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Disparities in survival of hematologic malignancies in the context of social determinants of health: a systematic review

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Social determinants of health (SDHs) have been reported as relevant factors responsible for health inequity. We sought to assess clinical data from observational studies conducted in the United States evaluating the impact of SDHs on the outcomes of patients with hematologic malignancies. Thus, we performed a systematic review in 6 databases on 1 September 2021, in which paired reviewers independently screened studies and included data from 41 studies. We assessed the risk of bias using the Joanna Briggs Institute appraisal tools and analyzed the data using a descriptive synthesis. The most common SDH domains explored were health care access and quality (54.3%) and economic stability (25.6%); others investigated were education (19%) and social and community context (7.8%). We identified strong evidence of 5 variables significantly affecting survival: lack of health insurance coverage or having Medicare or Medicaid insurance, receiving cancer treatment at a nonacademic facility, low household income, low education level, and being unmarried. In contrast, the reports on the effect of distance traveled to the treatment center are contradictory. Other SDHs examined were facility volume, provider expertise, poverty, and employment rates. We identified a lack of data in the literature in terms of transportation, debt, higher education, diet, social integration, environmental factors, or stress. Our results underscore the complex nature of social, financial, and health care barriers as intercorrelated variables. Therefore, the management of hematologic malignancies needs concerted efforts to incorporate SDHs into clinical care, research, and public health policies, identifying and addressing the barriers at a patient-based level to enhance outcome equity (PROSPERO CRD42022346854)

Introduction

Over the last decades, there have been significant improvements in the survival expectation of patients with hematologic malignancies.[1] Such progress in outcomes has been possible through a combination of advances in cancer biology research, the implementation of more accurate risk and prognostic scoring systems, and the breakthrough of novel drugs and subsequent lines of therapies.[2,3] Nevertheless, this enhancement has not been experienced equally across all populations, and certain groups experience disproportionately higher mortality rates.[4]

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Data that support the findings of this study are available on request from the corresponding author, Jorge E. Cortes (jorge.cortes@augusta.edu).

The full-text version of this article contains a data supplement.

The prevalence of cancer outcome inequity can be attributed to the complex interaction among multiple aspects, including genetic factors, health behaviors, and social determinants of health (SDHs).[5] SDHs are defined as the set of nonbiological factors and systems that shape the environment of daily life, such as the conditions where people are born, grow, work, live, and age, and affect health outcomes. SDHs are categorized into 5 key domains: health care access and quality, education access and quality, social and community context, economic stability, and neighborhood and built environment.[6]

Economic instability, a lower education level, decreased access to health care, residential segregation, discrimination, and a lack of social support systems have been linked to lower cancer screening rates, diagnosis at advanced stages, and worse cancer survival.[7-10] Although that evidence has enormously contributed to our understanding of the factors that underlie the inequity, the studies reporting on this topic have varied on the specific SDH analyzed, the scope and size of the population studied, and the reported influence of SDHs.

To better assess the impact of SDHs on cancer-treatment outcomes, we performed a systematic review to understand the degree to which multiple factors may contribute to cancer outcome disparities. Identifying these influences is an important step in building strategies and interventions to address the SDHs and accelerate progress toward health equity in cancer. Our broad review included all cancer types, and this article focused on reporting the findings for hematologic malignancies affecting adult patients.

Methods

We conducted and reported this systematic review in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines (supplemental Tables 1 and 2).[11] We registered our protocol at the Prospective Register of Systematic Reviews, which can be accessed through the registration number CRD42022346854.

Eligibility criteria

We based our inclusion criteria on the PECOS approach (population, exposure, comparison, outcome), consisting of observational studies investigating any SDH's impact on cancer-treatment survival. Because of the cross-national differences in social behaviors, economic conditions, and education and health systems, we limited our review to those studies, including only data from the United States from 2002 onward. We focused our review on recognizing actionable SDHs that clinicians could identify and address in routine clinical practice. Thus, we excluded studies for the following reasons: (1) studies that evaluated sex, age, race/ethnicity, geography, and rurality as SDH; (2) studies that did not assess the relationship between SDHs and cancer survival; (3) studies in which the results according to cancer type cannot be individualized; (4) studies written in languages other than English; and (5) reviews, letters, conference articles, personal opinions, and book chapters.

Information sources and search strategy

We performed a customized literature search using PubMed, Cochrane, EMBASE, Scopus, and the Web of Science databases. We conducted an additional search in the gray literature using Google Scholar and examined the reference lists of included studies (supplemental Table 3). Our searches included articles published on or after 1 January 2002 until 1 September 2022. We used the reference manager software EndNote 20.2.1 (Clarivate Analytics)[12] to export references and remove duplicate articles.

Studies selection process

We identified relevant studies in 2 phases. In phase 1, we imported references into Rayyan Systems Inc software,[13] where 2 authors (M.M.G. and K.C.T.) independently screened the titles and abstracts for eligibility. We excluded those articles that did not meet our inclusion criteria. In phase 2, we accessed the full text of the selected studies independently by the same 2 reviewers. We resolved disagreements in any phase by discussion among reviewers and, when necessary, arbitration by a third author (J.E.C.) (supplemental Table 4).

Data collection process and data items

One author (M.M.G.) extracted the data from the studies that fulfilled the inclusion criteria through the NVivo software. The second author (K.C.T.) cross-checked the data and verified their accuracy, and other authors (J.E.C., E.A. B., and G. A.) were involved when necessary, according to their area of expertise.

Risk of bias by individual studies

We independently assessed the risk of bias for the included studies by 2 reviewers (M.M.G. and K.C.T.) using the Joanna Briggs Institute checklist for analytical cross-sectional studies.[14] We categorized the studies according to the scores of items "yes" as high risk (<49%), moderate risk (50%-69%), and low risk (>70%).

Effect measures

Our outcomes were any cancer-treatment survival measures, such as early mortality, disease-free survival, cancer-specific survival, and overall survival (OS).

Synthesis of results

We conducted a qualitative synthesis of the data by categorizing studies across the 5 domains of SDH.[6] We next grouped the results into the following categories: (1) significant association between SDH and any cancer-treatment survival in multivariable-adjusted analysis, (2) significant association in multivariable-adjusted analysis only in a subgroup of the study population (such as according to age or cancer subtype), (3) significant association only in the unadjusted analysis, and (4) not significant association. We considered significant any association that was found to be statistically significant, between SDHs and survival by the authors of each manuscript. In case the statistical significance criterion was not described in the manuscript, we set the statistical significance as confidence intervals of hazard ratio not including 1. Because of the variability of methods, we did not attempt a uniform definition. For cases in which multiple SDHs, types of cancer, databases, and/or outcomes were studied, we extracted results for each variable separately and reported them individually. We presented the outcomes as hazard ratio with stated confidence interval as measures of significance.

Results

Study selection

We identified 38 654 records from the electronic databases we searched. These were reduced to 15 319 after removing duplicate studies. After screening of the title and abstract, 1477 records meet our inclusion criteria. We excluded 719 reports that presented data from countries other than the United States. We then selected the 28 studies that assessed hematologic malignancies in adult patients. In addition, we retrieved 13 additional studies from the reference list. After reading the full text, we retained 41 studies for data extraction (supplemental Figure 1).

Characteristics of included studies

Twenty-five of the 41 studies we included in our analysis evaluated national cohorts (61%), whereas 8 comprised state data studies (19.5%) and 6 single-center cohorts (14.6%). Two studies (4.9%) analyzed 2 different cohorts, national and institutional data. Studies used multiple data sources, including 17 studies evaluating the nationwide US databases, such as the National Cancer Database (NCDB; 41.5%), 7 used the Surveillance, Epidemiology, and End Results (SEER; 17.1%), and 1 used the Center for International Blood and Marrow Transplant Research (CIBMTR; 2.4%). State studies assessed cancer registries: 4 studies from California (11.1%), 1 from Florida (2.2%), 1 from New York (2.2%), 1 from North Carolina (2.2%), and 1 from Virginia (2.2%). Institutional studies retrieved data from the patients' medical records.

Owing to the diversity of study settings, the sample size ranges widely, from 95 to 132 402 patients (mean, 24 353; SD, 32 330), with a median value of 7073 (IQR, 3461-42 718). Overall, studies addressed the impact of SDHs on cancer outcomes for a variety of hematologic malignancies as follows: lymphoma in 16 studies (34.1%), myeloma in 11 (31.7%), and leukemia in 14 (34.2%). Five studies analyzed a mixed group of patients, in which 4 studies evaluated 2 cancer types and 1 evaluated 4 types of hematologic malignancies.

Most of the studies in our analysis (n = 30, 73.2%) examined more than 1 SDH, ranging from 1 to 8. Thus, this systematic review covered the analysis from 132 variables (median, 2; IQR, 2-4) of SDHs assessed in the 41 included manuscripts. The most common SDH domains explored were health care access and quality (n = 70, 53%) and economic stability (n = 33, 25%); others investigated were education (n = 19, 14.4%) and social and community context (n = 10, 7.6%). Although most of the studies evaluated a unique outcome (n = 28, 68.3%), 12 studies explored 2 outcomes (29.3%), and 1 assessed 3 outcomes (2.4%). The primary outcome was OS in 41 studies (73.2%). Other outcomes measured less frequently were early mortality in 6 studies (10.7%), cancer-specific survival in 5 (8.9%), progression-free survival in 2 (3.6%), disease-free survival in 1 (1.8%), and transplant-related mortality in 1 (1.8%) (supplemental Tables 5 and 6).

Risk of bias

The risk of bias from individual studies had low risk except for 1 study that was considered a moderate risk (supplemental Figure 2).

Synthesis of results

We presented the synthesis of our results in Tables 1-4 and Figure 1.

Health care access and quality. Included studies encompassed a variety of variables to evaluate health care access and quality, including health insurance coverage (n = 33, 47.1%), treatment facility type (n = 20, 28.5%), distance traveled from residence to treatment facility (n = 11, 15.7%), provider case volume (n = 4, 5.7%), and provider expertise (n = 2, 2.8%) (supplemental Table 6).

HEALTH INSURANCE COVERAGE. Health insurance coverage at diagnosis was the most studied SDH across all included manuscripts. There was variability in the grouping of insurance status across studies. However, broadly, the cohorts were compared in terms of private, or managed care vs uninsured, Medicare or Medicaid. Most studies (n = 30, 90.9%) found a significant association between health insurance coverage and survival in multivariable, univariate, and/or subgroup analysis. Overall, patients with Medicaid, Medicare, or other government insurance or who are uninsured have inferior survival rates compared with those with private or military insurance coverage. Of note, one of these studies reported that the difference was significant only in univariate analysis. Data source from that study was single-center data with a small sample size (652 patients) compared with other studies included.[15] In 3 out of the 30 studies, insurance coverage influenced survival only in patients younger than 65 years old.[16-18] In contrast, 3 studies (9.1%) reported no association between insurance status and cancer outcomes, including 2 studies of acute myeloid leukemia (AML)[19,20] and 1 of non-Hodgkin lymphoma (NHL)[21] (Table 1).

FACILITY TYPE. Twenty studies examined the impact of the type of facility on cancer outcome, including treatment facility type (n = 18, 64.3%), being diagnosed at National Cancer Institute (NCI)–designated cancer centers (n = 1, 3.6%), and access to NCI- and National Comprehensive Cancer Network (NCCN)–designated cancer centers (n = 1, 3.6%). Fourteen of 18 studies (77.8%) demonstrated a significant improvement in early and OS for patients treated at academic/research cancer centers compared with those receiving treatment at community cancer centers, comprehensive community cancer centers, or integrated network cancer programs. Of those, 1 study for NHL[22] found a statistically significant association in unadjusted analysis for patients treated at academic cancer centers (vs nonacademic centers) that was not confirmed in multivariate analysis. Three studies described significant association in multivariable-adjusted analysis only in subgroup analysis. Two of them[17,18] observed that treatment facility type influenced survival in patients older than 65, but this difference did not translate to patients younger. Another study[23] classified plasmacytomas as originating in bone (P-bone) or extramedullary tissue (P-EM) and noted a significant association between facility type and mortality only in the P-bone cohort.

Two studies[24,25] evaluated and reported better outcomes among patients treated at NCI–designated cancer centers vs non-NCI–designated cancer centers. However, one other study[26] did not observe differences in survival rates based on whether patients were diagnosed at an NCI–designated cancer center or not. In 1 study exploring the impact of NCI/NCCN CC access on outcomes of patients with multiple myeloma (MM),[27] access to 1 NCCN CC or 2 or more NCI CCs correlated with OS improvement in a multivariable-adjusted analysis. Finally, 1 study[28] established that patients diagnosed and treated at the same facility had an increased risk of death than those diagnosed at one facility and treated at another (Table 2).

Table 1. Summary of descriptive characteristics of included studies evaluating health insurance coverage (n = 33)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Yung et al,[19] (2011)	NYSCR 2001–2008	NY	HL 4752	OS/multi	Non-Medicaid Medicaid	Ref. 1.98 (1.47-2.68)*	Medicaid
	CCR 2000–2007	CA	HL 4752	OS/multi	Non-Medicaid Medicaid	Ref. 1.89 (1.43-2.49)*	Medicaid
Parikh et al,[39] (2015)	NCDB 1998-2011	National	HL 45 777	OS/multi	Uninsured Private Medicaid Medicare	Ref. 0.58 (0.49-0.69)* 1.60 (1.34-1.91)* 1.05 (0.70-1.60)	Uninsured and Medicaid
Abodunrin (2022)	SEER 2007-2015	National	NHL 44 609	OS/multi	Private Public Uninsured	Ref. 2.11 (2.00-2.24)* 1.76 (1.62-1.91)*	Public insurance and uninsured
Goldstein et al,[21] (2019)	NCDB 2004-2014	National	NHL <65 y.o. 22 133	OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.96 (1.69-2.28)* 1.83 (1.57-2.12)* 1.96 (1.71-2.24)*	Uninsured, Medicaid, and Medicare
			NHL. ≥65 y.o. 21 515	OS/multi	Private Medicare	Ref. 1.28 (1.17-1.4)*	Medicare
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	1-month mortality/multi	Private Medicaid Medicare Uninsured	Ref. 1.60 (1.34-1.92)* 1.75 (1.57-1.94)* 1.77 (1.43-2.19)*	Medicaid, Medicare, and uninsured
				OS/multi	Private Medicaid Medicare Uninsured Other government	Ref. 1.61 (1.53-1.70)* 1.66 (1.61-1.71)* 1.44 (1.35-1.54)* 1.29 (1.17-1.43)*	Medicaid, Medicare, uninsured, and other government insurance
Go (2016)	NCDB 1998-2011	National	NHL 278 985	OS/multi	Private Medicare Medicaid Government Uninsured	Ref. 1.66 (1.64-1.69)† 1.74 (1.70-1.79)† 1.16 (1.07-1.25)† 1.37 (1.34-1.40)†	Medicare, Medicaid, government insurance, and uninsured
Han (2014)	NCDB 2004-2010	National	NHL 3858	OS/multi	Private Uninsured Medicaid	Ref. 1.18 (0.96-1.44) 1.27 (1.06-1.53)†	Medicaid
Shah (2019)	NCDB 2004-2013	National	NHL 18 120	OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.44 (1.22-1.70)* 1.33 (1.15-1.54)* 1.05 (0.98-1.13)	Uninsured and Medicaid
Tao et al,[25] (2014)	CCR 2001-2009	CA	NHL	CSS/multi	Private/military Public/uninsured	Ref. 1.46 (1.30-1.63)*	Public insurance or uninsured
			16 133	OS/multi	Private/military Public/uninsured	Ref. 1.54 (1.40-1.69)*	Public insurance or uninsured

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NC CCR, North Carolina Central Cancer Registry; NCDB, National Cancer Database; NHL, non-Hodgkin lymphoma; NJ, New Jersey; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York State Cancer Registry; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; suppl., supplement; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 1 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Ermann (2020)	NCDB 2004-2015	National	NHL 27 690	OS/multi	Uninsured Private Medicaid Medicare	Ref. 0.71 (NS)* 1.25 (NS)* 1.76 (NS)*	Uninsured, Medicaid, and Medicare
Goldstein et al,[21] (2019)	NCDB 2004–2014	National	NHL aged <65 y.o. 314	OS/multi	Private Uninsured Medicaid Medicare	Ref. 0.85 (0.4-1.6) 0.78 (0.5-1.2) 1.2 (0.7-2.1)	-
			NH aged ≥65 161	OS/multi	Private Medicaid Medicare	Ref. 1.49 (0.1-14.8) 1.34 (0.4-4.3)	-
Chohan et al,[18] (2022)	NCDB 2004-2017	National	WM <65 y.o. 1249	OS/multi	Private Uninsured Medicaid Medicare	Ref. 3.11 (1.77-5.45)* 1.88 (1.01-3.48)* 2.78 (1.76-4.38)*	Uninsured, Medicare, and Medicaid
			WM ≥65 y.o. 2629	OS/multi	Private Uninsured Medicaid Medicare	Ref. 0.25 (0.03-1.77) 1.05 (0.45-2.43) 1.08 (0.85-1.36)	-
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3064	OS/multi	Private Government Uninsured	Ref. 1.31 (1.07-1.59)* 1.50 (0.91-1.47)	Government insurance
Goldstein et al,[21] (2019)	NCDB 2004–2014	National	BL < 65 y.o. 5235	OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.44 (1.2-1.7)* 1.22 (1.0-1.4)* 1.53 (1.2-1.9)*	Uninsured, Medicaid, and Medicare
			BL ≥ 65 y.o. 1838	OS/multi	Private Uninsured Medicaid Medicare	Ref. 8.38 (2.5-28.3)* 0.75 (0.3-1.8) 1.29 (0.9-1.8)	Uninsured
Fiala et al,[15] (2015)	Institutional 2000-2009	MO	MM 652	OS/Uni	Private Medicare Medicaid Uninsured	67.5 mo 37.5 mo* 38.3 mo* 59.0 mo*	Uninsured, Medicaid, and Medicare
				OS/multi	Private Medicare Medicaid Uninsured	Ref. 0.74 (0.53-1.03) 1.22 (0.70-2.14) 1.59 (0.94-2.70)	-
Makhani (2021)	SEER 2007-2016	National	MM. 41 789	CSS/multi	Private Uninsured Medicaid Insurance	Ref. 1.26 (1.11-1.42)* 1.44 (1.36-1.53)* 1.11 (1.06-1.17)	Medicaid and uninsured
Jayakrishnan (2021)	NCDB 2004-2016	National	MM 50 543	OS/multi	Uninsured Private Medicaid Medicare	Ref. 0.83 (0.78-0.89)* 1.09 (1.01-1.17)* 0.90 (0.84-0.96)*	Uninsured and Medicaid

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NC CCR, North Carolina Central Cancer Registry; NCDB, National Cancer Database; NHL, non-Hodgkin lymphoma; NJ, New Jersey; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York State Cancer Registry; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; suppl., supplement; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Ho et al,[24] (2017)	CCR 1999-2012	CA	MM 6359	60-day mortality	Private Medicare Public Uninsured	Ref. 1.07 (0.88-1.30) 1.08 (0.81-1.44) 2.44 (1.45-4.13)*	Uninsured
Chamoun (2021)	NCDB 2005-2014	National	MM 117 926	OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.62 (1.32-1.99)* 1.59 (1.36-1.87)* 1.09 (0.99-1.2)	Medicaid and uninsured
Huang et al,[31] (2021)	SEER 2007-2016	National	MM 17 981	CSS/multi	Insured Uninsured Medicaid	Ref. 1.13 (1.00-1.28)* 1.25 (1.16-1.36)*	Uninsured and Medicaid
				OS/multi	Insured Uninsured Medicaid	Ref. 1.33 (1.20-1.48)* 1.67 (1.56-1.78)*	Uninsured and Medicaid
Costa et al,[37] (2016)	SEER 2007-2012	National	MM 10 161	12-month mortality	Insured Medicaid Uninsured	Ref. 2.04 (1.74-2.41)* 1.72 (1.34-2.19)*	Medicaid and uninsured
				OS/multi	Insured Medicaid Uninsured	Ref. 1.76 (1.59-1.94)* 1.43 (1.23-1.67)*	Medicaid and uninsured
Ghiassi-Nejad et al,[23] (2019)	NCDB 2004-2013	National	PM P-bone 4056	OS/Multi.	Uninsured Private Government	Ref. 0.70 (0.48-0.98)* 1.02 (0.72-1.46)	Uninsured
			PM P-EM 1468	OS/multi	Uninsured Private Government	Ref. 0.44 (0.26-0.73)* 0.64 (0.37-1.09)	Uninsured
Yung et al,[19] (2011)	NYSCR 2001–2008	NY	AML 3506	OS/multi	Non-Medicaid Medicaid	Ref. 1.00 (0.84-1.19)	-
	CCR 2000–2007	CA	AML 3506	OS/multi	Non-Medicaid Medicaid	Ref. 1.02 (0.89-1.16)	-
Bhatt (2017)	NCDB 2003-2011	National	AML 60 738	1-month mortality/multi	Private Uninsured Medicaid Medicare	Ref. 2.02 (1.80-2.27)* 1.05 (0.94-1.16) 1.29 (1.21-1.37)*	Uninsured and Medicare
				OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.18 (1.12-1.25)* 1.11 (1.07-1.16)* 1.20 (1.17-1.23)*	Uninsured, Medicaid, and Medicare
Byrne et al,[35] (2011)	FCDS 1998-2002	FL	AML 4659	OS/multi	Private Uninsured Medicare Medicaid	Ref. 1.08 (0.83-1.39) 0.97 (0.87-1.07) 1.25 (1.06-1.47)*	Medicaid

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NC CCR, North Carolina Central Cancer Registry; NCDB, National Cancer Database; NHL, non-Hodgkin lymphoma; NJ, New Jersey; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York State Cancer Registry; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; suppl., supplement; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML 900	OS/multi	Private Medicare Medicaid	Ref. 0.91 (0.71-1.17) 1.36 (1.00-1.85)*	Medicaid
Borate et al,[38] (2015)	SEER 2007-2011	National	AML 5541	2-month mortality	Insured Medicaid Uninsured	Ref. OR. 1.34 (1.07-1.66)* 1.99 (1.46-2.73)*	Medicaid and uninsured
				OS/multi	Insured Medicaid Uninsured	Ref. 1.24 (1.13-1.37)* 1.24 (1.07-1.44)*	Medicaid and uninsured
Bradley et al,[34] (2011)	VCR/VHI 1999-2006	VA	AML No CTX NS	OS/multi	Private/military Uninsured Public	Ref. 1.29 (1.02-1.84)* 1.39 (1.02-1.88)*	Uninsured and public
			AML CTX NS	OS/multi	Private/military Uninsured Public	Ref. 1.07 (0.74-1.54) 1.31 (0.96-1.77)	-
Master et al,[28] (2016)	NCDB 1998-2012	National	AML 67 443	OS/multi	Private Uninsured Medicaid Medicare	Ref. 1.20 (1.14-1.27)* 1.16 (1.12-1.22)* 1.19 (1.15-1.23)*	Medicaid, uninsured and Medicare
Al-Ameri et al,[20] (2014)	Institutional 2002-2010	OH	AML/MDS 94	OS/multi	Private Medicaid/Medicare Medicare with suppl.	Ref. 0.61 (0.33-1.13) 0.93 (0.49-1.76)	-
Dhakal et al,[17] (2022)	NCDB 2004-2015	National	APL < 65 y.o. 5380	1-month mortality	Private Medicaid Medicare Uninsured	Ref. 1.14 (0.86-1.51) 1.78 (1.29-2.47)* 2.31 (1.61-3.32)*	Medicare and uninsured
			APL ≥ 65 y.o. 1520	1-month mortality	Private Nonprivate	Ref. 1.16 (0.76-1.77)	-
			APL < 65 y.o. 5380	OS/multi	Private Medicaid Medicare Uninsured	Ref. 1.40 (1.19-1.64)* 1.89 (1.58-2.26)* 1.24 (0.96-1.60)	Medicaid and Medicare
			APL ≥ 65 y.o. 1520	OS/multi	Private Nonprivate	Ref. 0.86-1.33	-
Krakora (2020)	Institutional 2007-2017	NJ	ALL 136	PFS/multi	Insured Uninsured	Ref. 3.31 (1.53-7.17)*	Uninsured
				OS/multi	Insured Uninsured	Ref. 1.84 (0.92-3.66)	-
Perry et al,[16] (2017)	SEER 2007-2012	National	CML 15-64 y.o. 3626	OS/multi	Insured Medicaid Uninsured	Ref. 1.83 (1.39-2.40)* 1.93 (1.40-2.66)*	Uninsured or Medicaid
			CML ≥ 65 y.o. 2142	OS/multi	Insured Medicaid	Ref. 1.26 (1.00-1.64)	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NC CCR, North Carolina Central Cancer Registry; NCDB, National Cancer Database; NHL, non-Hodgkin lymphoma; NJ, New Jersey; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York State Cancer Registry; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; suppl., supplement; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 2. Summary of descriptive characteristics of included studies evaluating facility type and characteristics (n = 20), distance traveled to treatment center (n = 11), treatment facility volume (n = 4), and provider expertise (n = 2)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Treatment facility type and characteristics							
Parikh et al,[39] (2015)	NCDB 1998-2011	National	HL 45 777	OS/multi	Community Comprehensive Academic	Ref. 0.89 (0.79-1.01) 0.78 (0.69-0.89)*	Treatment at community center
Patel et al,[5] (2022)	Institutional 2007-2020	TX	NHL. 95	PFS at 2 years	Public Hospital NCI-CCC	56% 43%	-
				OS at 2 years	Public Hospital NCI-CCC	77% 55%	-
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	1-month mortality/uni	Academic Nonacademic	Data not showed	Treatment at nonacademic center
				1-month mortality/multi	Academic Nonacademic	Ref. 0.95 (0.86-1.06)	-
				OS/uni	Academic Nonacademic	95 vs 78 months*	Treatment at nonacademic center
				OS/multi	Academic Non-academic	Ref. 1.01 (0.97-1.05)	-
Go (2016)	NCDB 1998-2011	National	NHL 278 985	OS/multi	Academic Comprehensive Community	Ref. 1.05 (1.04-1.07)† 1.03 (1.01-1.06)†	Treatment at comprehensive or community center
Shah (2019)	NCDB 2004-2013	National	NHL 18 120	OS/multi	Academic Community Comprehensive	Ref. 1.12 (1.03-1.22)* 1.06 (1.00-1.12)*	Treatment at community or comprehensive center
Ermann (2020)	NCDB 2004-2015	National	NHL 27 690	OS/multi	Nonacademic Academic	Ref. 0.86 (NS)	Treatment at nonacademic center
Tao et al,[25] (2014)	CCR. 2001-2009	CA	NHL 16 133	CSS/multi	Non-NCI NCI-designated	Ref. 0.90 (0.84-0.96)	Treatment at non–NCI-designated center
				OS/multi	No NCI-designated NCI-designated	Ref. 0.96 (0.90-1.01)	Treatment at non–NCI-designated center
Ai et al,[26] (2012)	CCR. 2001-2008	CA	NHL 213	OS/multi	Dx at no NCI-CCC Dx at NCI-CCC	Ref. 0.96 (0.59-1.54)	-
Chohan et al,[18] (2022)	NCDB 2005-2014	National	WM. <65 y.o. 1249	OS/uni	Community Academic	Ref. 0.81 (0.60-1.11)	-
				OS/multi	Community Academic	Ref. 0.90 (0.62-1.30)	-
			WM ≥65 y.o. 2629	OS/uni	Community Academic	Ref. 0.86 (0.75-0.97)	Treatment at community center
				OS/multi	Community Academic	Ref. 0.93 (0.80-1.08)	-
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3064	OS/multi	Academic Non-academic	Ref. 0.90 (0.77-1.05)	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CLL, chronic lymphocytic leukemia; CSS, cancer-specific survival; Dx, diagnosis; HL, Hodgkin lymphoma; HR, Hazard Ratio; MM, Multiple myeloma; MN, Minnesota; multi, Multivariate analysis; N, Sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NCCN, National Comprehensive Cancer Network; NCI-CCC, National Cancer Institute–designated comprehensive cancer center; NHL, non-Hodgkin Lymphoma; NS, not specified; OH, Ohio; P-bone, plasmacytoma originating in bone; P-EM, pasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; SLL, small lymphocytic lymphoma; TX, Texas; Tx, treatment; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 2 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Jayakrishnan (2021)	NCDB. 2004-2016	National	MM 50 543	OS/multi	Community Comprehensive Academic	Ref. 1.1 (0.97-1.05) 0.95 (0.91-0.98)*	Treatment at community center
Ho et al,[24] (2017)	CCR 1999-2012	CA	MM 6359	1-month mortality/multi	Private Kaiser NCI-designated Teaching	Ref. 0.91 (0.73-1.14) 0.45 (0.36-0.56)* 0.92 (0.72-1.19)	Treatment at private hospital
Chamoun (2021)	NCDB 2005-2014	National	MM 117 926	OS/multi	Academic Other types	Ref. 1.49 (1.39-1.59)*	Treatment at community, comprehensive, or integrated center
Ailawadhi (2016)‡	SEER-18 2003-2011	National	MM 34 529	OS/multi	0 NCI centers 1 NCI centers ≥ 2 NCI centers	Ref. 0.99 (0.95-1.04) 0.88 (0.84-0.93)*	No access to NCI centers
					0 NCCN centers 1 NCCN centers	Ref. 0.91 (0.86-0.95)*	No access to NCCN centers
Ghiassi-Nejad et al,[23] (2019)	NCDB 2004-2013	National	PM P-bone 4056	OS/multi	Community Comprehensive Academic/research Integrated	Ref. 0.95 (0.79-1.15) 0.76 (0.62-0.92)* 0.97 (0.77-1.22)	Treatment at community center
			PM P-EM 1468	OS/multi	Community Comprehensive Academic/research Integrated	Ref. 1.38 (0.98-1.93) 1.29 (0.90-1.84) 1.48 (0.98-2.24)	-
Master et al,[28] (2016)	NCDB 1998 -2012	National	AML 67 443	OS/multi	Same facility Different facility	Ref. 0.87 (0.85-0.89)†	Diagnosed and treated at the same facility
Bhatt (2017)	NCDB 2003-2011	National	AML 60 738	1-month/multi	Academic Nonacademic	Ref. 1.52 (1.46-1.59)*	Treatment at nonacademic center
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML 553	OS/multi	Tx at NCI-CCC Non-NCI-CCC	Ref. 1.25 (0.95-1.65)	-
Master et al,[28] (2016)	NCDB 1998 -2012	National	AML 67 443	OS/multi	Academic Community Comprehensive	Ref. 1.02 (0.98-1.07) 1.04 (1.02-1.06)†	Treatment at comprehensive center
Dhakal et al,[17] (2022)	NCDB 2004-2015	National	APL <65 y.o. 5380	1-month mortality	Academic Community Comprehensive	Ref. 0.92 (0.37-2.28) 1.18 (0.89-1.57)	-
			APL ≥65 y.o. 1520	1-month mortality	Academic Community Comprehensive	Ref. 1.16 (0.53-2.50) 1.53 (1.14-2.04)*	Treatment at comprehensive center
			APL <65 y.o. 5380	OS/multi	Academic Community Comprehensive	Ref. 0.77 (0.47-1.28) 1.06 (0.90-1.24)	-
			APL ≥65 y.o. 1520	OS/multi	Academic Community Comprehensive	Ref. 1.17 (0.80-1.69) 1.19 (1.03-1.39)*	Treatment at comprehensive center

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CLL, chronic lymphocytic leukemia; CSS, cancer-specific survival; Dx, diagnosis; HL, Hodgkin lymphoma; HR, Hazard Ratio; MM, Multiple myeloma; MN, Minnesota; multi, Multivariate analysis; N, Sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NCCN, National Comprehensive Cancer Network; NCI-CCC, National Cancer Institute–designated comprehensive cancer center; NHL, non-Hodgkin Lymphoma; NS, not specified; OH, Ohio; P-bone, plasmacytoma originating in bone; P-EM, pasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; SLL, small lymphocytic lymphoma; TX, Texas; Tx, treatment; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 2 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Distance traveled (in miles) to treatment center							
Loberiza et al,[30] (2009)	UNMC 1982-2006	NE	HL 2330	OS/multi	NS	NS	-
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	OS/multi	< 5.7 5.7-13.3 13.4-36.9	Ref. 0.96 (0.93-0.98) 0.92 (0.89-0.94)*	Distance traveled 13.4 to 36.9 miles
Chohan et al,[18] (2022)	NCDB 2004-2017	National	WM. < 65 y.o. 1249	OS/multi	< 10 10-25 ≥ 25	Ref. 0.92 (0.59-1.45) 1.49 (0.92-2.41)	-
			WM ≥ 65 y.o. 2629	OS/uni	< 10 10-25 ≥ 25	Ref. 0.89 (0.76-1.04) 0.82 (0.69-0.98)*	Distance traveled less than 10 miles
				OS/multi	< 10 10-25 ≥ 25	Ref. 0.97 (0.81-1.15) 0.95 (0.76-1.19)	-
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3064	OS/multi	>20 9–20 4–9	Ref. 1.1 (0.83-1.26) 1.10 (0.89-1.36)	-
Ghiassi-Nejad et al,[23] (2019)	NCDB 2004-2013	National	PM P-bone 4056	OS/uni	≤ 12.5 12.6-50 > 50	Ref. 0.85 (0.76-0.95)* 0.87 (0.73-1.04)	Distance less than 12.5 miles
			PM P-bone 4056	OS/multi	≤ 12.5 12.6-50 > 50	Ref. 0.91 (0.81-1.03) 0.97 (0.79-1.18)	-
			PM P-EM 1468	OS/multi	≤ 12.5 12.6-50 > 50	Ref. 0.98 (0.79-1.21) 0.93 (0.66-1.32)	-
Bhatt (2017)	NCDB 2003-2011	National	AML 60 738	1-month mortality/multi	≥ 34.8 0-4.9 5-11.9	Ref. 1.26 (1.18-1.34)* 1.12 (1.05-1.19)*	Distance traveled 0 to 11.9 miles
Rodriguez et al,[33] (2008)	Institutional 1997-2005	OH	AML 281	OS/multi	Per 20 increase	1.00 (0.98-1.02)	-
Master et al,[28] (2016)	NCDB 1998 -2012	National	AML 67 443	OS/multi	≥ 30 < 30	Ref. 0.99 (0.97-1.02)	-
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML. 553	OS/multi	< 20 > 20	Ref. 1.14 (0.85-1.52)	-
Borate et al,[38] (2015)	SEER 2007-2011	National	AML. 5541	OS/uni	< 20 20-70 70-200	Ref. 0.98 (0.91-1.04) 0.95 (0.89-1.02)	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CLL, chronic lymphocytic leukemia; CSS, cancer-specific survival; Dx, diagnosis; HL, Hodgkin lymphoma; HR, Hazard Ratio; MM, Multiple myeloma; MN, Minnesota; multi, Multivariate analysis; N, Sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NCCN, National Comprehensive Cancer Network; NCI-CCC, National Cancer Institute–designated comprehensive cancer center; NHL, non-Hodgkin Lymphoma; NS, not specified; OH, Ohio; P-bone, plasmacytoma originating in bone; P-EM, pasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; SLL, small lymphocytic lymphoma; TX, Texas; Tx, treatment; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 2 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Dhakal et al,[17] (2022)	NCDB 2004-2015	National	APL <65 y.o. 5380	1-month mortality	< 6 6-13.9 14-39.9	Ref. 0.71 (0.53-0.96)† 0.87 (0.65-1.16)	Distance traveled to less than 6 miles
			APL ≥65 y.o. 1520	1-month mortality/multi	< 6 6-13.9 14-39.9	Ref. 1.1 (0.70-1.47) 1.01 (0.70-1.46)	-
			APL <65 y.o. 5380	OS/HR	< 6 6-13.9 14-39.9	Ref. 0.95 (0.80-1.12) 0.97 (0.82-1.15)	-
			APL ≥65 y.o. 1520	OS/multi	< 6 6-13.9 14-39.9 ≥ 40	Ref. 0.92 (0.76-1.12) 1.05 (0.88-1.27) 0.94 (0.77-1.15)	-
Treatment facility volume (patients treated per year)							
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	1-month mortality/multi	Quartile1: lowest Quartile 2. Quartile 3. Quartile 4: highest[c]	Ref. 1.1 (0.91-1.13) 0.92 (0.82-1.03) 0.89 (0.78-1.01)	-
				OS/multi	Quartile1: lowest Quartile 2. Quartile 3. Quartile 4: highest[c]	Ref. 0.98 (0.95-1.01)* 0.96 (0.92-0.99) 0.89 (0.84-0.94)*	Treatment at facility with lowest volume
Go (2016)	NCDB 1998-2011	National	NHL 278 985	OS/multi	Quartile 4: ≥33 Quartile 3: 21-32 Quartile 2:14-20 Quartile 1: 2-13	Ref. 1.05 (1.04-1.06)* 1.08 (1.07-1.10)* 1.14 (1.11-1.17)*	Treatment at facility with lowest volume
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3064	OS/multi	Quartile 4[c:] highest Quartile 1: lowest Quartile 2 Quartile 3	Ref. 1.5 (1.18-1.88)* 1.4 (1.17-1.72)* 1.13 (0.92-1.38)	Treatment at facility with lowest volume
Go (2017)	NCDB 2003-2011	National	MM 94 722	OS/multi	Quartile 4: >10.3 Quartile 3: 6.2-10.3 Quartile 2: 3.6-6.1 Quartile 1: <3.6	Ref.[b] 1.16 (1.1-1.22)* 1.23 (1.16-1.3)* 1.26 (1.17-1.3)*	Treatment at facility with lowest volume
Provider expertise							
Loberiza et al,[30] (2009)	UNMC Database 1982-2006	NE	HL 2330	OS/multi	University-based Community-based	Ref. 1.26 (1.06-1.49)*	Rural patients treated by community-based providers
Shanafelt et al,[29] (2012)	The Mayo Clinic CLL Database 1999-2009	MN	CLL/SLL. 1309	OS/multi	CLL hematologist Hematologist	Ref. 1.49 (1.08-2.04)*	Treatment by a non-CLL hematologist
					Hematologist Fellow	Ref. 0.98 (0.64-1.50)	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CLL, chronic lymphocytic leukemia; CSS, cancer-specific survival; Dx, diagnosis; HL, Hodgkin lymphoma; HR, Hazard Ratio; MM, Multiple myeloma; MN, Minnesota; multi, Multivariate analysis; N, Sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NCCN, National Comprehensive Cancer Network; NCI-CCC, National Cancer Institute–designated comprehensive cancer center; NHL, non-Hodgkin Lymphoma; NS, not specified; OH, Ohio; P-bone, plasmacytoma originating in bone; P-EM, pasmacytoma originating in extramedullary; PFS, progression-free survival; PM, plasmacytoma; Ref., reference; SEER, Surveillance, Epidemiology, and End Results Registry; SLL, small lymphocytic lymphoma; TX, Texas; Tx, treatment; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 3. Summary of descriptive characteristics of included studies evaluating median household income (n = 27), percentage of population living in poverty (n = 4), and unemployment rate (n = 2)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Median household income (annual)							
Parikh et al,[39] (2015)	NCDB 1998-2011	National	HL 45 777	OS/multi	< $30 000 $30 000-34 999 $35 000-45 999 ≥46 000	Ref. 0.86 (0.74-0.99)* 0.84 (0.72-0.97)* 0.81 (0.69-0.95)*	Income lower than $30 000
Loberiza et al,[30] (2009)	UNMC 1982-2006	NE	HL 2 330	OS/multi	≤ $30 000 $30 001-39 999 $ 40 000-44 999 ≥ $45 000	Data not showed	-
Keegan (2009)	CCR 1988-2006	CA	HL 15-44 y.o. 8228	CCS/multi	5: Highest‡ 1: Lowest 2 3 4	Ref. 1.64 (1.23-2.20)* 1.48 (1.13-1.94)* 1.63 (1.26-2.10)* 1.23 (0.95-1.61)	Lower income
				OS/multi	5: Highest‡ 1: Lowest 2 3 4	Ref. 1.81 (1.46-2.24)* 1.57 (1.29-1.92)* 1.58 (1.30-1.91)* 1.28 (1.06-1.56)*	Lower income
			HL ≥ 45 y.o. 4264	CCS/multi	5: Highest‡ 1: Lowest 2 3 4	Ref. 1.36 (1.10-1.68) 1.27 (1.04-1.54) 1.19 (0.98-1.44) 1.00 (0.82-1.21)	Lower income
				OS/multi	5: Highest‡ 1: Lowest 2 3 4	Ref. 1.44 (1.26-1.66) 1.26 (1.01-1.44) 1.31 (1.15-1.48) 1.06 (0.93-1.20)	Lower income
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	1-month mortality/uni	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Data not showed	Lower income
				1-month mortality/multi	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Data not showed	-
				OS/multi	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Ref. 0.95 (0.92-0.98) 0.91 (0.88-0.95)* 0.86 (0.82-0.90)*	Income lower than $38 000

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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‡Not specified values.

Table 3 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Go (2016)	NCDB 1998-2011	National	NHL 278 985	OS/multi	≥ $46 000 $35 000-$45 999 $30 000-$34 999 < $30 000	Ref. 1.10 (1.09-1.11)† 1.16 (1.15-1.18)† 1.25 (1.23-1.27)†	Income lower than $45 999
Tao et al,[25] (2014)	CCR 2001-2009	CA	NHL 16 133	CSS/multi	5. Highest 20%‡ 1. Lowest 20% 2. 3. 4.	Ref. 1.24 (1.16-1.32)* 1.23 (1.16-1.30)* 1.12 (1.06-1.18)* 1.07 (1.02-1.13)*	Lower income
				OS/multi	5. Highest 20%‡ 1. Lowest 20% 2. 3. 4.	Ref. 1.34 (1.27-1.40)* 1.26 (1.20-1.32)* 1.17 (1.12-1.22)* 1.09 (1.05-1.14)*	Lower income
Ai et al,[26] (2012)	CCR 2001-2008	CA	NHL 213	OS/multi	High: Quartile 4, 5 Low: Quartile 1-3	Ref. 1.07 (0.73-1.57)	-
Shah (2019)	NCDB 2004-2013	National	NHL 18 120	OS/multi	≥ $63 000 < $38 000 $38 000-47 999 $48 000-62 999	Ref. 1.21 (1.10-1.33)* 1.06 (0.98-1.15) 1.01 (0.94-1.08)	Income lower than $38 000
Chohan et al,[18] (2022)	NCDB 2004-2017	National	WM < 65 y.o. 1249	OS/uni	< $40 227 $40 227–50 353 $50 354–63 332 ≥$63 333	Ref. 0.77 (0.48-1.24) 0.60 (0.38-0.96)* 0.55 (0.36-0.83)*	Income lower than $40 227
				OS/multi	< $40 227 $40 227–50 353 $50 354–63 332 ≥ $63 333	Ref. 1.16 (0.65-2.07) 0.97 (0.51-1.82) 1.12 (0.56-2.23)	-
			WM ≥ 65 y.o. 2629	OS/uni	< $40 227 $40 227–50 353 $50 354–63 332 ≥ $63 333	Ref. 0.98 (0.77-1.25) 0.84 (0.67-1.07) 0.76 (0.61-0.95)*	Income lower than $40 227
				OS/multi	< $40 227 $40 227–50 353 $50 354–63 332 ≥ $63 333	Ref. 1.02 (0.78-1.35) 0.93 (0.70-1.24) 0.90 (0.66-1.22)	-
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3 064	OS/multi	≥ $63 000 $48 000–$62 999 $38 000–$47 999 <$38 000	Ref. 1.19 (0.98-1.44) 1.21 (0.98-1.51) 1.25 (0.96-1.63)	-
Fiala et al,[15] (2015)	Institutional 2000-2009	MO	MM 652	OS/HR	≥ $57 177 $41 401-57 177 ≤ $41 400	Ref. 1.25 (0.95-1.65) 1.54 (1.13-2.09)*	Income lower than $41 400

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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‡Not specified values.

Table 3 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
	SEER 2000-2009	National	MM 45 505	OS/HR	≥ $57 177 $41 401-57 177 ≤ $41 400	Ref. 1.10 (1.07-1.13)* 1.18 (1.15-1.22)*	Income lower than $57 177
Jayakrishnan (2021)	NCDB 2004-2016	National	MM 50 543	OS/multi	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Ref. 0.96 (0.93-0.99)* 0.93 (0.90-0.97)* 0.91 (0.87-0.95)*	Income lower than $38 000
Evans et al,[40] (2021)	Institutional 2005-2015	NS	MM 2543	OS/uni	≥$63 000 < $63 000	Ref. 1.25 (1.09-1.43)*	Income lower than $63 000
				OS/multi	≥$63 000 < $63 000	Ref. 1.13 (0.89-1.43)	-
	NCDB 2004-2015	National	MM 122 858	OS/multi	≥$63 000 < $63 000	Ref. 1.11 (1.09-1.14)*	Income lower than $63 000
Chamoun (2021)	NCDB. 2005-2014	National	MM. 117 926	OS/multi	≥ $46 000 < $46 000	Ref. 1.16 (1.08-1.25)*	Income lower than $46 000
Ho et al,[24] (2017)	CCR 1999-2012	CA	MM 6359	60-day mortality	High SES‡ Low SES	Ref. 1.21 (1.03-1.41)	Lower income
Costa et al,[37] (2016)	SEER 2007-2012	National	MM 10 161	OS/multi	> $68 500 $56 601-$68 500 $49 301-$56 600 < $49 301	Ref. 0.97 (0.85-1.10) 1.19 (1.03-1.37)* 1.27 (1.09-1.49)*	Income lower than $49 301
Huang et al,[31] (2021)	SEER 2007-2016	National	MM 17 981	CSS/uni	$1926-5000 $5007-6081 $6090-6504 $6517-8185 $8197-11 097	Ref. 0.98 (0.90-1.07) 0.92 (0.84-1.01) 0.85 (0.78-0.94)* 0.84 (0.76-0.92)*	Income lower than $5000
				CSS/multi	$1926-5000 $5007-6081 $6090-6504 $6517-8185 $8197-11 097	Ref. 1.10 (0.91-1.30) 1.04 (0.85-1.26) 0.96 (0.76-1.22) 0.97 (0.75-1.25)	-
				OS/uni	$1926-5000 $5007-6081 $6090-6504 $6517-8185 $8197-11 097	Ref. 0.95 (0.88-1.02) 0.86 (0.79-0.92)* 0.75 (0.70-0.81)* 0.69 (0.63-0.75)*	Income lower than $5000
				OS/multi	$1926-5000 $5007-6081 $6090-6504 $6517-8185 $8197-11 097	Ref. 1.07 (0.92-1.24) 0.91 (0.77-1.08) 0.93 (0.77-1.11) 1.00 (0.79-1.28)	-

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 3 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Ghiassi-Nejad et al,[23] (2019)	NCDB 2004-2013	National	PM P-bone 4056	OS/multi	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Ref. 0.78 (0.67-0.92)* 0.77 (0.65-0.89)* 0.72 (0.61-0.85)*	Income lower than $38 000
			PM P-EM 1468	OS/uni	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Ref. 0.85 (0.65-1.11) 0.77 (0.59-1.01) 0.76 (0.58-0.98)*	Income lower than $38 000
				OS/multi	< $38 000 $38 000-47 999 $48 000-62 999 ≥ $63 000	Ref. 0.94 (0.71-1.25) 0.84 (0.63-1.12) 0.84 (0.63-1.13)	-
Bhatt (2017)	NCDB 2003-2011	National	AML 60 738	1-month mortality/multi	≥ 46 000 <$30 000 $30 000-34 999 $35 000-45 999	Ref. 1.26 (1.18-1.35)* 1.16 (1.10-1.24)* 1.12 (1.06-1.17)*	Income lower than $45 999
				OS/multi	≥ 46 000 < $30 000 $30 000-34 999 $35 000-45 999	Ref. 1.09 (1.05-1.12)* 1.07 (1.05-1.10)* 1.05 (1.03-1.07)*	Income lower than $45 999
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML 900	OS/multi	Fourth Quartile‡ First Quartile Second Quartile Third Quartile	Ref. 1.22 (0.81-1.86) 1.18 (0.86-1.62) 1.02 (0.77-1.33)	-
Borate et al,[38] (2015)	SEER 2007-2011	National	AML 5541	2-month mortality/uni	Quintile 5‡ Quintile 1 Quintile 2 Quintile 3 Quintile 4	Ref. OR 1.60 (1.20-2.13)* 1.54 (1.16-2.04)* 1.43 (1.06-1.93)* 1.39 (1.04-1.86)*	Lower income
				OS/multi	Quintile 5‡ Quintile 1 Quintile 2 Quintile 3 Quintile 4	Ref. OR 1.21 (1.08-1.36)* 1.25 (1.11-1.40)* 1.25 (1.11-1.40)* 1.11 (0.99-1.25)	Lower income
Baker (2009)	CIBMTR 1995-2004	National	AML/ALL/CML/ MDS. 6207	DFS	> $56 300 $43 600-56 300 $34 700-43 600 < $34 700	Ref. 1.03 (0.94-1.13) 1.02 (0.93-1.12) 1.12 (1.01-1.23)	-
				TRM	> $56 300 $43 600-56 300 $34 700-43 600 < $34 700	Ref. 1.11 (0.99-1.24) 1.11 (0.99-1.24) 1.21 (1.07-1.36)*	Income lower than $34 700
				OS	> $56 300 $43 600-56 300 $34 700-43 600 < $34 700	Ref. 1.06 (0.97-1.16) 1.06 (0.97-1.16) 1.15 (1.04-1.26)*	Income lower than $34 700

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 3 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Rodriguez et al,[33] (2008)	Institutional 1997-2005	OH	AML 281	OS/multi	Per $10 000 increment	1.02 (0.92-1.13)	-
Master et al,[28] (2016)	NCDB 1998 -2012	National	AML 67 443	OS/multi	≥ $46 000 $30 000 $30 000-34 000 $35 000-45 000	Ref. 1.10 (1.06-1.15)† 1.08 (1.05-1.12)† 1.05 (1.02-1.08)†	Income lower than $46 000
Bradley et al,[34] (2011)	VCR/ VHI 1999-2006	VA	AML No CTX NS	OS/multi	Advantage Disadvantage	Ref. 1.00 (0.99-1.01)	-
			AML CTX NS	OS/multi	Advantage Disadvantage	Ref. 1.00 (0.99-1.01)	-
Dhakal et al,[17] (2022)	NCDB 2004-2015	National	APL <65 y.o. 5380	1-month mortality	≥ $63 333 $50 354-63 332 $40 227-50 353	Ref. 1.02 (0.75-1.37) 1.08 (0.77-1.50)	-
			APL ≥65 y.o. 1520	1-month mortality	≥ $63 333 $50 354-63 332 $40 227-50 353	Ref. 1.06 (0.72-1.54) 1.31 (0.87-1.98)	-
			APL <65 y.o. 5380	OS/multi	≥ $63 333 $50 354-63 332 $40 227-50 353	Ref. 1.19 (1.00-1.42)* 1.03 (0.85-1.26)	Income from $50 354 to $63 332
			APL ≥65 y.o. 1520	OS/multi	≥ $63 333 $50 354-63 332 $40 227-50 353 < $40 227	Ref. 1.22 (1.00-1.49) 1.29 (1.03-1.60)* 1.36 (1.05-1.76)*	Income lower than $63 333
Perry et al,[16] (2017)	SEER 2007-2012	National	CML < 64 y.o. 3626	OS/HR	Above median household income	0.98 (0.69-1.40)	-
			CML ≥ 65 y.o. 2142	OS/HR	Above median household income	1.02 (0.83-1.27)	-
Percentage of population living in poverty							
Huang et al,[31] (2021)	SEER 2007-2016	National	MM 17 981	CSS/uni	< 10% 10%–19.99% ≥ 20%	Ref. 1.10 (1.02-1.19)* 1.20 (1.09-1.33)*	Poverty level higher than 10%
				CSS/multi	< 10% 10%–19.99% ≥ 20%	Ref. 0.97 (0.87-1.10) 0.90 (0.73-1.10)	-
				OS/uni	< 10% 10%–19.99% ≥ 20%	Ref. 1.27 (1.19-1.35)* 1.50 (1.38-1.62)*	Poverty level higher than 10%
				OS/multi	< 10% 10%–19.99% ≥ 20%	Ref. 1.04 (0.95-1.13) 1.05 (0.91-1.22)	-

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 3 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95% CI)	Social determinant associated with worse survival
Byrne et al,[35] (2011)	FCDS 1998-2002	FL	AML 4659	OS/multi	≤ 5% 5.1%-10% 10.1%-15% > 15%	Ref. 1.04 (0.97-1.14) 1.11 (1.00-1.22) 1.15 (1.04-1.27)*	Poverty level higher than 15%
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML 900	OS/multi	NS	0.99 (0.98-1.01)	-
Perry et al,[16] (2017)	SEER 2007-2012	National	CML 15-64 y.o. 3626	OS/multi	Below median Above median	Ref. 1.03 (0.69-1.54)	-
			CML ≥ 65 y.o. 2142	OS/multi	Below median Above median	Ref. 1.06 (0.83-1.36)	-
Unemployment rate							
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML. 900	OS/multi	NS	0.99 (0.97-1.02)	-
Perry et al,[16] (2017)	SEER 2007-2012	National	CML.15-64 y.o. 3626	OS/multi	Below median Above median	Ref. 1.01 (0.78-1.32)	-
			CML ≥ 65 y.o. 2142	OS/multi	Below median Above median	Ref. 1.02 (0.86-1.20)	-

ALL, acute lymphoblastic lymphoma, AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; CA, California; CCR, California Cancer Registry; CI, confidential interval; CIBMTR, Center for International Blood and Marrow Transplant Research; CML, chronic myeloid leukemia; CSS, cancer-specific survival; CTX, chemotherapy; DFS, disease-free survival; FCDS, Florida Cancer Data System; FL, Florida; HL, Hodgkin lymphoma; HR, hazard ratio; MDS, myelodysplastic syndromes; MO, Missouri; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NE, Nebraska; NHL, Nnn-Hodgkin Lymphoma; NS, not specified; OH, Ohio; OR, odds ratio; P-bone, plasmacytoma originating in bone; P-EM, plasmacytoma originating in extramedullary; PM, plasmacytoma; Ref., reference; SES, socioeconomic status; SEER, Surveillance, Epidemiology, and End Results Registry; TRM, transplant-related mortality; uni, univariate analysis; UNMC, University of Nebraska Medical Center Oncology Database; VA, Virginia; VCR, Virginia Cancer Registry; VHI, Virginia Health Information; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 4. Summary of descriptive characteristics of included studies evaluating marital status (n = 10) and education level (n = 19)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95%-CI)	Social determinant associated with worse survival
Marital status							
Yung et al,[19] (2011)	NYSCR 2001–2008	NY	HL 4752	OS/multi	Married Unmarried	Ref. 1.49 (1.11-1.99)*	Unmarried
	CCR 2000–2007	CA	HL 4752	OS/multi	Married Unmarried	Ref. 1.26 (0.97-1.64)	-
Tao et al,[25] (2014)	CCR 2001-2009	CA	NHL 16 133	CSS/multi	Married Never married Previously married	Ref. 1.13 (1.07-1.20)* 1.13 (1.09-1.18)*	Unmarried
Huang et al,[31] (2021)	SEER 2007-2016	National	MM 17 981	CSS/multi	Married Single	Ref. 1.15 (1.06-1.24)*	Single
				OS/multi	Married Single Other	Ref. 1.29 (1.22-1.38)* 1.35 (1.26-1.44)*	Single, divorced, separated, domestic partner, or widowed
Makhani (2021)	SEER 2007-2016	National	MM 41 789	OS/multi	Married Not Married	Ref. 1.18 (1.13-1.22)*	Unmarried
Evans et al,[40] (2021)	Institutional 2005-2015	NS	MM 2543	OS/multi	Married Unmarried	Ref. 1.32 (1.03-1.69)*	Unmarried
Costa et al,[37] 2016	SEER 2007-2012	National	MM 10 161	1-year mortality	Married Divorced Single Widowed	Ref. 1.31 (1.09-1.58)* 1.74 (1.48-2.03)* 1.38 (1.01-1.88)*	Divorced, single or widowed
Ho et al,[24] (2017)	CCR 1999-2012	CA	MM 6359	60-day mortality	Married Single	Ref. 1.25 (1.07-1.46)*	Single
Yung et al,[19] (2011)	NYSCR 2001–2008	NY	AML 3506	OS/multi	Married Unmarried	Ref. 1.25 (1.07-1.45)*	Unmarried
	CCR 2000–2007	CA	AML 3506	OS/multi	Married Unmarried	Ref. 1.31 (1.17-1.48)*	Unmarried
Borate et al,[38] (2015)	SEER 2007-2011	National	AML 5541	OS/multi	Married Single Divorced Widowed	Ref. 1.26 (1.15-1.38)* 1.16 (1.04-1.30)* 1.14 (0.93-1.41)	Single or divorced
				OS/multi	Married Divorced Single Widowed	Ref. 1.24 (1.11-1.39)* 1.39 (1.27-1.53)* 1.43 (1.20-1.71)*	Divorced, single, or widowed
Perry et al,[16] (2017)	SEER 2007-2012	National	CML 15-64 y.o. 3626	OS/multi	Married Single Divorced/separated/widowed	Reference 1.65 (1.29-2.13)* 1.30 (0.94-1.79)	Single
			CML 65 y.o. 2142	OS/multi	Married Single Divorced, separated, or widowed	Ref. 1.15 (0.89-1.48) 1.35 (1.16-1.59)*	Divorced, widowed, or separated

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; HL, Hodgkin lymphoma; HR, hazard ratio; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NHL, non-Hodgkin lymphoma; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York state cancer registry; Ref., Reference; SEER, Surveillance, Epidemiology, and End Results Registry; uni, univariate analysis; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Table 4 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95%-CI)	Social determinant associated with worse survival
Education: percentage of population without high school degree							
Parikh et al,[39] (2015)	NCDB 1998-2011	National	HL 45 777	OS/uni	≥ 29% 20%-28.9% 14%-19.9% <14%	Ref. 0.83 (0.78-0.89)* 0.78 (0.74-0.83)* 0.62 (0.58-0.66)*	Higher than 29%
				OS/multi	≥ 29% 20%-28.9% 14%-19.9% <14%	Ref. 0.98 (0.86-1.13) 1.14 (0.98-1.32) 0.97 (0.82-1.13)	-
Goldstein et al,[21] (2019)	NCDB 2004–2014	National	NHL ≥ 65y.o. 161	OS/uni	< 7% 7% to 12.9% 13% to 20.9% > 21%	Ref. 1.18 (0.7-2) 1.09 (0.6-1.9) 1.75 (1.3-1)	-
Han (2014)	NCDB 2004-2010	National	NHL 3 858	OS/multi	< 14% 14%-9.9% 20%-28.9% ≥ 29%	Ref. 1.17 (0.99-1.39) 1.27 (1.07-1.50)† 1.51 (1.25-1.82)†	Higher than 20%
Shah (2019)	NCDB 2004-2013	National	NHL 18 120	OS/multi	< 7% ≥ 21% 13%-20% 7%-12.99%	Ref. 1.14 (1.03-1.27)* 1.16 (1.07-1.26)* 1.12 (1.05-1.20)*	Higher than 7%
Goldstein et al,[21] (2019)	NCDB 2004-2014	National	NHL < 65 y.o. 22 133	OS/multi	< 7% 7%-12.9% 13%-20.9% > 21%	Ref. 1.19 (1.05-1.34)* 1.40 (1.24-1.59)* 1.42 (1.22-1.64)*	Higher than 7%
			NHL ≥ 65 y.o. 21 515	OS/multi	< 7% 7%-12.9% 13%-20.9% > 21%	Ref. 1.03 (0.96-1.11) 1.09 (1.01-1.18)* 1.19 (1.09-1.31)*	Higher than 13%
Dhakal et al,[22] (2019)	NCDB 2006-2012	National	NHL 132 402	1-month mortality/Uni	NS	Data not showed	Lower education level
Gunaratne et al,[35] (2021)	NCBD 2004-2014	National	WM 3064	OS/multi	High‡ Middle-2 Middle-1 Low	Ref. 1.16 (0.96-1.4) 1.30 (1.04-1.63) 1.28 (0.97-1.69)	-
Chohan et al,[18] (2022)	NCDB 2004-2017	National	WM < 65 y.o. 1249	OS/uni	≥ 17.6% 10.9%–17.5% 6.3%–10.8% <6.3%	Ref. 0.90 (0.56-1.43) 0.81 (0.52-1.28) 0.58 (0.36-0.93)*	Higher than 17.6%
				OS/multi	≥ 17.6% 10.9%–17.5% 6.3%–10.8% <6.3%	Ref. 1.02 (0.59-1.78) 1.02 (0.55-1.88) 0.86 (0.43-1.75)	-
			WM ≥ 65 y.o. 2629	OS/multi	≥ 17.6% 10.9%–17.5% 6.3%–10.8% <6.3%	Ref. 0.97 (0.75-1.26) 0.98 (0.75-1.27) 0.84 (0.72-0.97)*	Higher than 17.6%

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; HL, Hodgkin lymphoma; HR, hazard ratio; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NHL, non-Hodgkin lymphoma; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York state cancer registry; Ref., Reference; SEER, Surveillance, Epidemiology, and End Results Registry; uni, univariate analysis; WM, Waldenstrom macroglobulinemia; y.o., years old.

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Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95%-CI)	Social determinant associated with worse survival
Goldstein et al,[21] (2019)	NCDB 2004–2014	National	BL 65 y.o. 5235	OS/multi	< 7% 7% to 12.9% 13% to 20.9% > 21%	Ref. 1.1 (0.9-1.3) 1.35 (1.1-1.6) 1.39 (1.1-1.7)*	Higher than 21%
			BL ≥ 65 y.o. 1838	OS/multi	< 7% 7% to 12.9% 13% to 20.9% > 21%	Ref. 0.8 (0.6-1)* 0.9 (0.7-1.2)* 0.72 (0.5-1)*	Higher than 7%
Evans et al,[40] (2021)	Institutional 2005-2015	NS	MM 2543	OS/uni	≤ 7% >7%	Ref. 1.02 (0.88-1.18)	-
	NCDB 2004-2015	National	MM 2543	OS/multi	≤ 7% >7%	Ref. 1.08 (1.06-1.11)*	Higher than 7%
Jayakrishnan (2021)	NCDB 2004-2016	National	MM 50 543	OS/multi	≥ 21% 13.0%-20.9% 7.0%-12.9% < 7.0%	Ref. 0.99 (0.95-1.02) 0.98 (0.94-1.02) 0.94 (0.89-0.99)*	Higher than 21%
Costa et al,[37] (2016)	SEER 2007-2012	National	MM 10 161	12 month- mortality/multi	< 21.3% > 36.8% 29.7%-36.8% 21.3%-29.7%	Ref. 0.92 (0.72-1.17) 1.03 (0.80-1.32) 1.34 (1.05-1.72)*	From 21.3% to 29.7%
Huang et al,[31] (2021)	SEER 2007-2016	National	MM 17 981	CSS/uni	6.83%–21.52% 21.62%–30.99% 31.08%–34.03% 34.07%–41.84% 42.01%–65.45%	Ref. 0.87 (0.80-0.96)* 0.87 (0.79-0.95)* 0.87 (0.80-0.96)* 0.80 (0.73-0.88)*	From 68.3% to 21.52%
				OS/uni	< 21.3% > 36.8% 29.7%-36.8% 21.3%-29.7%	Ref. 1.13 (1.02-1.27)* 1.19 (1.07-1.33)* 1.46 (1.31-1.62)*	Higher than 21.3%
				CSS/multi	6.83%–21.52% 21.62%–30.99% 31.08%–34.03% 34.07%–41.84% 42.01%–65.45%	Ref. 0.95 (0.85-1.06) 0.93 (0.82-1.05) 1.02 (0.89-1.17) 0.96 (0.82-1.13)	-
				OS/uni	6.83%–21.52% 21.62%–30.99% 31.08%–34.03% 34.07%–41.84% 42.01%–65.45%	Ref. 0.88 (0.81-0.94)* 0.91 (0.85-0.98)* 0.80 (0.75-0.86)* 0.68 (0.63-0.74)*	From 6.83% to 21.52%
				OS/multi	6.83%–21.52% 21.62%–30.99% 31.08%–34.03% 34.07%–41.84% 42.01%–65.45%	Ref. 0.98 (0.90-1.06) 1.07 (0.97-1.18) 1.02 (0.92-1.14) 0.90 (0.79-1.03)	-
Freeman et al,[32] (2016)	NC CCR 2003-2009	NC	AML 900	OS/multi	NS	1.00 (0.99-1.02)	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; HL, Hodgkin lymphoma; HR, hazard ratio; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NHL, non-Hodgkin lymphoma; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York state cancer registry; Ref., Reference; SEER, Surveillance, Epidemiology, and End Results Registry; uni, univariate analysis; WM, Waldenstrom macroglobulinemia; y.o., years old.

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‡Not specified values.

Table 4 (continued)

Author (year)	Data source years	US region	Patients N	Outcome/analysis	Cohorts	HR (95%-CI)	Social determinant associated with worse survival
Master et al,[28] (2016)	NCDB 1998 -2012	National	AML. 67 443	OS/multi	< 14% 14%-19.9% 20%-28.9% ≥ 29%	Ref. 1.03 (1.00-1.06)† 1.05 (1.02-1.08)† 1.01 (0.97-1.05)	From 14% to 28.9%
Borate et al,[38] (2015)	SEER 2007-2011	National	AML 5541	OS/uni	Quintile 5‡ Quintile1 Quintile 2 Quintile 3 Quintile 4	Ref. 1.27 (1.13-1.42)* 1.17 (1.05-1.31) 1.17 (1.04-1.31) 1.15 (1.02-1.30)	Lower education level
Dhakal et al,[17] (2022)	NCDB 2004-2015	National	APL <65 y.o. 5380	1-month mortality	<6.3 6.3-10.8 10.9-17.5 ≥17.6	Ref. 1.18 (0.86-1.61) 1.02 (0.72-1.46) 1.40 (0.96-2.06)	-
			APL ≥65 y.o. 1520	1-month mortality	<6.3 6.3-10.8 10.9-17.5 ≥17.6	Ref. 1.38- (0.95-2.02) 1.14 (0.73-1.76) 1.18 (0.71-1.97)	-
			APL <65 y.o. 5380	OS/multi	<6.3 6.3-10.8 10.9-17.5 ≥17.6	Ref. 0.99 (0.83-1.19) 1.08 (0.89-1.32) 1.14 (0.91-1.43)	-
			APL ≥65 y.o. 1520	OS/multi	<6.3 6.3-10.8 10.9-17.5 ≥17.6	Ref. 1.12 (0.91-1.37) 1.12 (0.89-1.41) 1.11 (0.85-1.45)	-
Perry et al,[16] (2017)	SEER 2007-2012	National	CML 15-64 y.o. 3626	OS/multi	Below median Above median	Ref. 1.05 (0.73-1.52)	-
			CML ≥ 65 y.o. 2142	OS/multi	Below median Above median	Ref. 1.20 (0.94-1.53)	-
Education: percentage of population without <ninth grade degree							
Perry et al,[16] (2017)	SEER 2007-2012	National	CML 15-64 y.o. 3626	OS/HR	Above median % ninth grade education	NS	-
			CML ≥ 65 y.o. 2142	OS/HR	Above median % ninth grade education	NS	-

AML, acute myeloid leukemia; APL, acute promyelocytic leukemia; BL, Burkitt lymphoma; CA, California; CCR, California Cancer Registry; CI, confidential interval; CML, chronic myeloid leukemia; CSS, cancer-specific survival; HL, Hodgkin lymphoma; HR, hazard ratio; MM, multiple myeloma; multi, multivariate analysis; N, sample size; NC, North Carolina; NCDB, National Cancer Database; NC CCR, North Carolina Central Cancer Registry; NHL, non-Hodgkin lymphoma; NOS, not otherwise specified; NS, not specified; NY, New York; NYSCR, New York state cancer registry; Ref., Reference; SEER, Surveillance, Epidemiology, and End Results Registry; uni, univariate analysis; WM, Waldenstrom macroglobulinemia; y.o., years old.

*Reported as statistical significance by the author.

†Statistical significance but not discussed by the author.

‡Not specified values.

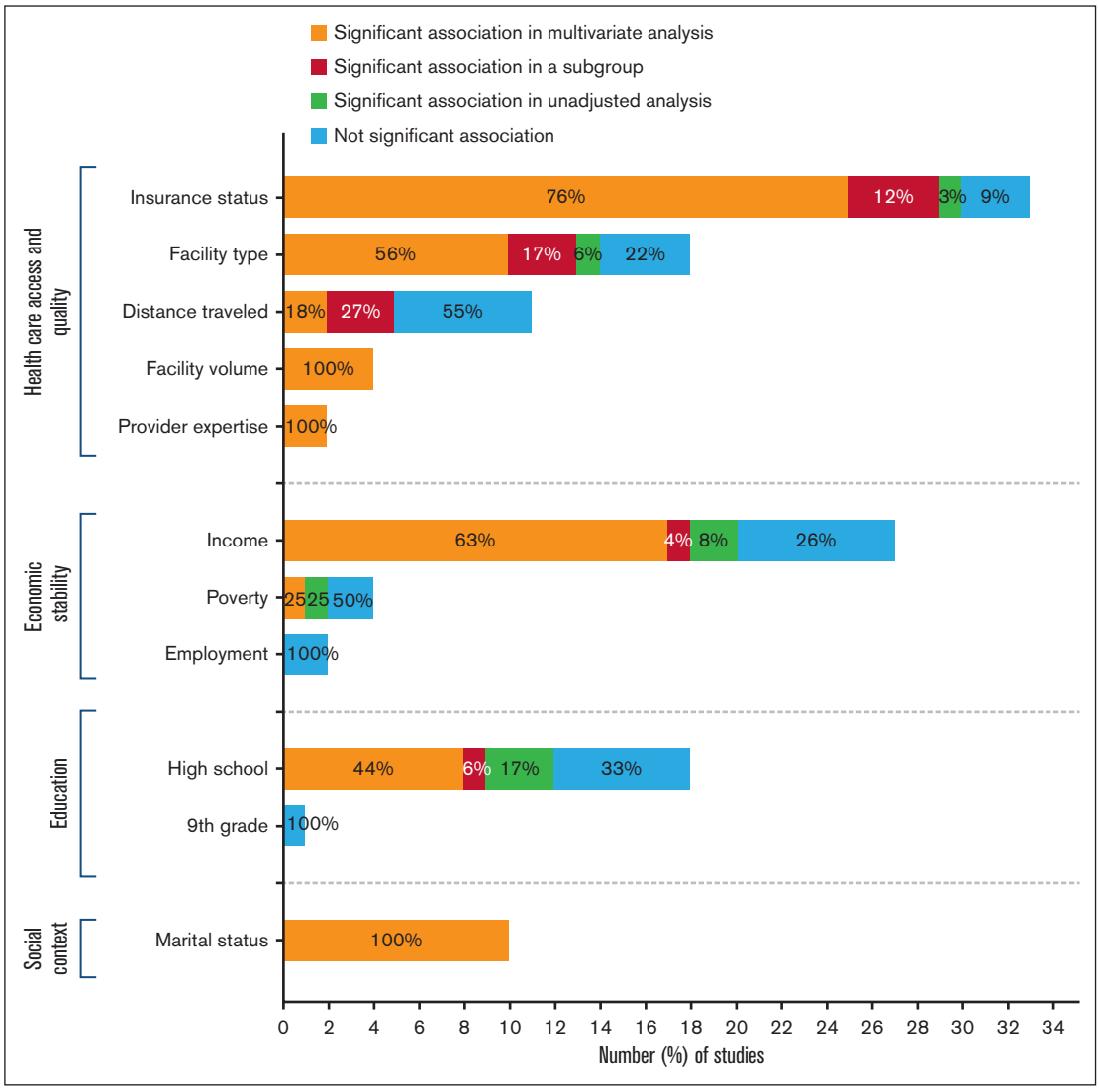

Figure 1. Distribution of the studies according to the impact of SDH within the major domains on cancer-treatment outcomes.

DISTANCE TRAVELED TO THE TREATMENT CENTER. The relationship between distance traveled to the treatment center and cancer outcomes was investigated in 11 studies with inconsistent results. None of the studies specified how distance was measured (eg, straight line vs car driving distance). Unexpectedly, 5 studies (45.5%) identified that 1-month and overall mortality were higher for those patients who traveled shorter distances (range, 6-40 miles), whereas 6 studies (54.5%) did not find a significant association. Three of the 5 studies identified significant differences in multivariable-adjusted analysis in subgroup analyses. Two studies categorized patients according to age (<65 vs ≥65 years old) and found contradictory results. Although in the cohort of Dhakal et al,[17] distance traveled affected 1-month mortality only in patients younger than 65 years old, Chohan et al[18] reported that this SDH was significantly associated with lower OS in the unadjusted analysis exclusively in subjects older than 65. Similar to the previous results in the insurance status section, Ghiassi-Nejad et al[23] described that distance traveled influenced mortality in the unadjusted analysis in patients with P-bone but not in the P-EM cohort (Table 2).

TREATMENT FACILITY VOLUME. Four studies evaluated facility volume as determined by the mean annual volume of newly diagnosed patients with the disease of interest treated at each treatment facility. All 4 studies supported a volume-outcome relationship: patients treated at lower-volume facilities had a higher mortality risk (Table 2).

PROVIDER EXPERTISE. Two studies examining whether provider expertise influences cancer-treatment outcomes reported a significant relationship in multivariable-adjusted analysis. Shanafelt[29] showed that patients treated by hematologists/oncologists who specifically focused on their specific malignancy had superior OS than those treated by general hematologists/oncologists. Loberiza et al[30] observed a higher risk of death among rural patients treated by community-based providers vs rural patients treated by university-based providers (Table 2).

Economic stability. Economic stability was investigated in 33 studies assessed by median household income (n = 27, 81.8%), poverty (n = 4, 12.1%), and unemployment rate (n = 2, 6.1%) (supplemental Table 6).

MEDIAN HOUSEHOLD INCOME. Household income was typically categorized into quartiles based on the patient's zip code. Low-income and high-income quantiles varied among studies from 30 000 to 63 332 and 30 000 to 68 500, respectively. Twenty of the 27 studies (74.1%) assessing this SDH demonstrated an influence of income on survival. Collectively, the results show an income gradient where lower income was associated with the shortest survival probability. Two of the 20 studies[18,31] (7.4%) only found a difference in the unadjusted model. Of those 7 studies (25.9%) that found no significant correlation between income and outcomes, 5 used state databases with a mean sample size of 849.4 patients (range, 213-2330).[26,30,32-34] The remaining 2 studies were population-based and reported no relationship between earnings[16,35] (Table 3).

POVERTY RATE. Four studies (12.1%) evaluated poverty rate–related differences in cancer survival and showed significant heterogeneity in the results. A state-level study[36] and a population-based study[31] concluded that patients living in areas with the highest poverty levels (≤10.1%) had worse OS than those residing in low-poverty neighborhoods. In contrast, Freeman et al[32] and Perry et al[16] reported no significant difference in mortality among poverty levels (Table 3).

UNEMPLOYED RATE. The relationship between the unemployed neighborhood rate and cancer outcome was examined in 2 studies.[16,32] Both studies reported no significant correlation between unemployment and patients' survival (Table 3).

Social context. Patients' social context was measured directly and exclusively through marital status in 10 studies (supplemental Table 6). Results showed that marital status consistently and significantly influences OS throughout all studies evaluated in multivariable-adjusted analysis. Overall, unmarried patients, including single, divorced, widowed, and/or separated, had a significantly higher probability of dying compared with married patients. In addition, 2 studies evaluating patients with MM[24,37] and 1 with AML[22] also attempted to understand whether marital status played a role in early mortality. Both MM studies found higher early mortality among unmarried vs married patients. In contrast, the 1 AML analysis[38] found no significant effect of marital status on early mortality (Table 4).

Education. Nineteen studies analyzed whether education level played a role in cancer survival. Most of the studies (n = 18, 94.7%) evaluated education level as determined by the percentage of adults without a high school diploma for the patient's geographical area, whereas 1 study[16] (5.3%) assessed education through the proportion of the population without ninth grade education (supplemental Table 6). Overall, 12 studies (66.7%) found that residing in low-education areas correlates with higher mortality. Three of those 12 studies[22,31,39] reported statistical significance only in the unadjusted mortality analysis. Six other studies (5.6%)[16,17,21,32,35,40] reported no significant relationship between the level of education and patients' outcomes. Finally, Perry[16] performed a comparative survival analysis between patients residing in areas above and below the median without ninth grade education and found no statistically significant difference between the cohorts (Table 4).

Discussion

Health care disparities affect patients with cancer in general and hematologic malignancies in particular. The role of SDHs in the outcome of patients with hematologic malignancies has been scarcely studied. In our review of 41 studies assessing patients with hematologic malignancies, we identified strong evidence of 5 variables of SDHs affecting survival: lack of health insurance or having Medicare or Medicaid insurance, receiving cancer treatment at a nonacademic facility, low household income, low education level, and being unmarried. Our findings have meaningful clinical applications, prompting physicians to identify patients who have been economically and socially marginalized and implement focused interventions.

Cumulative evidence assessing insurance status indicates that uninsured patients and those with Medicaid or Medicare insurance had a higher mortality risk than their private or military insurance counterparts. This might be explained by the fact that uninsured patients are less likely to receive preventive care, have more advanced disease at diagnosis, have more comorbid conditions, and have lower odds of receiving guideline-based treatment, likely driven by the cost of care and costly medications.[8,41,42] Given the protective financial role that insurance coverage exerts, the disparities found between patients insured by Medicare and Medicaid and those with private insurance are perhaps surprising and may be related to specific line items covered by various insurance plans. It is also possible that other factors (including other SDH) associated with being covered by Medicaid and Medicare are at least in part responsible for these differences.

The analysis of the type of facility where patients receive treatment and provider case volume revealed a similar impact on cancer survival. Overall, patients receiving treatment at academic/research cancer centers and high-volume facilities achieve better outcomes. This imbalance could be related to academic centers and high-volume facilities having multidisciplinary care teams, disease-specific expertise of physicians, adherence to guidelines, and access to new technologies and therapies, including clinical trials.[43,44] Consistent with this notion, evidence for our review revealed that provider expertise, access to NCI- and NCCN–designated cancer centers, and treatment at NCI–designated cancer centers provide a survival advantage. All things considered, our findings suggest that addressing health care access barriers through increasing access to preventive health care, reducing delayed cancer diagnosis and treatments, and expanding access to novel evidence–based therapies are focused actions on eliminating cancer-treatment disparities. Shared-care models where there is access to specialized centers for the care areas that most need it and care with local oncology clinics in close communication with the academic institutions would be optimal. The feasibility of such shared-care models for patients with hematologic malignancies has been shown to improve access to curative therapies, such as stem cell transplant (SCT), and the quality of life of patients, without compromising outcomes.[45,46] This requires, among other things, increased communication, true integration of electronic health records, more access to telehealth, and decreasing barriers to practice across state lines.

Another important finding in our review is that unmarried patients present a higher mortality risk than married ones. Although the cause of this effect is multifactorial, the literature suggests the

effect comes mainly through emotional and social support.[47] Married patients seek prompt medical care encouraged by spouses, display higher treatment adherence, and present fewer mental health conditions such as depression, anxiety, and emotional distress.[48-50] Furthermore, the caregiver role that spouses provide is an undervalued but critical component of the health care system. Spouses may support patients in different ways, including by assisting with personal care, making household chores, managing finances and legal matters, making medical appointments, assisting with mobility, and administering medications.

On economic stability and education, our results suggest a protective effect of higher median household income and education levels on survival. Importantly, education access and quality were measured as the percentage of adults who did not graduate from high school. We did not identify any study that evaluated the role of postsecondary degrees, such as undergraduate, graduate, and postgraduate. In addition, this has been assessed at the community level rather than at the individual level. There is a close correlation between the level of education and economic status.[51,52] Higher educational levels are linked to more stable employment, higher salaries, and access to work with additional benefits,[53] including insurance with better coverage.[54]

The reports on the effect of poverty level on patients' outcomes are, in contrast, contradictory. It is difficult to draw any conclusion because of the limited number of studies that evaluated this variable. Altogether, the mechanisms involved in the influence of education and economic stability on cancer survival are multifactorial, complex, and strongly related to other domains of SDHs.

One of the most striking results from our analysis is the role of distance traveled to treatment facilities. Nearly half of the evaluated studies reported higher mortality rates for patients who traveled shorter distances. Although those results need to be interpreted carefully, a possible explanation might be that some patients prefer to be treated at high-quality cancer centers instead of local centers, even if that means traveling long distances and incurring additional economic expenses. This assumption is intercorrelated with other SDHs, including having a more outstanding financial position and job flexibility that allows for such travel.

Our results highlight the need to identify patients who have been economically and socially marginalized and need psychosocial support and to invest in socially targeted interventions as part of a comprehensive cancer-treatment approach. Some progress has been made in designing screening tools to identify patients' social and economic needs.[55] These should be routinely assessed in clinical practice and recorded in patients' charts. Required actions must focus on multidimensional strategies to provide patients with a social network that assists, encourages, and offers emotional and informative support that positively affects cancer outcomes.[56,57]

Our analysis is subject to some limitations that need to be acknowledged. First, there is a lack of individual patient data on most SDHs. Most studies used data routinely collected for other purposes and implemented a census-based approach. Second, there is a risk of data duplication considering those studies that analyzed national or state databases. Third, we identified a lack of data in the literature in terms of transportation, debt, higher education, diet, social integration, environmental factors, or stress. Our search strategy may not identify studies that do not identify variables as SDHs. In addition, how SDHs are measured and reported and what SDHs are reported vary across studies, making assessment of the interconnectivity of various factors challenging. However, the strengths of our review compensate for these limitations. To the best of our knowledge, this is the first systematic review assessing the role of SDHs on the outcomes strictly of patients affected by hematologic malignancies. We also restricted our analysis to only studies conducted in the United States because of the particular context of each country regarding health systems, education, the economy, and social behaviors.

In conclusion, our review highlights the extension of disparities among different populations in health care access and quality, financial burden, and social support. Furthermore, these results indicate the major effect of SDHs on survival outcomes in patients with hematologic malignancies. SDHs are a complex matrix of social, financial, and cultural elements as multiple intercorrelated variables. They represent a potential area of intervention independent of tumor biology or therapeutic efficacy. Strategies to incorporate SDHs into clinical care, research, and public health policies are needed, identifying and addressing social barriers at a patient-based level to enhance cancer equity.

Authorship

Contributions: J.E.C., M.M.G., and K.C.T. conceptualized the study; J.E.C., E.A.B., and G.A., were responsible for methodology; M.M.G., K.C.T., E.A.B., and G.A. curated the data; M.M.G. and J.E.C. wrote the original draft; J.E.C., E.A.B., and G.A. supervised the study; and M.M.G., K.T., E.A.B., G.A., and J.E.C. wrote and reviewed the manuscript.

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