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Author manuscript

Cancer. Author manuscript; available in PMC 2017 September 01.

Published in final edited form as:

Cancer. 2016 September 1; 122(17): 2723–2730. doi:10.1002/cncr.30089.

RACIAL DISPARITIES IN THE SURVIVAL OF AMERICAN CHILDREN, ADOLESCENTS AND YOUNG ADULTS WITH ACUTE LYMPHOBLASTIC LEUKEMIA, ACUTE MYELOGENOUS LEUKEMIA AND HODGKIN LYMPHOMA

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Abstract

Background—Race-based survival in children and adolescents with hematologic malignancies has been a national challenge for decades. Large-scale investigations of age- and race-based survival trends over time in these patients have not previously been reported.

Objective—To investigate whether race- and age-related differences in pediatric and adolescent and young adult (AYA) leukemia and lymphoma survival persist and to what extent these differences have changed over time.

Methods—Using the Surveillance, Epidemiology and End Results (SEER) Program we investigated the outcomes of black and white (1975–2012; N=27,369) and white and Hispanic (1992–2012; N=20,574) children (0–14 years old) and AYAs (15–39 years old) with acute lymphoblastic leukemia (ALL), acute myelogenous leukemia (AML) and Hodgkin lymphoma (HL). Five- and 10-year relative survival estimates were compared over time.

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There are no conflicts of interest to disclose.

Author Contributions: *Conceptualization, JMK, THMK, LT, RA, AB, ADV; Methodology, LT, RA, AB; Investigation, JMK, THMK, AB, ADV; Writing – Original Draft, JMK, THMK; Writing – Review & Editing, JMK, THMK, LT, RA, AB, ADV; Funding Acquisition, This work is unfunded; Resources, AB, ADV; Supervision, AB, ADV*

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Results—Trends showed convergence of survival in white and black children with ALL, but divergence in survival in AYA patients. Hispanic children and AYAs both suffer inferior outcomes. Trends for AML revealed persistent survival differences between black and white children and suggested worsening disparities for AYAs. Survival trends in HL revealed sustained survival differences between black and white AYA patients whereas no differences were found in Hispanic vs. white patient outcomes for AML or HL.

Conclusion—Although survival in children and AYAs with ALL, AML and HL has improved over the past four decades, differences persist between black, white, and Hispanic children and AYAs; Survival disparities between black and white children with ALL has been nearly eliminated. Strategies aimed at identifying causality and reducing disparities are warranted.

Keywords

Leukemia; Lymphoma; SEER; Adolescent; AYA; Pediatric; Survival; Race; Disparities

INTRODUCTION

Advances made in the treatment of acute lymphoblastic leukemia (ALL), acute myelogenous leukemia (AML) and Hodgkin lymphoma (HL) over the last quarter-century are among the most dramatic and successful in modern medicine. Despite successes, patients of racial/ethnic minorities and adolescent and young adults (AYAs) continue to suffer reduced survival.[1,2] The cancer burden facing AYA patients has been underestimated. Cancer incidence is more than five times higher among 15- to 39-year-olds than in younger patients and the rate of progress in prolonging survival and reducing mortality in the AYA group has been approximately half.[3] Studies report disparities in ALL outcomes, with black and Hispanic patients having considerably lower 5-year survival than non-Hispanic whites.[4,5] Similarly, survival differences based on age and race hold true in pediatric and AYA AML and HL.[6,7,8]

While the epidemiology of ALL, AML and HL in pediatric and AYA patients has been investigated, survival trends over time have not been fully described. We investigated whether black and Hispanic patients with ALL, AML and HL in the pediatric and AYA populations continue to experience poorer survival when compared with non-Hispanic white patients. Here we present the results of a retrospective analysis of Surveillance, Epidemiology and End Results (SEER) data investigating relative survival trends of black and white children (0–14 years) and AYAs (15–39 years) with ALL, AML and HL from 1975 to present, and Hispanic and non-Hispanic white children and AYAs from 1992 to present.

METHODS

Study Population

Using the SEER database we identified 27,369 black and white children and AYAs diagnosed with a ALL, AML or HL between 1975 and 2012 inclusive (International Classification of Diseases-Oncology, 3rd edition [ICD-O-3] morphology codes 9811–9818, 9826, 9835–9837 for ALL, 9840, 9861, 9865–9867, 9869, 9871–9874, 9895–9897, 9898,

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9910–9911, 9920 for AML, and 9650–9667 for HL). Patients from nine original SEER sites including Connecticut, Iowa, New Mexico, Utah, Hawaii, metropolitan areas of Detroit, San Francisco-Oakland, Atlanta and 13 counties of the Seattle-Puget Sound region (SEER-9) were included. Data from 1973 and 1974 were excluded because of inconsistent and incomplete entries. Our study of SEER-9 consisted of black and white races only; insufficient cases were available for analysis of other racial/ethnic groups before 1992. We excluded 103 patients who were diagnosed by death certificate/autopsy only or who had no reported survival time. The final study population was 27,266. We obtained information routinely recorded at diagnosis for each patient including age, sex, race and year of diagnosis. Patients were divided into two age groups: children (0–14 years) and AYAs (15–39 years) and into black and white cohorts for subgroup analyses. Non-Hodgkin lymphoma (NHL) was not included in this study because the human immunodeficiency virus /acquired immunodeficiency syndrome (HIV/AIDS) epidemic during the 1980s and early 1990s resulted in a temporary increase in incidence of a poor-prognosis type of NHL in AYAs and we lacked information on which patients had HIV/AIDS;.[9] As a result, the overall survival of AYAs with NHL dropped as much as 25% and the effect lasted for 20–25 years, from 1985 to 2000–2005.

In 1992, SEER expanded its registries with four additional regions: Los Angeles, San Jose-Monterey, the rest of the state of Georgia, and Alaska native (SEER-13) and included data on whether patients identified as Hispanic-Spanish-Latino. Using the SEER-13 database we identified 14,188 non-Hispanic white and 6,386 Hispanic children or AYA patients. Trends over time using the SEER-13 database were limited to a relatively short interval.

Statistical Analysis

Relative survival was used to assess cancer mortality changes over time. Relative survival accounts for competing causes of death and is the ratio of observed survival among cancer patients to expected survival in the overall population as computed from life tables of mortality in the general population.[10] We obtained 5- and 10-year relative survival estimates with corresponding 95% confidence intervals (95% CI) by age, race, and primary site of the cancer in the body pooled over multiple years by using SEER*Stat software program (version 4.2.0.2; National Cancer Institute [NCI], Bethesda, MD)[11] Average percent change (APC) in annual survival was determined by converting 5- and 10-year survival estimates to log values, applying the linear estimate regression, and the exponential of the linear regression. If the survival estimate was 0% (zero), the rate was estimated as the average of the prior and succeeding years for which the estimates were non-zero. The test of APC= 0 was tested with the F-test for regression. P-values ≥0.05 were considered not significant (NS).

RESULTS

Five-year relative survival was calculated for successive intervals children and AYAs with ALL, AML and HL, by race (Figure 1). In general, all subgroups have improved over the 32 calendar years depicted. Among 8,201 ALL patients, 92% were white and 28% were AYAs. Among 3,958 AML patients, 87% were white and 77% were AYAs. Among 15,107 HL

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patients, 89% were white and 93% were AYAs (Table 1). Five- and 10-year relative survival rates with 95% CI among black and white children and AYAs for ALL, AML, and HL are presented in Table 2. A comparison of Hispanic and non-Hispanic cohorts with ALL, AML, and HL are presented in Table 3.

Acute Lymphoblastic Leukemia

Children with ALL—From 1975–1981, the 10-year survival in white children was 57.7% (95% CI 54.2–61.0) vs. 37.9% (95% CI 25.8–49.8) in black children. Improvements in survival for black children with ALL have been greater than improvements in white children (APC=3.01% vs. 1.37%), resulting in a narrowing of the survival gap between these cohorts. From 2003–2007, 10-year survival rates were 86.8% (95% CI 84.7–88.7) in white children and 78.1% (95% CI 68.9–84.8) in black children.

AYAs with ALL—From 1975–1981, 10-year relative survival in white AYAs was 22.7% (95% CI 17.9–27.9) vs. 14.6% (95% CI 3.6–32.7) in black AYAs. There was no significant improvement in 5- or 10-year survival of black AYAs (5-year APC=1.25%,10-year APC= −1.26%) over the study periods. In contrast, white AYAs had significant improvements in 5- and 10-year survival (5-year APC=3.13%, 10-year APC=3.74%). For Black AYAs, there is a decrease in relative survival between 1996 and 2002 (Figure 1, top panel) in an otherwise increasing trend over time, which may be a result of a small number of patients (Table 1) rather than a true survival nadir.

Comparison of children and AYAs with ALL—From 2003–2007 there was a difference of 36 percentage-points in 5-year survival between white children and AYAs (93.3%, 95% [CI 91.3–94.9] vs. 57.0%, [95% CI 51.5–62.2]). Similarly, there was a 37 percentage-point difference between black children and black AYAs (54.9%, [95% CI 39.1–68.2] vs. 92%, [95% CI 82.9–96.3]).

Comparison of Hispanic and non-Hispanic children and AYAs with ALL—Differences in 10-year survival between Hispanic and non-Hispanic white children with ALL have persisted since 1992. From 2000–2003, survival in Hispanic children with ALL was 11 percentage-points lower than in non-Hispanic white children (79.1%, [95% CI 74.9–82.7] vs. 90.9%, [95% CI 88.2–93.0]). Similarly, 10-year relative survival in Hispanic AYAs was 16 percentage-points lower than in non-Hispanic white AYAs, (34.4%, [95% CI 27.3–41.6] vs. 50.3%, [95% CI 43.6–56.7]). From 2004–2007, 5-year survival in Hispanic AYAs was 46.9% (95% CI 40.8–52.8) vs. 88.3% (95% CI 85–90.9) in Hispanic children. There remained a 35 percentage-point difference in 10-year survival between Hispanic AYAs and Hispanic children (34.4%, [95% CI 27.3–41.6] vs. 79.1%, [95% CI 74.9–82.7]) from 2000–2003.

Acute Myeloid Leukemia

Children with AML—From 1975–1981, 10-year relative survival in white children with AML was 18.7% (95% CI 12.4–26.0) vs. 33.4% (95% CI 13.7–54.6) in black children. Survival improvements in black children have been lower than in white children (5-year APC=0.31% vs. 4.58%). Ten-year APCs revealed no significant improvement in survival for

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black children with AML vs. significant improvement for white children (APC=0.01% vs. 5.47%).

AYAs with AML—From 1975–1981, the 5-year survival in white AYAs was 15% (95% CI 12–18.3) vs. 13% (95% CI 5.7–23.5) in black AYAs. Improvements in 5- and 10-year survival in white AYAs were greater than for black AYAs (APC=5.10% vs. 2.07%). From 2003–2007 there remained an 18 percentage-point difference in 5-year relative survival between black and white AYAs (37.6%, [95% CI 25.5–49.6] vs. 55.1%, [95% CI 53.2–63.6]).

Comparison of children and AYAs with AML—From 2003 to 2007, 5-year relative survival for white children remained higher than for white AYAs (71%, [95% CI 61.2–79.0] vs. 55%, [95% CI 49.7–60.2]) and both cohorts had significant improvements in APC over time. Black children did not have a significant improvement in 10-year survival rates (APC=0.01%) while black AYAs did (APC=2.55%).

Comparison of Hispanic and non-Hispanic children and AYAs with AML—Relative survival estimates in Hispanic vs. non-Hispanic white children and AYAs with AML were comparable between all groups in the most recent evaluable time period.

Hodgkin Lymphoma

Children with HL—From 1975 to 1981, 10-year relative survival in white children was 81.7% (95% CI 75.8–86.3) vs. 55.4% (95% CI 31.5–74.0) in black children. Improvements in 10-year survival of black children have been greater than in white children (APC=2.4 vs. 0.81). As a result, the survival gap has decreased, with 5- and 10-year survival averaging between 96–98% and 92–95% in white and black patients, respectively.

AYAs with HL—From 1975 to 1981, 10-year survival in white AYAs was 78.3% (95% CI 76.4–80.1) vs. 66.2% (95% CI 57.3–73.8) in black AYAs. Over the study period white AYAs had significant improvements in 10-year survival (APC=0.73%) vs. black AYAs who did not (APC=0.53%). From 2003–2007 there remained a four percentage-point difference in 5-year survival between white and black AYA patients (96%, [95% CI 95.3–97.3] vs. 92%, [95% CI 87.6–94.9]) and a 9 percentage-point difference in 10-year survival (80.5%, [95% CI 75.5–84.6] vs. 91.1%, [95% CI 89.7–92.3]).

Comparison of children and AYA with HL—Over the study period, 10-year relative survival improved significantly for both white children and white AYAs (APC=0.81 vs. 0.73). In contrast, black children had significant improvements in 10-year survival (APC=2.4) but black AYAs did not (APC=0.53).

Comparison of Hispanic and non-Hispanic children and AYAs with HL—Relative survival estimates in Hispanic vs. non-Hispanic white children and AYAs with HL were similar in the most recent evaluable time period.

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DISCUSSION

Relative survival in children and AYAs with ALL, AML and HL have improved over the last four decades, albeit to varying degrees, which has resulted in persistent age- and race-related survival differences since 1975. Improved survival in all patients likely reflects diagnostic and therapeutic advances, such as improvements in cellular and molecular diagnostics, staging, targeted therapies, hematopoietic cell transplantation (HCT), supportive care, and expansion of pediatric cooperative group trials.[4,6] Unequal access to these advances may potentially underlie survival disparities between groups as well as both biologic and non-biologic factors (e.g. medication adherence, disease biology and pharmacogenomics).[12]

Clinical trial enrollment

Survival improvements in pediatric ALL and AML patients are largely a result of national efforts aimed at enrolling children on cooperative group clinical trials. In general, AYA patients are not enrolled on clinical trials as often as children.[13–15] As of 2008, 90–95% of children <15 years were treated at Children's Oncology Group (COG) institutions and approximately 50–60% enrolled on clinical trials.[16] In contrast, 21% of 15 to 19 year-olds and 8% of 20 to 29 year-olds were treated at institutions with NCI-sponsored clinical trials.[16] Identification of the AYA gap in clinical trial participation has fueled a collaborative initiative between the COG and the adult groups aimed at expanding eligibility criteria for trial enrollment.[17,18] While this program represents a major effort to improve AYA outcomes, its survival impact will likely not be appreciable for decades.

Biologic basis for survival differences

Age-related differences in disease-specific prognostic factors may contribute to observed survival differences between children and AYAs with ALL and AML. AYAs with ALL more often have high-risk disease characteristics such as L2 morphology or pro-T cell immunophenotype.[19,20] The BCR-ABL genotype occurs in <3% of children and in up to 26% of AYAs with ALL.[21] Nearly 50% of children with ALL have favorable genotypes such as *TEL-AML* translocation vs. approximately 10% of AYAs.[22] In patients with AML, FLT3-ITD mutations increase in frequency with age and are associated with poorer prognosis in all age groups.[21] Additionally, certain genetic factors in patients with ALL and AML may be associated with drug-resistant phenotypes and may partly explain the reduced survival observed in certain ethnic groups.[23,24]

Treatment-related mortality

Historically, the risk of treatment-related mortality in AYA patients is higher than in children.[25] Truong et al identified adolescent age as an independent risk factor for tumor lysis syndrome, a potentially life-threatening condition at initiation of leukemia or lymphoma treatment.[6,26,27] Patients receiving ALL and AML therapy are at risk for serious bacterial infections and higher rates of infection-associated mortality in ALL patients over age 10.[6] Multiple clinical trials have identified a correlation between infection-associated mortality and older patient age during AML therapy.[28,29] In recent years, children with ALL and AML who are treated on clinical trials receive prophylactic antibiotics during times of

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prolonged immune-suppression. This supportive care measure has resulted in significant reduction in infection-related mortality rates in both populations.

Oral chemotherapy adherence

Non-adherence to prescribed treatment regimens is a challenge in both pediatric and adult oncology.[30] Oral corticosteroids are a key component of therapeutic regimens in both HL and ALL. In children with ALL, Bhatia and colleagues identified that <90% adherence to oral mercaptopurine over the course of therapy was associated with a 3.9-fold increased risk of relapse.[31,32] In a follow up study, non-adherence rates were quoted as high as 33% and were higher in Hispanics, blacks and teenagers.[32,33] In our ALL populations, 5-year relative survival rates were comparable across age and race, but 10-year relative survival diverged, with black and Hispanic patients having reduced long-term survival. This difference may, in part, be a reflection of more frequent late-relapses associated with non-adherence in the black and Hispanic cohorts.

Access to hematopoietic cell transplantation

Allogeneic HCT is a key treatment option for with AML and Philadelphia chromosome positive ALL, for patients with relapsed ALL and HL, and at some centers in AYAs with high-risk Philadelphia chromosome negative ALL.[29] Historically, Hispanic and African American patients are under-represented in national marrow donor registries and as a result, are less likely to undergo transplantation. In a 2006 report, Aplenc et al investigated the treatment and outcomes of black and white children with AML on a series of Children's Cancer Group (CCG) studies. Investigators noted that because of fewer available donors, black children with high-risk disease were less likely to receive HCT as consolidation therapy than white children.[7] As the field of HCT moves forward, the use of alternative donor sources may expand the donor pool for minority patients with relapsed or high-risk hematologic malignancies.[34]

Study strengths and limitations

This study includes a large number of patients from a population-based setting thus eliminating biases related to treatment/referral patterns observed in single-institution or smaller consortium-based clinical studies. Moreover, survival trends were calculated over many decades informing the kinetics of population-based survival metrics. There are important limitations in the SEER registry such as minimal disease-, treatment- and relapse-specific data. We could not assess socioeconomic determinants and indicators of access-to-care (e.g., health insurance status and treatment facility) and medication adherence, which are potential contributing factors to observed survival outcomes.

Conclusion

To date, this is the largest longitudinal analysis of race and age-related survival trends in pediatric and AYA patients with ALL, AML and HL. Our findings clearly identify a major and persistent public health disparity. Particular attention should be paid to Hispanic and black children with ALL and AML as these patients continue to suffer significantly poorer outcomes when compared to non-Hispanic white children. Similarly, characteristics that

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distinguish the unique cancer burden of AYAs with ALL and AML should be investigated and interventions aimed at improving awareness, access and quality cancer care to these patient populations should be implemented.

Acknowledgments

Supported in part by a fellowship from the NCI (R25 CA094061, JMK), an ASCO Young Investigator Award (ADV) and a William Raveis Charitable Fund Fellow of the Damon Runyon Cancer Research Foundation (DRG-117-15, ADV). This work is unfunded.

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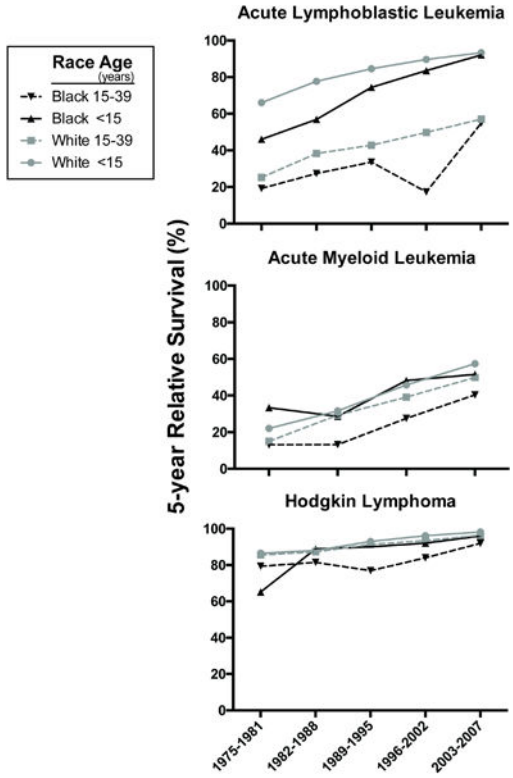

Figure 1.

Five-year relative survival by 5-year period of diagnosis and cancer site, SEER-9, 1975–2012. ALL, acute lymphoblastic leukemia; AML, acute myeloid leukemia, HL. Due to insufficient data, survival estimate for black children with HL for the time period 1989–1995 is not reported.

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Table 1

Number and proportion of children and AYAs with race, gender and distribution of acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML) and Hodgkin lymphoma (HL) in children, adolescents and young adults by race, sex, age and era of diagnosis, SEER 9, 1975–2012

	ALL		AML		HL	
	N	%	N	%	N	%
Sex						
Female	4777	58.2%	2015	50.9%	8001	53.0%
Male	3424	41.8%	1943	49.1%	7106	47.0%
Race						
White	7500	91.5%	3390	85.6%	13494	89.3%
Black	701	8.5%	568	14.4%	1613	10.7%
Era of diagnosis						
1975–1981	82	11.7%	72	12.7%	159	9.9%
1982–1988	103	14.7%	98	17.3%	217	13.5%
1989–1995	130	18.5%	89	15.7%	319	19.8%
1996–2002	143	20.4%	119	21.0%	353	21.9%
2003–2007	119	17.0%	89	15.7%	277	17.2%
2008–2012	124	17.7%	101	17.8%	288	17.9%

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Table 2

Five- and 10-year relative survival (%) and annual percentage change (APC) among children and AYAs with acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML) and Hodgkin lymphoma (HL) by race, age and era, SEER-9, 1975–2012

Age and era of diagnosis	White		Black	
	5-year (95% CI)	10-year (95% CI)	5-year (95% CI)	10-year (95% CI)
ALL, 0–14 years	N = 5497		N = 517	
1975–1981	66.0 (62.6–69.1)	57.7 (54.2–61.0)	46.0 (33.2–57.9)	37.9 (25.8–49.8)
1982–1988	77.7 (74.9–80.3)	72.2 (69.1–75.1)	56.9 (45.4–66.9)	53.3 (41.9–63.5)
1989–1995	84.5 (82.1–86.6)	80.6 (78.0–82.9)	74.4 (64.4–81.9)	68.3 (58.0–76.6)
1996–2002	89.6 (87.7–91.2)	86.8 (84.7–88.7)	83.5 (75.0–89.3)	78.1 (68.9–84.8)
2003–2007	93.3 (91.3–94.9)	–	92.0 (82.9–96.3)	
APC (95% CI)	1.37 * (1.08–1.66)	2.15 * (1.59–2.71)	3.01 * (2.09–3.93)	3.91 * (2.29–5.55)
ALL, 15–39 years	N = 2003		N = 184	
1975–1981	25.2 (20.2–30.5)	22.7 (17.9–27.9)	19.2 (6.0–38.0)	14.6 (3.6–32.7)
1982–1988	38.3 (33.3–43.4)	33.4 (28.5–38.3)	27.4 (11.2–46.6)	18.4 (5.7–36.7)
1989–1995	42.8 (37.6–47.8)	38.5 (33.4–43.5)	33.6 (18.3–49.6)	33.6 (18.3–49.6)
1996–2002	49.8 (44.7–54.7)	46.9 (41.7–51.8)	17.3 (7.0–31.4)	11.6 (3.7–24.5)
2003–2007	57.0 (51.5–62.2)	–	54.9 (39.1–68.2)	–
APC (95% CI)	3.13 * (2.18–4.08)	3.74 * (2.56–4.94)	1.25 (−0.68–3.22)	−1.26 (−3.19–0.71)
AML, 0–14 years	N = 729		N = 158	
1975–1981	22 (15.2–29.6)	18.7 (12.4–26.0)	33.4 (13.7–54.6)	33.4 (13.7–54.6)
1982–1988	31.6 (22.9–40.5)	30.6 (22.1–39.6)	28.6 (11.7–48.2)	28.6 (11.7–48.2)
1989–1995	45.8 (37.4–53.8)	44.4 (36.1–52.4)	48.2 (28.7–65.3)	44.5 (25.6–61.9)
1996–2002	57.4 (49.2–64.8)	54.8 (46.6–62.3)	51.5 (34.0–66.5)	48.9 (31.6–64.1)
2003–2007	71.2 (61.2–79.0)	–	53.6 (33.8–69.9)	–
APC (95% CI)	4.58 * (3.69–5.48)	5.47 * (3.83–7.14)	0.31 (−0.86–1.49)	0.01 (−1.31–1.35)
AML, 15–39 years	N = 2661		N = 410	
1975–1981	15.0 (12.0–18.3)	12.8 (10.0–16.0)	13.1 (5.7–23.5)	11.3 (4.6–21.4)
1982–1988	29.3 (25.1–33.5)	25.4 (21.5–29.5)	13.2 (6.8–21.8)	11.9 (5.9–20.4)
1989–1995	39.1 (34.6–43.5)	35.3 (31–39.7)	27.5 (17.0–39.0)	27.5 (17.0–39.0)
1996–2002	49.9 (45.5–54.1)	46.7 (42.4–51)	40.4 (29.7–50.7)	38 (27.5–48.4)
2003–2007	55.1 (49.7–60.2)	–	37.6 (25.5–49.6)	–
APC (95% CI)	5.10 * (4.15–6.06)	6.67 * (5.13–8.22)	2.07 * (0.41–3.75)	2.55 * (0.12–5.04)
HL, 0–14 years	N = 973		N = 146	
1975–1981	86.5 (81.2–90.4)	81.7 (75.8–86.3)	65.2 (40.4–81.8)	55.4 (31.5–74.0)
1982–1988	88.0 (82.2–92.1)	84.9 (78.5–89.5)	88.9 (62.4–97.1)	88.9 (62.4–97.1)
1989–1995	93.0 (87.8–96.0)	91.5 (85.9–94.9)	~	~
1996–2002	96.2 (92.0–98.2)	94.8 (90.1–97.3)	92.1 (71.5–98.0)	92.1 (71.5–98.0)

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Age and era of diagnosis	White		Black	
	5-year (95% CI)	10-year (95% CI)	5-year (95% CI)	10-year (95% CI)
2003–2007	98.2 (92.7–99.6)	–	96.0 (74.8–99.4)	–
APC (95% CI)	0.55* (0.29–0.80)	0.81* (0.39–1.23)	0.78 (−0.08–1.66)	2.40* (1.16–3.66)
HL, 15–39 years	N = 12521		N = 1467	
1975–1981	85.5 (83.9–87.0)	78.3 (76.4–80.1)	79.4 (71.4–85.4)	66.2 (57.3–73.8)
1982–1988	87.3 (85.9–88.6)	81.9 (80.3–83.4)	81.5 (75.1–86.5)	77.3 (70.3–82.9)
1989–1995	91.3 (90.1–92.4)	87.5 (86.0–88.8)	76.9 (71.5–81.4)	69.1 (63.2–74.2)
1996–2002	93.5 (92.4–94.5)	91.1 (89.7–92.3)	84.0 (79.4–87.7)	80.5 (75.5–84.6)
2003–2007	96.4 (95.3–97.3)	–	92.0 (87.6–94.9)	–
APC (95% CI)	0.44* (0.37–0.51)	0.73* (0.61–0.86)	0.38* (0.13–0.63)	0.53 (−0.06–1.12)

*, APC is significant at P< 0.05; -, Survival estimate not available due to insufficient number of patients

APC for 5-year survival was calculated based on data from 1975–2007; APC for 10-year survival was calculated based on data from 1975–2002.

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Table 3

Five-and ten-year relative survival (%) with 95% confidence intervals (CI) among children and AYAs with acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML) and Hodgkin lymphoma (HL) by race, age, and era, SEER-13, 1992–2007

Age and era of diagnosis	Non-Hispanic White		Hispanic	
ALL, 0–14 years	N = 3180		N = 2343	
1992–1995	87.3 (84.4–89.7)	84.4 (81.2–87.1)	78.4 (73.8–82.3)	76.5 (71.7–80.5)
1996–1999	90.1 (87.6–92.2)	86.8 (84–89.2)	83.1 (79.1–86.5)	78.4 (74.1–82.2)
2000–2003	93.3 (91–95.1)	90.9 (88.2–93)	84.5 (80.8–87.6)	79.1 (74.9–82.7)
2004–2007	92.9 (90.5–94.7)	–	88.3 (85–90.9)	–
ALL, 15–39 years	N=1100		N=1060	
1992–1995	47.5 (40.7–54)	3.1 (36.4–49.6)	37.8 (29.3–46.3)	33.7 (25.4–42.2)
1996–1999	56.1 (49–62.7)	53 (45.7–59.7)	38.9 (31–46.6)	35.5 (27.8–43.2)
2000–2003	51.5 (44.9–57.8)	50.3 (43.6–56.7)	42 (34.7–49.2)	34.4 (27.3–41.6)
2004–2007	62.4 (55.4–68.7)	–	46.9 (40.8–52.8)	–
AML, 0–14 years	N=425		N=292	
1992–1995	47.6 (36.8–57.6)	45.3 (34.7–55.4)	46.8 (32.3–59.9)	46.8 (32.3–59.9)
1996–1999	57.5 (47.2–66.4)	56.6 (46.3–65.6)	44.5 (31–57.1)	44.5 (31–57.1)
2000–2003	58.8 (47.2–68.7)	56.3 (44.7–66.3)	59.4 (44–71.9)	54.4 (38.8–67.6)
2004–2007	80.6 (69.3–88.0)	–	63.5 (49.7–74.5)	–
AML, 15–39 years	N=1504		N=810	
1992–1995	43 (37.5–48.4)	39.4 (33.9–44.8)	36.7 (27.9–45.6)	34.9 (26.2–43.8)
1996–1999	49.3 (43.2–55.2)	46.2 (40.1–52.1)	47.9 (39.7–55.6)	45.1 (36.8–53)
2000–2003	56.2 (50.3–61.7)	53.7 (47.8–59.3)	46.1 (38.1–53.7)	41.5 (33.4–49.3)
2004–2007	54.7 (48.5–60.6)	–	51.8 (43.6–59.3)	–
HL, 0–14 years	N=498		N=286	
1992–1995	90.9(82.3–95.4)	89.7 (81–94.6)	92.2 (80.2–97.1)	88.4 (75.5–94.7)
1996–1999	94.8(88.6–97.7)	92.5 (85.5–96.2)	98.1 (87–99.7)	98.1 (87–99.7)
2000–2003	98 (92–99.5)	96.2 (89.3–98.7)	87.7 (75.7–94)	85.8 (73.3–92.7)
2004–2007	97.7(90.8–99.5)	–	–	–
HL, 15–39 years	N=7481		N=1595	
1992–1995	92.3(90.9–93.6)	89.4 (87.6–90.8)	86.3 (81.1–90.1)	79.8 (73.9–84.5)
1996–1999	93.4(91.9–94.6)	91.1 (89.4–92.5)	88.8 (84.4–92)	83.3 (78.2–87.3)
2000–2003	94.6(93.2–95.7)	92.3 (90.6–93.7)	92.2 (88.2–94.9)	87.8 (82.8–91.4)
2004–2007	96.6(95.5–97.5)	–	93.9 (90.5–96.1)	–