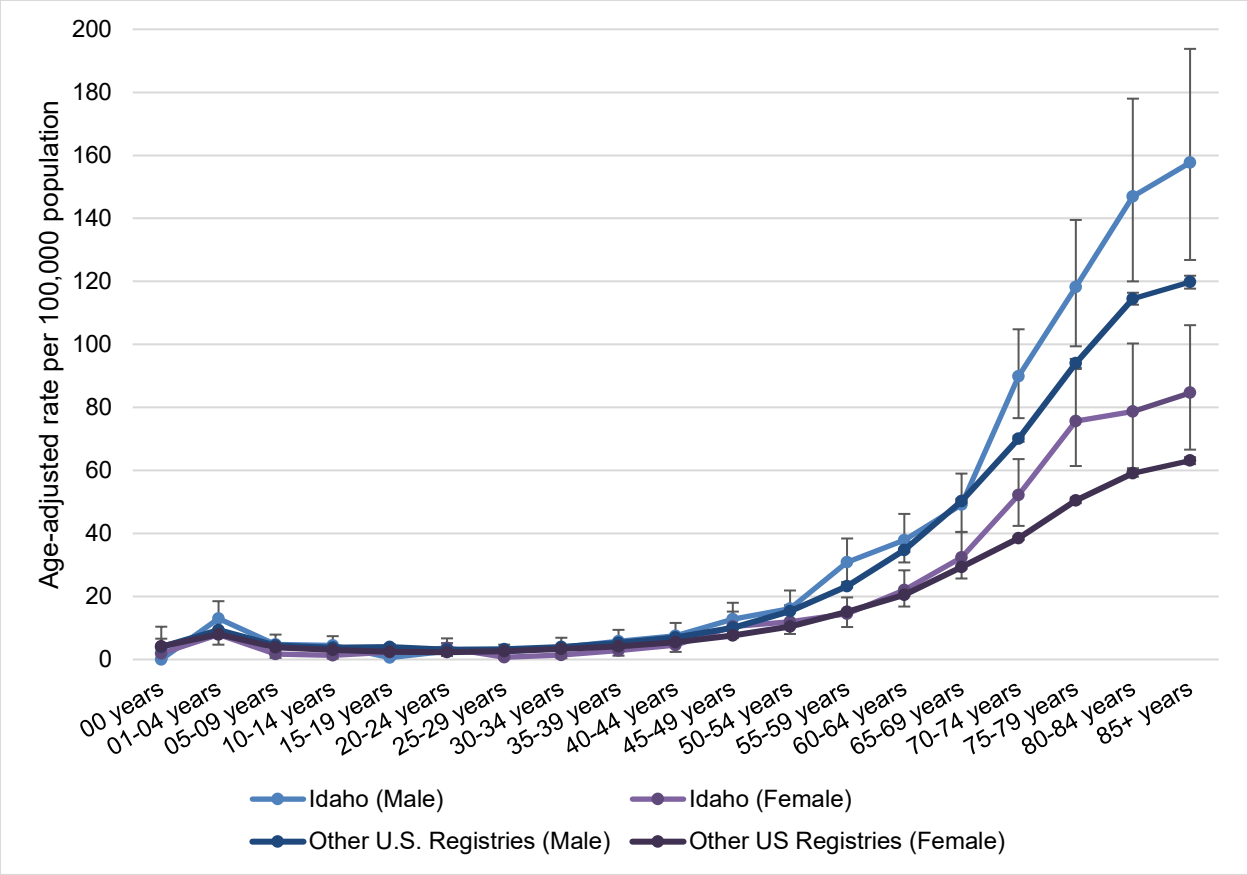

Figure 2: Age-adjusted incidence rates (with 95% CI) of leukemia by age category in Idaho versus other U.S. states — 2016–2020.

During 2001–2020, incidence rates of leukemia were higher among non-Hispanic whites than any other race/ethnicity category in the United States (**Table 2**). Exceptions include acute and chronic myeloid leukemia, where incidence rates were similar between non-Hispanic whites and non-Hispanic American Indian/Alaska Native people. In Idaho, differences in incidence rates of leukemia overall are only noted between non-Hispanic whites and Non-Hispanic Asian or Pacific Islander (RR = 0.57, 95% CI: 0.39, 0.81) and Hispanics of all races (RR = 0.78, 95% CI: 0.65, 0.93); for chronic lymphocytic leukemia, rates were higher among non-Hispanic whites than non-Hispanic Asians/Pacific Islanders (RR = 0.20, 95% CI: 0.06, 0.48) and Hispanics of all races (RR = 0.45, 95% CI: 0.31, 0.62); and for acute lymphocytic leukemia, rates were lower among Idaho non-Hispanic whites than Hispanics of all races (RR = 1.84, 95% CI: 1.08, 3.00). Even using data from a 10-year period, statistical comparisons are hampered by small numbers of cases diagnosed among Idaho residents.

Table 2: Age-adjusted incidence rates of leukemia (overall and by type) by race/ethnicity among Idaho residents and residents of 47 other U.S. states and the District of Columbia, 2001–2020.

	Idaho				Other U.S. States			
	Rate	**Lower CI**	**Upper CI**	**Count**	**Rate**	**Lower CI**	**Upper CI**	**Count**
Leukemia								
Non-Hispanic White	21.2	20.6	21.9	4,603	19	19	19.1	669,802
Non-Hispanic Black	17.4	9	30.3	16	14.1	14	14.2	65,698
Non-Hispanic AI/AN	14.3	8.3	23.0	19	15.2	14.6	15.8	2,756
Non-Hispanic API	12.2	8.3	17.3	33	9.4	9.3	9.5	19,686
Hispanic (All Races)	16.6	14	19.6	192	13.6	13.5	13.7	61,207
Lymphocytic Leukemia								
Non-Hispanic White	10.7	10.3	11.1	2,368	9.2	9.2	9.3	330,980
Non-Hispanic Black	4.8	1.5	12.5	5	5.7	5.6	5.8	26,181
Non-Hispanic AI/AN	7.3	3.2	13.9	10	5.8	5.4	6.2	1,049
Non-Hispanic API	4.1	2	7.4	11	2.7	2.6	2.8	5,671
Hispanic (All Races)	5.9	4.5	7.7	71	5.4	5.3	5.5	24,277
Acute Lymphocytic Leukemia								
Non-Hispanic White	0.8	0.7	1	170	0.8	0.8	0.9	26,534
Non-Hispanic Black	0	0	5.8	0	0.6	0.6	0.7	3,284
Non-Hispanic AI/AN	2	0.6	5.9	4	1.3	1.1	1.5	270
Non-Hispanic API	1.9	0.6	4.6	5	0.8	0.7	0.8	1,804
Hispanic (All Races)	1.5	0.9	2.4	26	1.6	1.6	1.6	9,366
Chronic Lymphocytic Leukemia								
Non-Hispanic White	9.2	8.8	9.6	2,056	7.7	7.7	7.7	280,775
Non-Hispanic Black	4.8	1.5	12.5	5	4.7	4.7	4.8	21,398
Non-Hispanic AI/AN	5.2	1.7	11.6	6	4.1	3.8	4.4	699
Non-Hispanic API	1.9	0.6	4.4	5	1.7	1.6	1.8	3,416
Hispanic (All Races)	4.1	2.8	5.7	40	3.4	3.4	3.5	13,131
Other Lymphocytic Leukemia								
Non-Hispanic White	0.7	0.6	0.8	142	0.7	0.7	0.7	23,671

	Idaho				Other U.S. States			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Non-Hispanic Black	0	0	5.8	0	0.3	0.3	0.3	1,499
Non-Hispanic AI/AN	0	0	3.0	0	0.4	0.3	0.5	80
Non-Hispanic Asian or Pacific Islander	0.3	0	1.9	1	0.2	0.2	0.2	451
Hispanic (All Races)	0.3	0.1	0.8	5	0.4	0.4	0.4	1,780
Myeloid and Monocytic Leukemia								
Non-Hispanic White	9.3	8.9	9.7	1,963	8.7	8.6	8.7	298,345
Non-Hispanic Black	11.3	4.5	23.3	9	7.2	7.2	7.3	34,057
Non-Hispanic AI/AN	7.1	3.1	13.7	9	7.9	7.5	8.3	1,448
Non-Hispanic API	7.8	4.7	12	21	6.1	6	6.2	12,776
Hispanic (All Races)	8.9	7	11.1	103	7.2	7.1	7.3	32,710
Acute Myeloid Leukemia								
Non-Hispanic White	5.6	5.3	6	1,195	5.6	5.5	5.6	192,671
Non-Hispanic Black	5.7	1.1	16.1	4	4.5	4.4	4.6	20,959
Non-Hispanic AI/AN	3.5	1.1	8.6	5	4.8	4.5	5.2	872
Non-Hispanic API	5.7	3.1	9.5	15	4.2	4.1	4.3	8,730
Hispanic (All Races)	5.3	3.8	7	62	4.5	4.4	4.6	20,170
Acute Monocytic Leukemia								
Non-Hispanic White	0.3	0.2	0.4	64	0.3	0.3	0.3	10,430
Non-Hispanic Black	0.9	0	7	1	0.2	0.2	0.2	873
Non-Hispanic AI/AN	0	0	3.0	0	0.3	0.2	0.4	54
Non-Hispanic API	0	0	1.3	0	0.2	0.2	0.2	394
Hispanic (All Races)	0.7	0.2	1.6	4	0.2	0.2	0.2	1,022
Chronic Myeloid Leukemia								
Non-Hispanic White	3.2	2.9	3.4	667	2.5	2.5	2.6	86,358
Non-Hispanic Black	4.8	1.1	13.4	4	2.3	2.3	2.4	11,264
Non-Hispanic AI/AN	3.6	0.9	9.1	4	2.6	2.4	2.8	496
Non-Hispanic API	2	0.7	4.6	6	1.6	1.5	1.6	3,388

	Idaho				Other U.S. States			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Hispanic (All Races)	2.9	1.9	4.2	36	2.2	2.2	2.3	10,659
Other Myeloid/Monocytic Leukemia								
Non-Hispanic White	0.2	0.1	0.2	37	0.3	0.3	0.3	8,886
Non-Hispanic Black	0	0	5.8	0	0.2	0.2	0.2	961
Non-Hispanic AI/AN	0	0	3.0	0	0.2	0.1	0.2	26
Non-Hispanic API	0	0	1.3	0	0.1	0.1	0.1	264
Hispanic (All Races)	0.1	0	0.5	1	0.2	0.2	0.2	859
Other Leukemia								
Non-Hispanic White	1.3	1.1	1.4	272	1.1	1.1	1.1	40,477
Non-Hispanic Black	1.2	0.1	7.3	2	1.2	1.2	1.2	5,460
Non-Hispanic AI/AN	0	0	3.0	0	1.5	1.3	1.7	259
Non-Hispanic API	0.3	0	1.8	1	0.6	0.6	0.7	1,239
Hispanic (All Races)	1.8	0.9	3.1	18	1	1	1.1	4,220
Other Acute Leukemia								
Non-Hispanic White	0.4	0.3	0.5	91	0.4	0.3	0.4	12,624
Non-Hispanic Black	0	0	5.8	0	0.3	0.3	0.3	1,439
Non-Hispanic AI/AN	0	0	3.0	0	0.4	0.3	0.5	62
Non-Hispanic API	0	0	1.3	0	0.2	0.2	0.2	420
Hispanic (All Races)	0.9	0.3	1.9	9	0.3	0.3	0.3	1,275
Aleukemic, Subleukemic, and NOS								
Non-Hispanic White	0.8	0.7	1	181	0.8	0.8	0.8	27,853
Non-Hispanic Black	1.2	0.1	7.3	2	0.9	0.9	0.9	4,021
Non-Hispanic AI/AN	0.0	0	3.0	0	1.1	1	1.3	197
Non-Hispanic API	0.3	0	1.8	1	0.4	0.4	0.4	819
Hispanic (All Races)	0.9	0.3	1.8	9	0.7	0.7	0.7	2,945

Analyses of rates among American Indian/Alaska Native populations restricted to 2020 PRCDA counties, excluding 42% of cases diagnosed in Idaho and reported to be among American Indian/Alaska Natives. AI/AN = American Indian/Alaska Native API = Asian or Pacific Islander

In Idaho, incidence rates of leukemia vary by rurality of residency at diagnosis. Incidence rates of leukemia were lowest among Idahoans living in either entirely urban or entirely rural census tracts; incidence rates were higher among Idahoans living in “mixed” areas that were either mostly urban (RR = 1.25, 95% CI: 1.10, 1.41) or mostly rural (RR = 1.20, 95% CI: 1.02, 1.41) relative to all urban areas (**Figure 3**). These differences were primarily driven by increased incidence rates of chronic lymphocytic leukemia in mostly urban (9.7 cases per 100,000 population; 95% CI: 8.5, 11.0) and mostly rural (9.5 cases per 100,000 population; 95% CI: 7.7, 11.5) areas relative to all urban areas (7.2 cases per 100,000 population; 95% CI: 6.2, 8.4).

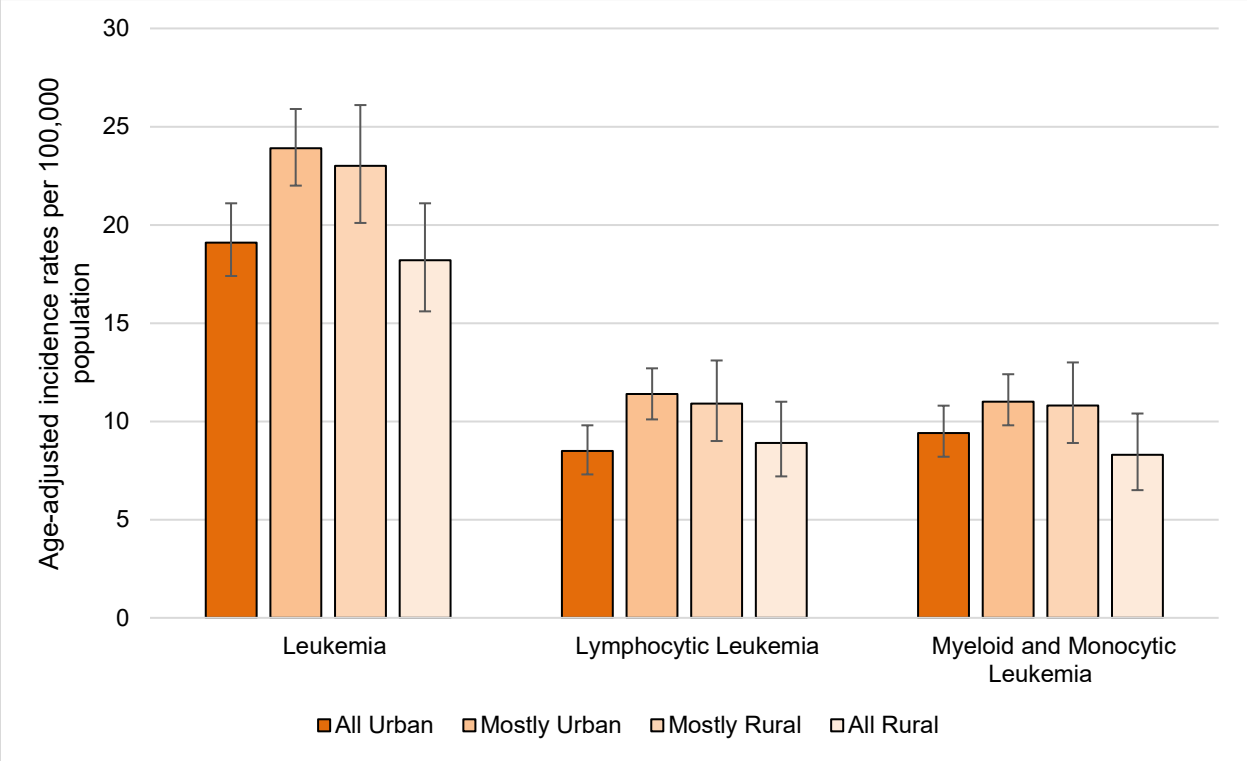

Figure 3: Incidence rates of leukemia by urban/rural census tracts in Idaho among adult Idahoans (20+ years at diagnosis) — 2016–2020.

In Idaho, incidence rates of leukemia vary by area-based poverty (percent individuals living in a census tract with income below the federal poverty level in the past 12 months)[34] – although statistical differences were influenced by how poverty was classified (**Table 3**). Broadly speaking, incidence rates of leukemia among adults were higher among patients living in areas with lower levels of poverty. Incidence rates were ~12% lower in areas where 10% or more residents live below the federal poverty level when compared to areas where less than 10% of resident live below the federal poverty level (RR = 0.88; 95% CI: 0.79, 0.97); incidence rates were 20.4 cases per 100,000 population (95% CI: 19.0, 21.8) in the former versus 23.2 cases per 100,000 population (95% CI: 21.5, 25.1) in the latter. These differences are driven by lower incidence rates of chronic lymphocytic leukemia (RR = 0.83; 95% CI: 0.70, 0.98) and chronic myeloid leukemia (RR = 0.71; 9%% CI: 0.54, 0.94) in areas of lower poverty.

Table 3: Age-adjusted incidence rates of leukemia among adult Idahoans (20+ years old at diagnosis) by area-level poverty indicators, 2016–2020.

	Rate	SE	Lower CI	Upper CI	Count
Proportion Households Living Below Federal Poverty Level (4 categories)					
Leukemia					
0-<5%	21.9	2.3	17.7	27.0	97
5-<10%	23.5	1.0	21.5	25.6	564
10-<20%	20.7	0.8	19.1	22.4	660
20% or more	19.4	1.4	16.8	22.3	212
Lymphocytic Leukemia					
0-<5%	11.8	1.7	8.7	15.6	52
5-<10%	10.7	0.7	9.4	12.1	263
10-<20%	9.7	0.6	8.6	10.8	312
20% or more	9.1	0.9	7.3	11.1	100
Myeloid and Monocytic Leukemia					
0-<5%	9.2	1.5	6.5	12.6	41
5-<10%	11.4	0.7	10	12.9	266
10-<20%	9.6	0.6	8.6	10.8	302
20% or more	9.3	1.0	7.6	11.4	100
Other Leukemia					
0-<5%	1.0	0.5	0.3	2.6	4
5-<10%	1.5	0.3	1.0	2.1	35
10-<20%	1.4	0.2	1.0	1.9	46
20% or more	1.0	0.3	0.5	1.8	12
Proportion Persons Living Below Federal Poverty Level (2 categories)					
Leukemia					
0-<10%	23.2	0.9	21.5	25.1	661
10% or more	20.4	0.7	19	21.8	872
Lymphocytic Leukemia					
0-<10%	10.8	0.6	9.6	12.1	315
10% or more	9.5	0.5	8.6	10.5	412
Myeloid and Monocytic Leukemia					
0-<10%	11.1	0.6	9.8	12.4	307
10% or more	9.5	0.5	8.6	10.6	402
Other Leukemia					
0-<10%	1.4	0.2	1.0	1.9	39
10% or more	1.3	0.2	1.0	1.7	58

Rates are per 100,000 and age-adjusted to the 2000 US Std Population (19 age groups - Census P25-1130) standard. Confidence intervals (Tiwari mod) are 95% for rates and ratios.

Leukemia Mortality (Aged 20+ Years at Death)

During 2016–2020, the age-adjusted rate of leukemia mortality among adult Idaho residents was 9.0 deaths per 100,000 population (95% CI: 8.3, 9.7) versus 8.2 per 100,000 population (95% CI: 8.2, 8.3) in 49 other U.S. states and the District of Columbia ("the remainder of the U.S."). Mortality rates were 8.9% higher in Idaho than the remainder of the U.S. (RR = 1.09; 95% CI: 1.00, 1.18). However, among non-Hispanic whites only, there was no difference in leukemia mortality (RR = 1.04, 95% CI: 0.96, 1.13) between Idaho and the remainder of the U.S.

In Idaho, males die of leukemia at 1.65 times higher (95% CI: 1.39, 1.94) rates than females (11.4 deaths per 100,000 [95% CI: 10.2, 12.6] versus 6.9 deaths per 100,000 [95% CI: 6.1, 7.8]) a smaller but statistically comparable difference than elsewhere in the United States (RR = 1.80, 95% CI: 1.77, 1.82). Rates of leukemia mortality by sex and diagnosis years during 2001–2020 are shown in **Figure 4** for Idaho and the remainder of the U.S. Both Idaho and the remainder of the U.S. show similar downward trends in leukemia mortality among adults during 2002–2020. Mortality rates for specific leukemias by males and females in Idaho and compared to the remainder of the U.S are presented in **Table 4**. Like incidence, leukemia mortality rates during 2016–2020 are higher in males than in females in Idaho and the United States for every type of leukemia.

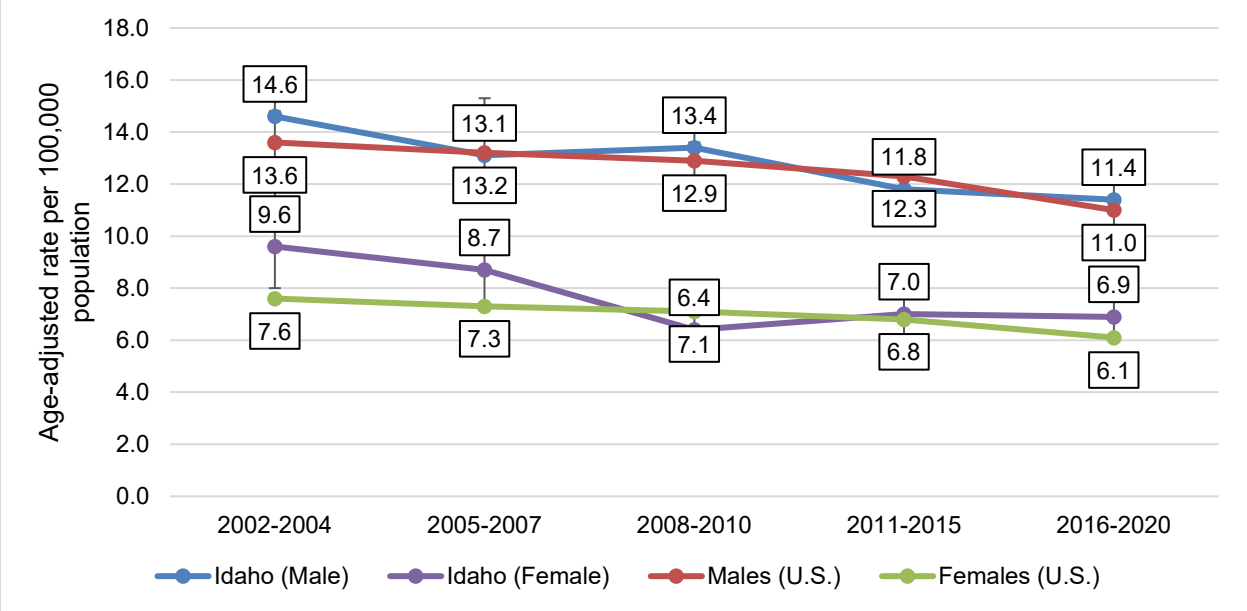

Figure 4: Age-adjusted leukemia mortality rates (with 95% CI) by sex in Idaho versus other U.S. states — 2002–2020.

Table 4: Leukemia Mortality Rates for Idaho and the remainder of the U.S., 2016–2020.

	Idaho				All Other US States			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Male and female								
Leukemia	9	8.3	9.7	629	8.2	8.2	8.3	114,393
Lymphocytic Leukemia	2.6	2.2	3	180	2.2	2.2	2.2	30,374
Acute Lymphocytic Leukemia	0.5	0.4	0.7	37	0.5	0.5	0.5	6,544
Chronic Lymphocytic Leukemia	1.9	1.6	2.3	130	1.5	1.5	1.5	21,416
Other Lymphocytic Leukemia	0.2	0.1	0.3	13	0.2	0.2	0.2	2,414
Myeloid and Monocytic Leukemia	5.1	4.5	5.6	359	4.6	4.5	4.6	63,567
Acute Myeloid Leukemia	4.0	3.6	4.5	286	3.8	3.7	3.8	52,288
Acute Monocytic Leukemia	^	^	^	^	0.0	0	0	462
Chronic Myeloid Leukemia	0.5	0.3	0.7	34	0.4	0.4	0.4	5,830
Other Myeloid/Monocytic Leukemia	0.5	0.3	0.7	34	0.4	0.3	0.4	4,987
Other Leukemia	1.3	1	1.6	90	1.5	1.4	1.5	20,452
Other Acute Leukemia	0.5	0.4	0.7	38	0.5	0.4	0.5	6,381
Aleukemic, Subleukemic and NOS	0.8	0.6	1	52	1.0	1	1	14,071
Male								
Leukemia	11.4	10.2	12.6	369	11	10.9	11.1	66,476
Lymphocytic Leukemia	3.5	2.9	4.2	111	3.1	3	3.1	17,990
Acute Lymphocytic Leukemia	0.7	0.4	1	24	0.6	0.6	0.6	3,607
Chronic Lymphocytic Leukemia	2.5	1.9	3.1	76	2.2	2.2	2.2	12,891
Other Lymphocytic Leukemia	0.3	0.2	0.6	11	0.3	0.2	0.3	1,492
Myeloid and Monocytic Leukemia	6.3	5.5	7.3	207	6.0	5.9	6.1	36,861
Acute Myeloid Leukemia	5.0	4.3	5.9	166	4.9	4.8	4.9	30,084
Acute Monocytic Leukemia	^	^	^	^	0.0	0	0.1	274
Chronic Myeloid Leukemia	0.5	0.3	0.8	17	0.6	0.5	0.6	3,322
Other Myeloid/Monocytic Leukemia	0.6	0.4	1	20	0.5	0.5	0.5	3,181
Other Leukemia	1.6	1.2	2.1	51	1.9	1.9	2	11,625

	Idaho				All Other US States			
	Rate	Lower CI	Upper CI	Count	Rate	Lower CI	Upper CI	Count
Other Acute Leukemia	0.6	0.4	0.9	21	0.6	0.6	0.6	3,590
Aleukemic, Subleukemic and NOS	1.0	0.6	1.4	30	1.3	1.3	1.4	8,035
Female								
Leukemia	6.9	6.1	7.8	260	6.1	6.1	6.2	47,917
Lymphocytic Leukemia	1.8	1.4	2.3	69	1.5	1.5	1.6	12,384
Acute Lymphocytic Leukemia	0.4	0.2	0.7	13	0.4	0.4	0.4	2,937
Chronic Lymphocytic Leukemia	1.4	1.1	1.9	54	1.0	1	1	8,525
Other Lymphocytic Leukemia	^	^	^	^	0.1	0.1	0.1	922
Myeloid and Monocytic Leukemia	4.0	3.4	4.8	152	3.5	3.4	3.5	26,706
Acute Myeloid Leukemia	3.2	2.6	3.8	120	2.9	2.9	2.9	22,204
Acute Monocytic Leukemia	^	^	^	^	0.0	0	0	188
Chronic Myeloid Leukemia	0.5	0.3	0.8	17	0.3	0.3	0.3	2,508
Other Myeloid/Monocytic Leukemia	0.4	0.2	0.6	14	0.2	0.2	0.2	1,806
Other Leukemia	1.0	0.7	1.4	39	1.1	1.1	1.1	8,827
Other Acute Leukemia	0.5	0.3	0.7	17	0.4	0.3	0.4	2,791
Aleukemic, Subleukemic and NOS	0.6	0.4	0.9	22	0.8	0.7	0.8	6,036

Underlying mortality data provided by NCHS (**www.cdc.gov/nchs**). Rates are per 100,000 and age-adjusted to the 2000 US Std Population (19 age groups - Census P25-1130) standard. Confidence intervals (Tiwari mod) are 95% for rates and ratios. ^ Statistic not displayed due to fewer than 10 cases.

Similar to during 2016–2020, during 2002–2020, mortality rates for leukemia were 1.06 times higher (95% CI: 1.01, 1.10) in Idaho than other U.S. states, although not when stratifying by race/ethnicity, e.g. among non-Hispanic whites, the mortality rate ratio was 1.02 (95% CI: 0.97, 1.06). The age-adjusted mortality rate for leukemia in Idaho was 9.7 deaths per 100,000 population (95% CI: 9.2, 10.1) during this period, versus 9.1 deaths per 100,000 population in the remainder of the United States (95% CI: 9.1, 9.2). Elevated mortality rates of leukemia in Idaho relative to other U.S. states are seen more specifically for chronic lymphocytic leukemia (RR = 1.15, 95% CI: 1.05, 1.26) and chronic myeloid leukemia (RR = 1.26, 95% CI: 1.05, 1.50) among males and females. Rates of deaths from aleukemic, subleukemic and not otherwise specified leukemias were lower among Idahoans than other U.S. residents (RR = 0.82, 95% CI: 0.72, 0.94) during 2002–2020. Within Idaho, 2016–2020 mortality rates for adults were similar between counties,

although rates were lower than expected in Jerome County relative to the state average (1.1 deaths per 100,000 population (95% CI: 0.0, 6.7). Mortality rates by Idaho county are described in greater detail in the Cancer Data Registry of Idaho annual report.[14]

Leukemia mortality rates decreased in Idaho during 2001–2020 at an average annual percentage change of 1.5% (95% CI: -2.3, -0.8), from 10.5 deaths per 100,000 population among males and females in 2001 to 8.9 per 100,000 population in 2020. Leukemia mortality rates in the remainder of the U.S. also decreased, with an average annual percentage change of 1.3% (95% CI: -1.5, -1.2). In the U.S., decreases in leukemia mortality rates were noted in all types/subtypes with the exception of acute myeloid leukemia. In Idaho, statistically significant decreases in leukemia mortality rates were noted in most leukemia types/sub-categories, with the exception of myeloid and monocytic leukemia (APC -1., 95% CI: -2.1, 0.1) and more specifically acute myeloid leukemia (APC -0.7%, 95% CI: -1.9, 0.6).

Similar to incidence, deaths attributable to leukemia occur at higher rates with increasing age (data for patients aged < 20 years at diagnosis included below). Mortality rates among pediatric cases are uniformly lower than rates among adults. During 2016–2020, leukemia mortality rates were similar among Idahoans versus other U.S. residents for all age categories (**Figure 5**). This pattern is consistent for males and females.

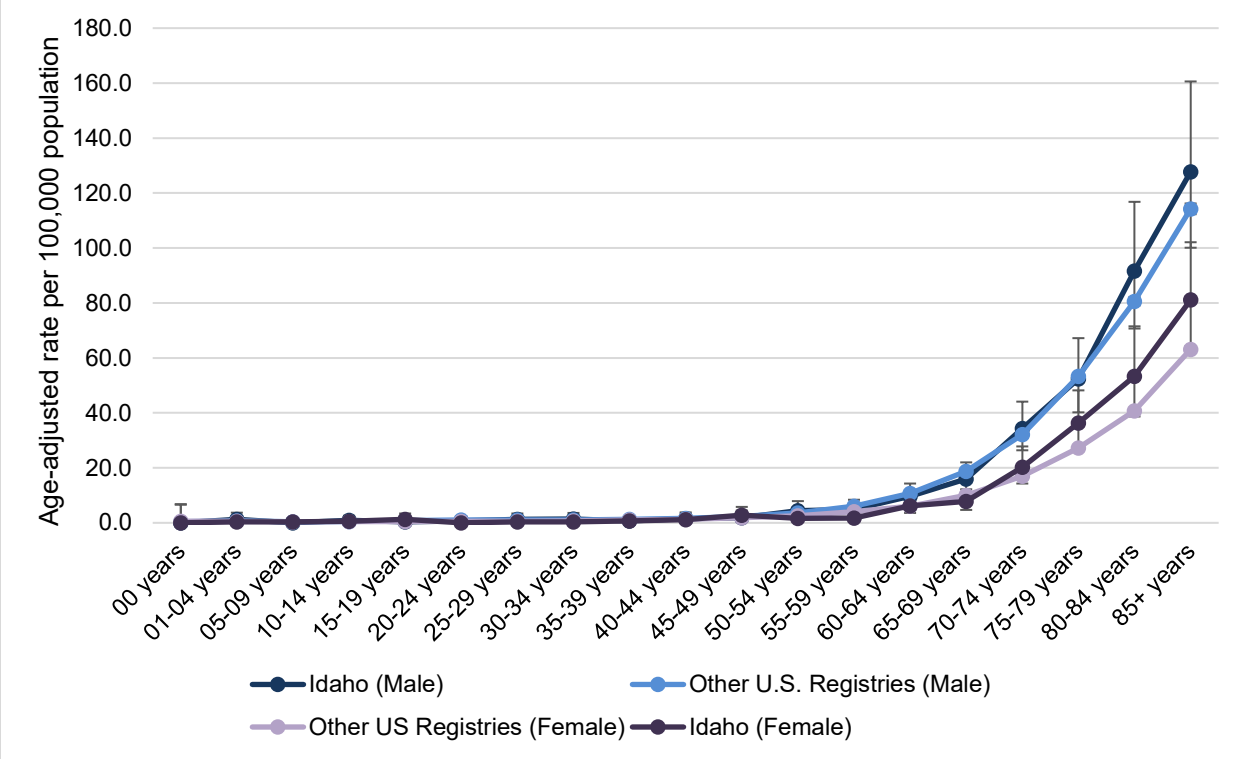

Figure 5: Age-adjusted leukemia mortality rates (with 95% CI) by age category in Idaho versus other U.S. states — 2016–2020.

During 2016–2020, rates of leukemia mortality were higher among non-Hispanic whites than any other race/ethnicity category in the United States (**Table 5**), with the exceptions of acute lymphocytic leukemia, where rates between non-Hispanic whites and non-Hispanic American Indian/Alaska Natives were similar, and chronic myeloid leukemia, where rates were similar between non-Hispanic whites, non-Hispanic Blacks and non-Hispanic American Indian/Alaska Natives. In Idaho, there are no statistically significant differences in rates of leukemia mortality by race/ethnicity; statistical comparisons are, however, hampered by small numbers of deaths from leukemia among Idaho residents who are a race/ethnicity besides non-Hispanic white.

Table 5: Age-adjusted leukemia mortality rates (overall and by type) by race/ethnicity among Idaho residents and residents of other U.S. states, 2016–2020.

	Idaho				All Other U.S. States			
	Rate	**Lower CI**	**Upper CI**	**Count**	**Rate**	**Lower CI**	**Upper CI**	**Count**
Leukemia								
Non-Hispanic White	9.2	8.4	10	598	8.8	8.7	8.8	92,610
Non-Hispanic Black	^	^	^	^	7.2	7	7.3	9,941
Non-Hispanic American Indian/Alaska Native	^	^	^	^	4.8	4.3	5.3	421
Non-Hispanic Asian or Pacific Islander	^	^	^	^	4.6	4.4	4.7	3,185
Hispanic (All Races)	6.5	3.9	10	23	5.7	5.6	5.9	8,007
Lymphocytic Leukemia								
Non-Hispanic White	2.7	2.3	3	171	2.4	2.3	2.4	25,064
Non-Hispanic Black	^	^	^	^	1.8	1.8	1.9	2,449
Non-Hispanic American Indian/Alaska Native	^	^	^	^	1.2	0.9	1.4	102
Non-Hispanic Asian or Pacific Islander	^	^	^	^	0.7	0.6	0.7	472
Hispanic (All Races)	^	^	^	^	1.5	1.4	1.5	2,219
Myeloid and Monocytic Leukemia								
Non-Hispanic White	5.1	4.6	6	338	4.9	4.9	4.9	51,254
Non-Hispanic Black	^	^	^	^	3.9	3.8	4	5,476
Non-Hispanic American Indian/Alaska Native	^	^	^	^	2.7	2.3	3	238
Non-Hispanic Asian or Pacific Islander	^	^	^	^	3.2	3	3.3	2,198
Hispanic (All Races)	4.7	2.4	7.9	15	3.1	3	3.2	4,288
Other Leukemia								
Non-Hispanic White	1.4	1.1	1.7	89	1.5	1.5	1.6	16,292
Non-Hispanic Black	^	^	^	^	1.5	1.4	1.5	2,016
Non-Hispanic American Indian/Alaska Native	^	^	^	^	1.0	0.8	1.2	81
Non-Hispanic Asian or Pacific Islander	^	^	^	^	0.7	0.7	0.8	515
Hispanic (All Races)	^	^	^	^	1.1	1.1	1.2	1,500

Underlying mortality data provided by NCHS (www.cdc.gov/nchs). Rates are per 100,000 and age-adjusted to the 2000 US Std Population (19 age groups - Census P25-1130) standard; Confidence intervals (Tiwari mod) are 95% for rates and ratios.
^ Statistic not displayed due to fewer than 10 cases.

During 2016–2020, rates of leukemia mortality in Idaho varied by rurality of residency. Leukemia mortality rates were lowest among Idahoans living in entirely urban census tracts (7.9 deaths per 100,000 population; 95% CI: 6.8, 9.1); rates were highest among Idahoans living in “mixed” and mostly urban census tracts (10.5 deaths per 100,000 population; 95% CI: 9.2, 11.8), with a mortality rate ratio of 1.32 (95% CI: 1.09, 1.61) in mostly urban relative to entirely urban areas. These differences were primarily driven by increased rates of chronic lymphocytic leukemia mortality in mostly urban areas relative to all urban areas (10.5 per 100,000 population versus 7.9 per 100,000 population). By area-based poverty, mortality rates were similar in areas with ≥ 10% of persons living below the federal poverty level versus areas with less than 10% of persons living below the federal poverty level. One exception was for myeloid and monocytic leukemia, where rates were higher in areas with lower poverty (6.0 deaths per 100,000 population in areas with less than 10% of persons below the federal poverty level versus 4.7 deaths in areas with ≥ 10% of persons living below the federal poverty level (RR = 1.29; 95% CI: 1.03, 1.61). A similar evaluation using ten years of data (2011–2020) yields similar results.

Leukemia Survival (Aged 20+ Years at Diagnosis)

Five-year survival among adults diagnosed with leukemia varies significantly by type. For adult Idahoans diagnosed during 2013–2019 and followed through the end of 2019, age-adjusted five-year relative survival for all leukemias combined was 0.620 (95% CI: 0.588, 0.650) versus 0.592 (95% CI: 0.589, 0.594) for the remainder of the U.S. states[§] meeting NAACCR Fitness for Use for Survival & Prevalence Recognition standards.[35,36] In Idaho, survival ranged from 0.177 (95% CI: 0.055, 0.355) for acute monocytic leukemia to 0.901 (95% CI: 0.847, 0.937) for chronic lymphocytic leukemia. Relative survival estimates were similar for Idaho and other U.S. states, although survival for other myeloid/monocytic leukemia and other acute leukemia were unable to be calculated for Idaho.

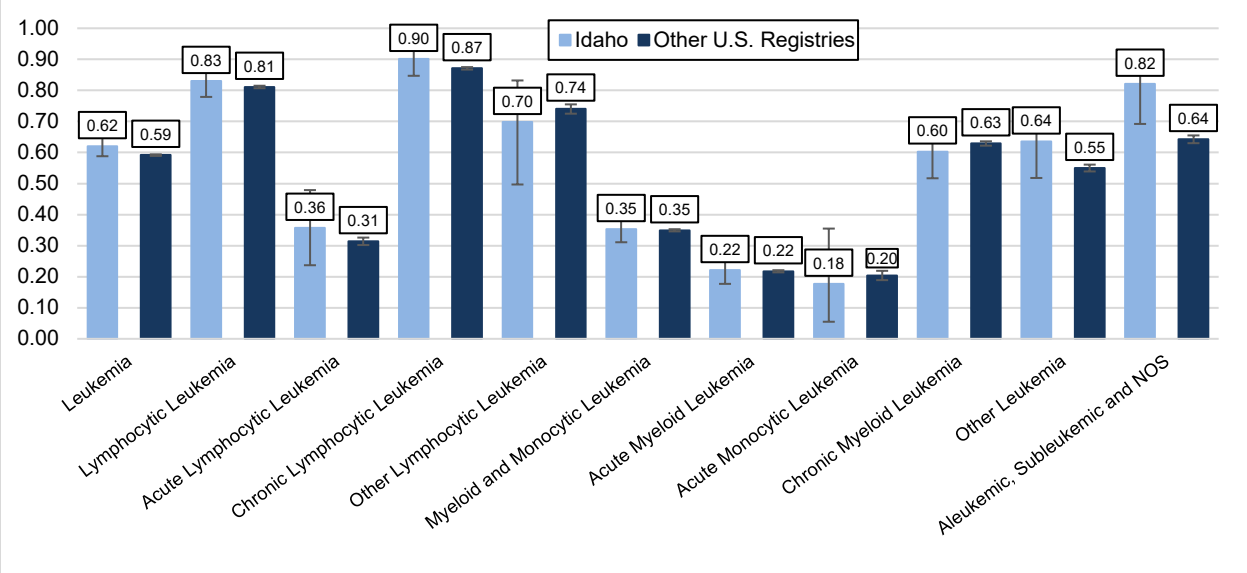

Figure 6: 5-year relative survival among adults diagnosed with leukemia during 2013–2019 with follow-up through 2019 by leukemia type for Idaho versus other U.S. states.

Leukemia survival has increased over time in Idaho (**Figure 7**). Since 2000, 5-year relative survival for all leukemias has increased 0.128 absolute points, from 0.472 (95% CI: 0.433, 0.510) among adults diagnosed during 2000–2004 to 0.600 (95%: 0.560, 0.638) for adults diagnosed during 2015–2019 and followed through the end of 2020. These improvements in survival were largely driven by improvements in survival among adults diagnosed with lymphocytic leukemia overall, from 0.705 (95% CI: 0.645, 0.756) among adults diagnosed in 2000–2004 to 0.837 (95%: 0.771, 0.885) among adults diagnosed during 2015–2019. Larger

[§] States included in survival analyses include Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Kansas, Kentucky, Louisiana, Maine, Maryland, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, West Virginia, Wisconsin, Wyoming, all of which meet NAACCR Fitness for Use for Survival & Prevalence Recognition standards, outlined here: https://www.naaccr.org/certification-criteria/ and in the CiNA Monographs.

absolute improvements were seen in survival among adults diagnosed with chronic leukemias than acute leukemias; for the former, survival improvements among Idahoans ranged from 0.123 to 0.160 absolute points; for the latter, survival improvements ranged from 0.045 to 0.085 absolute points.

Survival between male and female Idahoans was similar, with relative survival estimates of 0.621 (95% CI: 0.577, 0.663) for females and 0.601 (95% CI: 0.563, 0.638) for males.

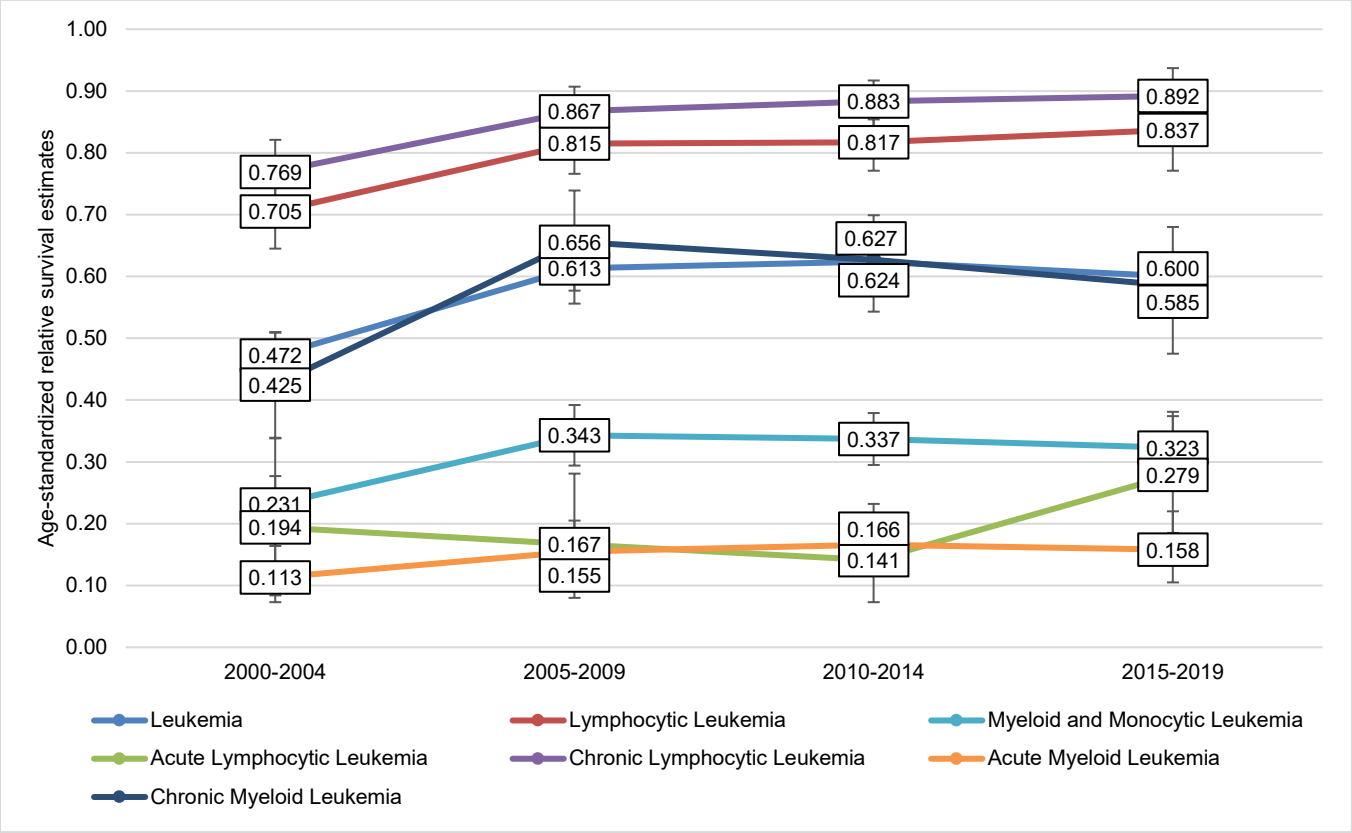

Figure 7: 5-year relative survival among adult Idahoans diagnosed with leukemia during 2000–2019 with follow-up through 2020 by leukemia type.
Calculations use the actuarial and Ederer II methods, and are age-standardized to the International Cancer Survival Standard 1 - Ages 15+. All Tumors Matching Selection Criteria has been specified: only the first tumor for an individual that could contribute to a given life page will be included in that life page. Confidence intervals are log(-log()) transformations at 95%.

Differences in survival by race/ethnicity are difficult to evaluate in Idaho, with 93.1% (1,838/1,975) of eligible leukemia cases diagnosed during 2013–2019 occurring in non-Hispanic white Idahoans. Eligible cases for survival analyses reported for other race/ethnicity categories are as follows: 7 among Non-Hispanic Blacks, 15 among Non-Hispanic American Indian/Alaska Native persons, 15 among Non-Hispanic Asians or Pacific Islanders, 91 among Hispanics of any race, and 9 among non-Hispanics of unknown race.

Differences in survival are, however, noted when using additional years of data; among patients diagnosed during 2000–2019 and followed through the end of 2019, all race/ethnicity categories

had lower survival than non-Hispanic white Idahoans (**Figure 8**) – although many race/ethnicity categories still had a small number of patients. Differences in survival among Idaho adults diagnosed during 2000–2019 were noted between non-Hispanic whites and Hispanics of all races diagnosed with lymphocytic leukemia; age-adjusted relative survival estimates for the former were 0.815 (95% CI: 0.791, 0.841) and 0.644 (95% CI: 0.496, 0.758) for the latter; a similar survival disparity was noted for remaining U.S. states. These differences were driven by survival among patients diagnosed with chronic lymphocytic leukemia.

Non-Hispanic white Idahoans demonstrate slightly better survival than non-Hispanic white patients in other areas of the United States, with Idahoans having relative survival of 0.600 (95% CI: 0.581, 0.618) and residents of other U.S. states having relative survival of 0.568 (95% CI: 0.566, 0.569) among people diagnosed with any type of leukemia. Conversely, for non-Hispanic Asian or Pacific Islanders, survival was better in the remainder of U.S. states (RSR = 0.427; 95% CI: 0.418, 0.436) than in Idaho (RSR = 0.256; 95% CI: 0.147, 0.378; N = 27). There were no differences in survival among American Indian/Alaska Native peoples in Idaho versus the remainder of the U.S. states when restricting to PRCDA Counties, although only 19 Idahoans were included.

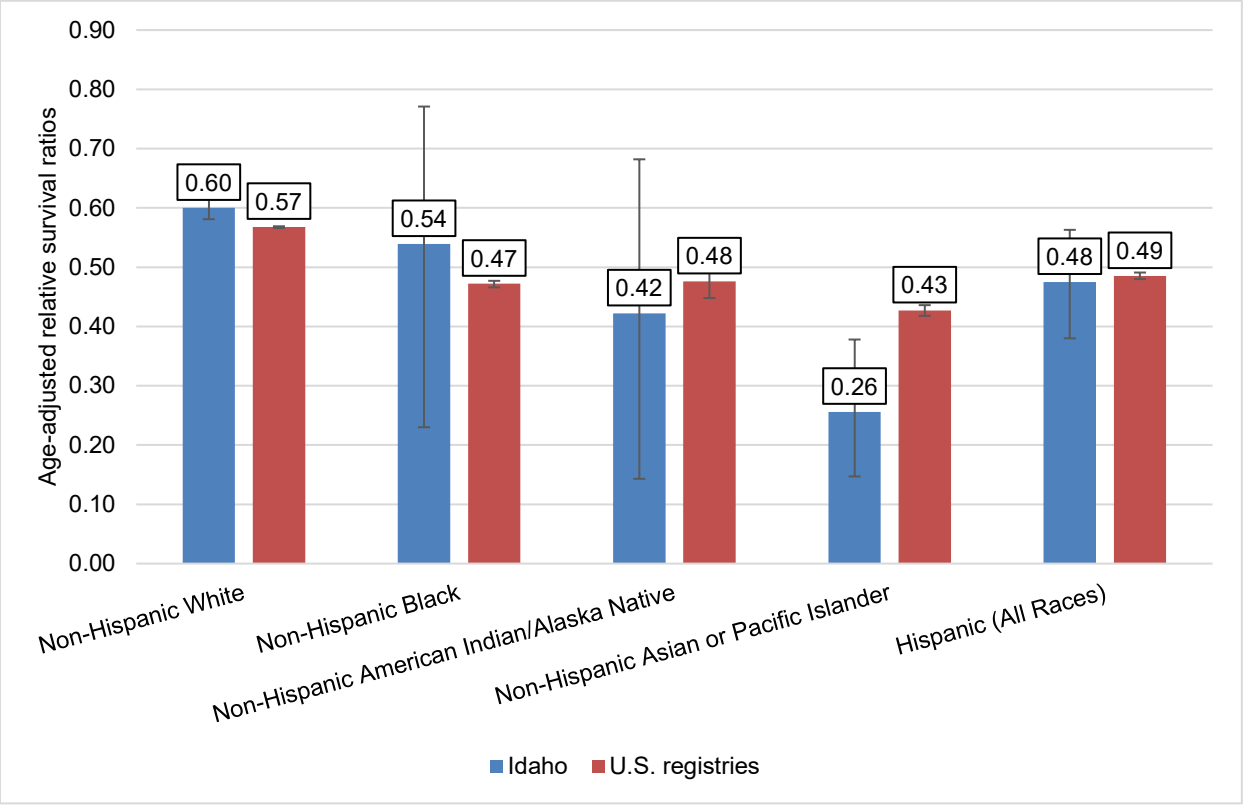

Figure 8: 5-year relative survival among adults diagnosed with leukemia during 2000–2019 and followed through 2019 by race/ethnicity in Idaho versus the remainder of U.S. states.

Survival among Idahoans diagnosed with leukemia during 2013–2019 and followed through the end of 2020 was better among patients living in urban areas or areas near urban areas ("urban commuting areas") than patients living in non-urban commuting areas;[37] among adult Idahoans

diagnosed with any form of leukemia, survival among residents of urban commuting areas was 0.636 (95% CI: 0.600, 0.669) versus 0.555 (95% CI: 0.504, 0.604) among residents of non-urban commuting areas. Similar patterns of improved survival among urban commuting area residents were also noted for specific leukemia types, e.g. acute lymphocytic leukemia, chronic lymphocytic leukemia, but no statistically significant differences were observed for diagnosis years 2013–2019.

Survival was also lower among Idahoans diagnosed with leukemia when living in areas of relatively higher poverty. Among adults diagnosed with any type of leukemia during 2013–2019, age-adjusted relative survival was 0.647 (95% CI: 0.598, 0.691) in areas where less than 10% of residents were living below the federal poverty level versus 0.592 (95% CI: 0.555, 0.627) in areas where 10% or more of residents live below the federal poverty level. Similar patterns were seen for specific leukemia types, but no statistically significant differences for this time period were noted. On a longer timescale, i.e. diagnosis years 2000–2019, survival was statistically significantly higher among patients in areas of lower poverty for all leukemias by 5.5 absolute points, lymphocytic leukemia by 7.7 absolute points, chronic lymphocytic leukemia by 6.5 absolute points, and acute myeloid leukemia by 2.3 absolute points.

Relative survival among adults diagnosed with leukemia overall and specific types of leukemia varied by Idaho Public Health District,[38] but were not statistically different (**Table 6**). An analysis of survival by Public Health District for diagnosis years 2000–2019 with follow-up through the end of 2020 does, however, indicate that survival is lower among residents of Public Health District 2 (Idaho North Central District Public Health) and Public Health District 6 (Southeastern Idaho Public Health) than the statewide survival rate for all leukemias combined, and survival is higher among residents of Public Health District 4 (Central District Health) than the statewide survival rate for all leukemias combined.

Table 6: Age-adjusted 5-year relative survival among adult Idahoans diagnosed with leukemia during 2013–2019 with follow-up through the end of 2020 by type and Idaho Public Health District.

Idaho Geography	N	Age Standardized Relative Survival	Lower 95% CI	Upper 95% CI
Leukemia				
State of Idaho	1,975	0.611	0.581	0.639
Health District 1	349	0.587	0.521	0.647
Health District 2	140	0.524	0.412	0.623
Health District 3	328	0.634	0.564	0.696
Health District 4	531	0.602	0.543	0.657
Health District 5	224	0.551	0.464	0.630
Health District 6	196	0.630	0.534	0.712

Idaho Geography	N	Age Standardized Relative Survival	Lower 95% CI	Upper 95% CI
Health District 7	209	0.629	0.534	0.710
Lymphocytic Leukemia				
State of Idaho	994	0.826	0.782	0.862
Health District 1	174	0.766	0.660	0.843
Health District 2	74	*0.624#*	*0.437#*	*0.765#*
Health District 3	158	0.826	0.723	0.893
Health District 4	269	0.852	0.758	0.912
Health District 5	97	*0.770*	*0.588*	*0.879*
Health District 6	112	0.800	0.668	0.884
Health District 7	110	0.865	0.671	0.948
Acute Lymphocytic Leukemia				
State of Idaho	92	0.235	0.157	0.322
Health District 1	20	*0.180#*	*0.034#*	*0.420#*
Health District 2	13	0.0	--	--
Health District 3	12	0.051	0.028	0.086
Health District 4	22	*0.645#*	*0.406#*	*0.808#*
Health District 5	7	--	--	--
Health District 6	11	*0.551#*	*0.229#*	*0.785#*
Health District 7	7	*0.719#*	*0.256#*	*0.923#*
Chronic Lymphocytic Leukemia				
State of Idaho	851	0.894	0.848	0.926
Health District 1	146	0.891	0.778	0.949
Health District 2	61	*0.755#*	*0.521#*	*0.885#*
Health District 3	136	0.893	0.774	0.951
Health District 4	235	0.889	0.785	0.945
Health District 5	81	*0.828*	*0.598*	*0.933*
Health District 6	98	*0.854#*	*0.676#*	*0.939#*
Health District 7	94	*0.890#*	*0.621#*	*0.972#*
Other Lymphocytic Leukemia				
State of Idaho	52	0.690	0.506	0.817
Health District 1	9	*0.676#*	*0.194#*	*0.911#*
Health District 2	0	+	+	+
Health District 3	10	*0.578#*	*0.131#*	*0.863#*
Health District 4	12	*0.679#*	*0.337#*	*0.872#*
Health District 5	9	*0.701#*	*0.234#*	*0.916#*
Health District 6	3	*0.716#*	*0.025#*	*0.970#*

Idaho Geography	N	Age Standardized Relative Survival	Lower 95% CI	Upper 95% CI
Health District 7	9	*0.890#*	*0.430#@*	*0.984#@*
Myeloid and Monocytic Leukemia				
State of Idaho	881	0.345	0.308	0.383
Health District 1	155	0.321	0.231	0.415
Health District 2	61	0.414	0.276	0.547
Health District 3	156	0.392	0.309	0.474
Health District 4	236	0.302	0.229	0.378
Health District 5	110	0.323	0.225	0.425
Health District 6	76	*0.375#*	*0.246#*	*0.504#*
Health District 7	89	0.340	0.237	0.445
Acute Myeloid Leukemia				
State of Idaho	547	0.203	0.165	0.245
Health District 1	106	*0.160#*	*0.080#*	*0.264#*
Health District 2	43	0.303	0.161	0.458
Health District 3	89	*0.251#*	*0.158#*	*0.355#*
Health District 4	149	*0.143#*	*0.084#*	*0.217#*
Health District 5	65	*0.248#*	*0.135#*	*0.378#*
Health District 6	43	*0.154#*	*0.056#*	*0.297#*
Health District 7	52	*0.129*	*0.045*	*0.259*
Acute Monocytic Leukemia				
State of Idaho	23	*0.177#*	*0.055#*	*0.355#*
Health District 1	2	*0.0*	+	+
Health District 2	2	*0.0*	+	+
Health District 3	7	+	+	+
Health District 4	5	*0.203#*	*0.008#*	*0.588#*
Health District 5	2	*0.0*	+	+
Health District 6	3	*0.334#*	*0.009#*	*0.775#*
Health District 7	2	*0.0*	+	+
Chronic Myeloid Leukemia				
State of Idaho	311	0.606	0.530	0.673
Health District 1	49	0.550	0.360	0.705
Health District 2	16	*0.738#*	*0.235#*	*0.939#*
Health District 3	61	0.575	0.401	0.714
Health District 4	79	0.598	0.426	0.734
Health District 5	41	0.467	0.311	0.609
Health District 6	30	*0.714#*	*0.466#*	*0.862#*

Idaho Geography	N	Age Standardized Relative Survival	Lower 95% CI	Upper 95% CI
Health District 7	35	0.637	0.472	0.762
Other Leukemia				
State of Idaho	104	0.592	0.452	0.708
Health District 1	24	*0.468#*	*0.260#*	*0.652#*
Health District 2	5	*0.451#*	*0.007#*	*0.880#*
Health District 3	14	*0.844#*	*0.404#*	*0.969#*
Health District 4	26	*0.471#*	*0.228#*	*0.681#*
Health District 5	17	*0.449#*	*0.166#*	*0.699#*
Health District 6	8	+	+	+
Health District 7	10	*0.620#*	*0.252#*	*0.847#*
Aleukemic, Subleukemic and NOS				
State of Idaho	69	0.782	0.617	0.882
Health District 1	17	*0.660#*	*0.380#*	*0.837#*
Health District 2	3	*0.564#*	*0.002#*	*0.950#*
Health District 3	12	*0.907*#*	*0.273#@*	*0.993#@*
Health District 4	15	*0.846#*	*0.396#*	*0.970#*
Health District 5	9	*0.858#*	*0.085#*	*0.990#*
Health District 6	6	+	+	+
Health District 7	7	*0.880#*	*0.258#@*	*0.988#@*

Italicized estimates are relative survival estimates that were unable to be age-standardized.
Actuarial method Ederer II method used for cumulative expected Age standardized to the International Cancer Survival Standard 1 - Ages 15+ One or more age groups had one or more age standardization groups that contributed a zero count All Tumors Matching Selection Criteria has been specified: only the first tumor for an individual that could contribute to a given life page will be included in that life page
@ The width of the confidence interval is more than 25% larger than if the normal approximation was applied
* The relative cumulative survival is over 100 percent and has been adjusted.
# The relative cumulative survival increased from a prior interval and has been adjusted.
+ The statistic could not be calculated.

Conclusions

The data presented in this report provide insight into leukemia among adult Idahoans. Rates of new leukemia cases were consistently higher in Idaho than other areas of the

United States, including when conducting analyses stratified by race/ethnicity. Rates of leukemia mortality were also higher in Idaho compared to other areas of the U.S., although not when stratifying analyses by race/ethnicity. Rates of leukemia in Idaho are increasing, whereas they are stable in other areas of the country. We also noted differences in mortality and survival by race/ethnicity, rurality, and area-based poverty, although there were few differences by Idaho geography (county, public health district). These findings may be useful in guiding public health and healthcare professionals and policy makers to additional areas of investigation that will reduce the number of new cases of leukemia and improve post-diagnosis care among Idahoans.

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