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Ethnic Variations in Diagnosis, Treatment, Socioeconomic Status and Survival in a Large Population-Based Cohort of Elderly Patients with Non-Hodgkin's Lymphoma

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Abstract

Background: There is a lack of research on ethnic disparities in survival among patients with Non-Hodgkin's Lymphoma (NHL), although these disparities have been documented for patients with many **other** tumors.

Methods: A retrospective cohort of 13,321 patients diagnosed with incident NHL at age ≥ 65 in 1992–1999, were identified from the SEER (Surveillance, Epidemiology and End Results)-Medicare linked database with 11 years of follow-up. Of these patients, 11,868 were Caucasians, 533 were African-Americans, and 920 were other ethnicities. A time-to-event Cox regression model was used to examine the relative risk of all-cause and disease-specific mortality.

Results: A larger proportion (72.2%) of African-Americans were in the poorest quartile of socioeconomic status as measured by the poverty level compared to 21.8% of Caucasians, and 43.2% of African-Americans received chemotherapy compared to 52.4% of Caucasians ($p < 0.01$). Hazard ratio of all-cause and NHL-specific mortality increased significantly with age, advanced stage, higher comorbidity scores, and poorer socioeconomic status. Patients receiving either chemotherapy or radiotherapy or both were significantly less likely to die. After taking into account of differences in treatment, comorbidity, and socioeconomic status, there was no statistically significant difference in the risk of all-cause (Hazard ratio=0.97, 95% confidence interval: 0.88–1.08) and disease-specific mortality (1.07, 0.92–1.25) between African-Americans and Caucasians.

Conclusions: The risk of mortality in patients with NH-lymphoma was associated with socioeconomic status and was reduced in patients receiving chemotherapy. No significant differences in the risk of mortality were observed between African-Americans and Caucasians after controlling for factors such as treatment and socioeconomic status.

Condensed abstract

The risk of mortality in patients with NH-lymphoma was associated with socioeconomic status and was reduced in patients receiving chemotherapy. No significant differences in the risk of mortality were observed between African-American and Caucasian patients after controlling for factors such as treatment and socioeconomic status.

Keywords

Non-Hodgkin's lymphoma; chemotherapy; socioeconomic status; racial disparity; survival

Introduction

Non-Hodgkin's Lymphoma (NHL) is a common tumor in the elderly population with median age at diagnosis of 67 years.^{1,2} It is estimated that over 63,000 men and women will be diagnosed with NHL each year and about 18,660 men and women will die of NHL with a median age at death of 74 years in the United States.^{1,2} The incidence of NHL has been increasing over the last several decades worldwide,¹⁻⁷ and Caucasians have higher incidence and mortality rates of NHL than patients in other ethnic groups.^{1,2,5} During this period of time, treatment has improved, particularly with combination chemotherapy CHOP (cyclophosphamide, doxorubicin, vincristine, and prednisone)⁸⁻¹⁶ and later with the addition of Rituximab to CHOP for B cell NHL since 1998.¹⁷⁻²⁰ Although there were several studies that demonstrated ethnic disparities in receiving these treatments,²¹⁻²³ none of these studies has specifically addressed ethnic disparities in survival, and whether these survival differences were due to disparities in treatment, diagnosis, socioeconomic status or other factors in patients with NHL.

Patients and Methods

Data Sources

This study used the SEER (Surveillance, Epidemiology and End Results)-Medicare linked data for patients diagnosed in 1992–1999. The method of linking these data has been described elsewhere.^{24,25} The SEER program, supported by the National Cancer Institute, consists of population-based tumor registries that collect standardized information on all cancers diagnosed within the specified geographic regions.²⁴⁻²⁷ The metropolitan areas of San Francisco/Oakland, Detroit, Atlanta, and Seattle; Los Angeles County; the San Jose–Monterey area; and the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii were included in this report. The Medicare component, on the other hand, is the primary health insurer for the great majority of the U.S. population ≥ 65 years of age. It covers hospital, physician, and other medical services for >97% of persons age ≥ 65 years.^{24,25} The Committee for Protection of Human Subjects at the University of Texas Health Science Center at Houston approved this study.

Study Population

The retrospective cohort consisted of 13,570 patients diagnosed with incident NHL at age 65 in 1992–1999, and identified from the SEER-Medicare linked database. The 249 cases were excluded with missing information on socioeconomic status, leaving 13,321 subjects in the final analysis. Of 13,321, 11,868 were Caucasians (non-Hispanic), 533 were African-Americans (non-Hispanic), and 920 were other ethnicities.

Study Variables

Survival variables—The vital status, cause of death, and date of death in SEER data were obtained from the National Center for Health Statistics by National Cancer Institute.²⁷

Survival time in months was calculated from the date of diagnosis to the date of death or date of last follow-up (December 31, 2002). All-cause mortality was defined if patients died of any cause that was the underlying cause of death. Patients still alive at the last date of follow-up were censored. NHL-specific mortality was defined if lymphoma was the underlying cause of death, in which patients who died of causes other than lymphoma were censored.

Socioeconomic status—Three variables from the 1990 census available in the SEER-Medicare linked data were used to define socioeconomic status at the census tract level and were categorized into quartiles: a) education - percent of adults aged 25 who had less than 12 years of education: first (0%–10.89%), second (10.91%–17.94%), third (17.95%–25.80%), and fourth quartile (25.81%); b) poverty - percent of persons living below the poverty line: first (3.70%), second (3.71%–6.89%), third (6.90%–11.98%), and fourth quartile (11.99%); c) income - median annual household income (in U.S. dollars): first (\$45,427), second (\$35,178–45,424), third (\$26,894–35,174), and fourth quartile (\$26,882). In addition, a composite socioeconomic variable combining these three variables with equal weights was created and categorized into quartiles.²⁸

Chemotherapy—Information on chemotherapy was identified from Medicare claims, which was described elsewhere.^{29,30} In brief, the following Medicare claim codes were used for defining chemotherapy: International Classification of Disease (ICD)-9-CM procedure code 9925 for injection or infusion of cancer chemotherapeutic substance, the Common Procedure Terminology codes 96400–96549, J8510, J8520, J8521, J8530–J8999, J9000–J9999, and Q0083–Q0085 for chemotherapy administration, revenue center codes 0331 (chemotherapy injected), 0332 (chemotherapy oral), and 0335 (chemotherapy intravenous), and the ICD-9-CM V codes of V58.1, V66.2, or V67.2 for follow up examination or care after chemotherapy. Because only 23 (0.2%) patients received stem cell transplantation (ICD-9-CM codes of 4100–4109, or CPT codes of 38230, 38231, 38240, or 38241)^{31,32} within 12 months of diagnosis, this variable was not included in the final analysis.

Radiation Therapy—Since the information on radiation therapy from SEER and Medicare complement each other,³³ cases were defined as having received radiation therapy if SEER data or Medicare claims data indicated so.

Tumor Factors—Tumor stage as defined in the SEER Extension of Disease (EOD)-88 (3rd edition)²⁷ was included. The Ann Arbor staging system was used and reported as follows: Stage I (involvement of a single lymph node region, or localized involvement of a single extralymphatic organ or site); Stage II (involvement of two or more lymph node regions on the same side of the diaphragm, or localized involvement of a single extralymphatic organ or site and its regional lymph nodes on the same side of the diaphragm with or without involvement of other lymph node regions on the same side of the diaphragm); Stage III (involvement of lymph node regions on both sides of the diaphragm, with or without localized involvement of an extralymphatic organ or site or spleen involvement); Stage IV (disseminated or multifocal involvement of one or more extralymphatic organs); and unknown stage. The Extent of Disease codes from SEER data were: stage 1= 00–17, 2=20–29, 3=30–78, 4=80–90, and unstaged=99. Because of heterogeneities of different histologic subtypes of NHL, analysis was stratified by several major types of NHL according to the methods by Morton and colleagues:^{5,34,35} diffuse large B-cell lymphoma (histology codes of 9675,9678–9684), chronic lymphocytic leukemia (9670), follicular lymphoma (9690–9698), and all other subtypes or unknown.

Comorbidity Scores—Comorbidity was ascertained from Medicare claims data through diagnoses or procedures made 1 year before and 1 month after the diagnosis of NHL. The Medicare inpatient, outpatient, and physician claims were used to create a comorbidity score. The detailed method has been discussed elsewhere.³⁶ The rationale for including diagnoses from the physician claims was that many more patients saw a physician rather than being hospitalized, thus increasing the possibility of identifying more comorbid conditions.³⁶ This score reflects the Deyo adaptation of the Charlson comorbidity index,^{37,38} with several procedure codes that reflect the Romano adaptation.³⁹ The comorbidity score was then categorized into: 0, 1, 2, or 3.

Other Characteristics—Other characteristics obtained from the SEER data include age at diagnosis, race/ethnicity, marital status, year of diagnosis, geographic area, tumor stage, and nodal site. Tumor variables were well-validated in SEER registries,^{24,25} and so was the information on marital status, year of diagnosis and geographic area. Although race/ethnicity categories may have involved a certain degree of misclassification, two categories (African-American and Caucasian) in this study are likely to have a minimal misclassification bias, if any.⁴⁰

Analysis

The differences in the distribution of baseline characteristics among the three ethnic groups were tested using the chi-square statistic. Cox proportional hazard regression model was used for analysis of survival using the PHREG procedure in SAS.⁴¹ The proportionality assumption was considered to be satisfied when the log-log Kaplan-Meier curves for survival functions by race/ethnicity or SES were parallel and did not intersect. The median survival time in months was obtained from the LIFETEST procedure that is based on the Kaplan-Meier method. The interaction between race/ethnicity and SES was tested using the product term of these two variables in the model. Variables that were adjusted for in the

model include age, sex, race, tumor stage, nodal site, radiation, comorbidity score, geographic area, and year of diagnosis.

Results

Table 1 presents the distribution of patient demographic and tumor characteristics across the ethnic groups of patients with NH-lymphoma. A higher proportion of cases were diagnosed at age 65–69 in African-Americans (24.8%) and in other ethnic groups (22.4%) than in Caucasians (19.5%). The mean age was 76 years for Caucasians, 74 for African-Americans and 75 for others. There were slightly more female patients than males, and a larger proportion (58.2%) of African-American patients were unmarried. A slightly greater proportion of cases was diagnosed at an early stage and had a lower Comorbidity score in Caucasians and other ethnic groups than that in African-Americans. The percentage of patients receiving chemotherapy and radiation therapy was lower in African-Americans. For example, 43.2% of African-Americans received chemotherapy compared to 52.4% of Caucasians and 54.7% of others ($p<0.001$). Similarly, 18.2% of African-Americans received radiation therapy compared to 24.3% of Caucasians and 26.6% of others ($p<0.001$). The proportion of cases was stable over ten years among these three ethnic groups.

Table 2 presents the distribution of socioeconomic status among the three racial/ethnic groups of patients. A larger proportion of African-Americans were in the poorest quartiles of education, poverty, income, and composite socioeconomic status compared to that of Caucasians. For example, 72.2% of African-Americans and 38.7% of others were in the poorest quartile of socioeconomic status as measured by the poverty level compared to 21.8% of Caucasians ($p<0.001$). The differences in these factors in Tables 1 and 2 between Caucasians and African-Americans were all statistically significant except for sex and year of diagnosis. The tests for trend across ethnic groups by age, socioeconomic status, comorbidity, and year of diagnosis were statistically significant at $p<0.01$ but not for stage ($p=0.425$).

Table 3 presents the 1, 3 and 5-year observed survival rates by racial/ethnic groups and socioeconomic status, stratified by tumor stage. Since the last date of follow-up in Medicare was December 2002, all cases in our study cohort had been followed for at least 3 years. The 3-year observed survival for stage I-II from all-causes was 55.8% in Caucasians, 52.6% in African-Americans, and 44.7% in others. Survival increased with higher socioeconomic status. For example, the 3-year observed survival was 59.9% in subjects who lived in the community with highest quartile of composite socioeconomic status, and 48.8% in those with lowest quartile. This survival pattern in association with race/ethnicity and socioeconomic status was similar at the 1 and 5-year level and for NHL-specific survival (Table 3). Median survival time was 32.5 months (95% confidence interval: 31.0–34.8) for patients receiving chemotherapy and 11.9 months (95% confidence interval: 1.4–1.8) for those who did not receive chemotherapy.

Table 4 presents the percentage of patients receiving chemotherapy and radiation therapy by stage, ethnicity and socioeconomic status, and the odds ratio of receiving these therapies while controlling for other confounding factors such as age, sex, marital status, comorbidity,

year of diagnosis and SEER regions. For patients with both early stage (I-II) and late stage (III-IV), African-American patients were significantly less likely to receive chemotherapy (odds ratio = 0.69, 95% CI=0.50–0.95 for stage I-II) and other ethnic groups were slightly more likely but not significantly to receive this therapy (odds ratio=1.16, 95% CI=0.92–1.47) compared to Caucasians. However, there were no significant differences in receiving radiation therapy among these ethnic groups. There were also no significant variations by socioeconomic status.

Table 5 presents the effects of patient and tumor factors on the risk of all-cause and NHL-specific mortality in association with race/ethnicity for all populations and stratified by stage I-II and stage III-IV. Compared to Caucasians, African-Americans did not have statistically significant risks of all-cause (Hazard ratio = 0.97, 95% confidence interval: 0.88–1.08 for all stages) and disease-specific mortality (1.07, 0.92–1.25), whereas other ethnic patients with stage I-II were significantly more likely to die of all-cause (1.28, 1.12–1.46) and of NHL-specific mortality (1.43, 1.15–1.78), after adjusting for treatment, comorbidity and socioeconomic factors. Women were significantly less likely to die than men while the opposite was the case for unmarried patients compared to married ones. The hazard ratio of all-cause and disease-specific mortality increased significantly with age ($P<0.001$). The hazard ratio also increased with advanced tumor stage, higher comorbidity scores, and poorer socioeconomic status. Overall, patients receiving either chemotherapy or radiation therapy or both were significantly less likely to die of all-causes.

When stratified by subtypes of NHL, the results were similar (Table 6). For example, racial disparities in both all-cause and NHL-specific mortality were not significant across diffuse large B-cell lymphoma, chronic lymphocytic leukemia or small lymphocytic lymphoma, follicular lymphoma, and all other subtypes.

Discussion

This study examined racial/ethnic disparities in diagnosis, treatment and socioeconomic factors in association with survival in patients with NH-lymphoma. Our study revealed several important findings. First, it indicates that 52.4% of elderly Caucasian patients with NHL received chemotherapy compared to 43.2% of African-Americans ($P<0.01$). Second, although chemotherapy has been documented to be efficacious in prolonging survival in clinical trial settings, few community-based studies demonstrated its effectiveness. Our study of this large population-based cohort indicates that the receipt of chemotherapy was significantly associated with prolonged survival in patients with NHL. Third, there were substantial variations in socioeconomic status within this cohort of patients, with a larger proportion of African-American patients living in the lowest or poorest quartile of socioeconomic status. Poor socioeconomic status was significantly associated with increased risk of mortality. Finally, ethnic disparities at diagnosis, treatment and socioeconomic status played a major role in survival disparities. After adequately controlling for these factors in the analysis, there were no significant differences in all-cause and NHL-specific mortality between African-American and Caucasian patients.

With advances in medical care, particularly with effective chemotherapy, patients with NHL can now live much longer. This survival benefit documented in numerous clinical trials^{8–20} has been translated into the community effectiveness according to our population-based study. Those patients receiving chemotherapy had a significantly lower risk of death. However, substantial disparities in receiving these therapies were observed among ethnic groups with a particularly lower rate of chemotherapy and radiation therapy in African-American patients. Furthermore, there was a strong relationship between the risk of mortality and socioeconomic status, while a larger proportion of elderly African-American patients lived in communities with poorer socioeconomic status. Therefore, controlling for socioeconomic factor in the analysis was important when examining racial disparities in survival. This study was the first to show ethnic survival disparity in patients with NHL.

Our study also indicated that other ethnic groups had a slightly higher risk of all-cause and disease-specific death that was limited in patients with stage I-II lymphoma. However, because other ethnic groups had small numbers of cases and included numerous different ethnic populations, the results would be more vulnerable to residual confounding due to imperfect adjustment for differences in these populations. Our study also found that women with NHL were significantly less likely to die of all causes for all stages and to die of lymphoma specifically for stages I-II only, even after adjustment for other factors. This finding was consistent with reports from the SEER registries with a higher relative survival in women than in men.^{1,2}

This study has a number of strengths. First, this SEER-Medicare linked data not only provided well-validated information on tumor characteristics at diagnosis and 11 years of follow-up of the vital status, but also allowed the examination of socioeconomic status at the census tract level. Second, our study cohort of elderly patients was covered by Medicare insurance program regardless of where they received care in the country. Thus, more complete information on cancer therapy were obtained by Medicare claims. In addition, comorbid conditions can well be identified from Medicare data. Since comorbidity is a known factor associated with treatment and survival, controlling for comorbidity in analysis is important to minimize residual confounding when addressing ethnic disparities in survival.

It is also important to note several limitations of this study. First, only Medicare beneficiaries with fee-for-service for Part A and Part B coverage and without HMO enrollment were selected in the analysis because Medicare data does not include claims for HMO enrollees. There were potential selection biases here if those beneficiaries excluded had different characteristics or patterns of care among ethnic groups. As a result, the generalizability of the results to other populations could be affected. In addition, the study findings may not be generalizable to population of less than 65 year old. Furthermore, this database does not have detailed clinical information on lymphoma grade which may form the basis on which chemotherapy and radiation therapy may be recommended. Therefore, appropriateness of these therapies cannot be assessed adequately from these existing Medicare claims data. Furthermore, there are numerous histologic subtypes of NHL, but some subtypes may not be reliably differentiated. For example, agreement between cancer registry data and chart coders was 90% for diffuse large B-cell lymphoma and 89% for

follicular lymphoma, but only 52% for mantle cell lymphoma.³⁵ Therefore, certain groupings may be helpful to reduce misclassification bias.^{34,35} Our analysis was stratified by several major subtypes of NHL. Finally, since patients were diagnosed with NH lymphoma in 1992–1999 and their treatments were followed to 2002, the use of newly approved chemotherapy agents was unknown, including rituximab that was approved for treating NHL at the end of 1997. Further studies including cases diagnosed in more recent years would help to address the effect of these new chemotherapy agents.

In conclusion, there was a strong positive association between the use of chemotherapy and prolonged survival, and poorer socioeconomic status was significantly associated with the higher risk of mortality. There were no significant differences in all-cause and lymphoma-specific mortality between African-American and Caucasian patients with Non-Hodgkin's lymphoma after controlling for treatment, socioeconomic status and patient demographics and tumor factors. It would be helpful if further studies incorporate patients' clinical performance status and disease severity.

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Table 1.

Comparison of characteristics among different ethnic groups in patients with NH-lymphoma

Characteristics	Caucasians		African-Americans		Others		P value by ethnicity
	N	%	n	%	n	%	
Median age (range)	76(65–104)		74(65–100)		75(65–100)		
Age							
65–69	2319	19.5	132	24.8	206	22.4	<0.001
70–74	2939	24.8	153	28.7	221	24.0	
75–79	2864	24.1	112	21.0	224	24.4	
80	3746	31.6	136	25.5	269	29.2	
Sex							
Male	5375	45.3	228	42.8	459	49.9	0.011
Female	6493	54.7	305	57.2	461	50.1	
Marital Status							
Married	6458	54.4	200	37.5	530	57.6	<0.001
Unmarried	4927	41.5	310	58.2	355	35.6	
Missing	483	4.1	23	4.3	35	3.8	
Tumor Stage							
I	3623	30.5	121	22.7	282	30.7	<0.001
II	1700	14.3	69	13.0	150	16.3	
III	1437	12.1	93	17.5	130	14.1	
IV	3981	33.5	204	38.3	279	30.3	
Unknown	1127	9.5	46	8.6	79	8.6	
Lymph node site							
Nodal	3585	30.2	166	31.1	388	42.2	<0.001
Extranodal	8283	69.8	367	68.9	532	57.8	
Chemotherapy							
No	5648	47.6	303	56.9	417	45.3	<0.001
Yes	6220	52.4	230	43.2	503	54.7	
Radiation therapy							
No	8985	75.7	436	81.8	675	73.4	0.001
Yes	2883	24.3	97	18.2	245	26.6	
Comorbidity score							
0	6273	52.9	228	42.8	463	50.3	<0.001
1	3173	26.7	144	27.0	254	27.6	
2	1384	11.7	73	13.7	105	11.4	
>=3	1038	8.8	88	16.5	98	10.7	
Year of diagnosis							
1992	1409	11.9	63	11.8	106	11.5	0.105
1993	1493	12.6	61	11.4	102	11.1	
1994	1480	12.5	60	11.3	108	11.7	
1995	1448	12.2	70	13.1	96	10.4	

Characteristics	Caucasians		African-Americans		Others		P value by ethnicity
	N	%	n	%	n	%	
1996	1563	13.2	62	11.6	114	12.4	
1997	1526	12.9	85	16.0	116	12.6	
1998	1458	12.3	67	12.6	134	14.6	
1999	1491	12.6	65	12.2	144	15.7	
Total	11868	100.0	533	100.0	920	100.0	

Table 2.

Comparison of socioeconomic status among different racial/ethnic groups in patients with NH-lymphoma

Socioeconomic Status (quartile from high to low)	Caucasians		African-Americans		Others	
	n	%	n	%	n	%
Education						
1 st	3153	26.6	32	6.0	143	15.5
2 nd	3101	26.1	57	10.7	175	19.0
3 rd	3052	25.7	80	15.0	197	21.4
4 th	2562	21.6	364	68.3	405	44.0
Poverty						
1 st	3149	26.5	22	4.1	153	16.6
2 nd	3087	26.0	59	11.1	200	21.7
3 rd	3040	25.6	67	12.6	211	22.9
4 th	2592	21.8	385	72.2	356	38.7
Income						
1 st	3078	25.9	34	6.4	217	23.6
2 nd	3034	25.6	70	13.1	228	24.8
3 rd	2979	25.1	121	22.7	232	25.2
4 th	2777	23.4	308	57.8	243	26.4
Composite Socioeconomic Status						
1 st	3128	26.4	31	5.8	170	18.5
2 nd	3116	26.3	47	8.8	169	18.4
3 rd	3023	25.5	80	15.0	226	24.6
4 th	2601	21.9	375	70.4	355	38.6
Total	11868	100.0	533	100.0	920	100.0

Table 3.

All-cause and lymphoma-specific survival in patients with NHL, by tumor stage, race/ethnicity and socioeconomic status

Race/ethnicity and socioeconomic status	1-year survival (%) (cases in 1992–1999) (n=13321)		3-year survival (%) (cases in 1992–1999) (n=13321)		5-year survival (%) (cases in 1992–1997) (n=9962)	
	All-cause	NHL-specific	All-cause	NHL-specific	All-cause	NHL-specific
Tumor Stage I–II						
Racial/Ethnic Groups						
Caucasians	72.0	84.4	55.8	77.1	44.6	68.9
African-Americans	68.4	84.7	52.6	77.9	36.2	68.1
Others	63.2	78.7	44.7	73.8	35.7	61.6
Socioeconomic Status (quartile)						
1 st (high)	75.6	86.2	59.9	79.5	50.1	70.9
2 nd	72.3	84.3	56.2	76.9	44.6	69.2
3 rd	70.9	84.4	54.3	76.4	42.7	67.8
4 th (Low)	65.8	81.0	48.8	74.6	37.0	65.6
Patients with stage I–II	71.2	84.0	54.9	76.9	43.7	68.4
Tumor Stage III–IV						
Racial/Ethnic Groups						
Caucasians	54.6	71.8	36.3	63.5	25.4	52.2
African-Americans	43.8	66.0	27.3	56.9	21.2	48.2
Others	50.9	69.7	34.5	61.9	22.9	50.2
Socioeconomic Status (quartile)						
1 st (high)	58.8	74.9	40.3	66.3	28.5	55.6
2 nd	55.5	72.5	38.0	65.0	28.2	54.4
3 rd	51.5	68.3	33.6	59.7	22.8	47.2
4 th (Low)	49.7	69.8	31.3	61.2	20.9	50.4
Patients with stage III–IV	53.8	71.3	35.7	63.0	25.0	51.9
All Tumor Stages						
Racial/Ethnic Groups						
Caucasians	62.3	77.6	45.3	70.0	34.4	60.3
African-Americans	54.0	73.4	37.7	65.1	27.9	55.6
Others	56.6	74.6	39.5	68.3	29.3	56.7
Socioeconomic Status (quartile)						
1 st (high)	66.8	80.7	49.6	73.0	38.8	63.3
2 nd	63.0	77.8	46.6	70.6	36.5	61.9
3 rd	59.8	75.8	43.1	67.9	32.2	57.3
4 th (Low)	56.9	74.8	39.1	67.1	27.7	56.9

Race/ethnicity and socioeconomic status	1-year survival (%) (cases in 1992–1999) (n=13321)		3-year survival (%) (cases in 1992–1999) (n=13321)		5-year survival (%) (cases in 1992–1997) (n=9962)	
	All-cause	NHL-specific	All-cause	NHL-specific	All-cause	NHL-specific
Patients with all stages	61.6	77.2	44.6	69.7	33.8	59.8

Table 4.

Receipt of chemotherapy and radiation therapy in patients with NH-lymphoma, by stage, race/ethnicity, and socioeconomic status

Race and Socioeconomic Status, and Stage	Number of patients (n=13321)	Receipt of Chemotherapy		Receipt of Radiotherapy	
		%	Odds ratio * (95% CI)	%	Odds ratio * (95% CI)
Stage I–II					
Racial/Ethnic Groups					
Caucasians	5323	50.9	1.00	35.4	1.00
African-Americans	190	40.0	0.69(0.50–0.95)	25.3	0.72(0.50–1.02)
Others	432	49.5	1.16(0.92–1.47)	39.6	1.13(0.89–1.44)
Socioeconomic Status (quartile)					
1 st (high)	1554	51.1	1.00	36.5	1.00
2 nd	1476	48.4	0.93(0.80–1.09)	37.7	1.02(0.87–1.18)
3 rd	1482	52.2	1.07(0.92–1.26)	35.8	0.88(0.75–1.04)
4 th (low)	1433	50.2	0.98(0.83–1.15)	31.1	0.75(0.63–0.89)
Stage					
I	4026	45.4	1.00	39.8	1.00
II	1919	61.2	1.79(1.59–2.02)	26.0	0.54(0.48–0.61)
Subtotal	5945	50.5	-	35.3	-
Stage III–IV					
Racial/Ethnic Groups					
Caucasians	5418	57.1	1.00	15.3	1.00
African-Americans	297	46.8	0.66(0.51–0.86)	14.1	0.85(0.59–1.22)
Others	409	62.1	1.47(1.15–1.88)	15.2	0.88(0.64–1.22)
Socioeconomic Status (quartile)					
1 st (high)	1491	56.1	1.00	16.4	1.00
2 nd	1544	58.5	1.13(0.97–1.31)	15.7	0.96(0.79–1.18)
3 rd	1519	56.8	1.06(0.91–1.25)	14.2	0.90(0.72–1.11)
4 th (low)	1570	56.5	1.10(0.93–1.30)	14.8	0.96(0.77–1.19)
Stage					
III	1660	59.7	1.00	11.4	1.00
IV	4464	56.0	0.86(0.76–0.97)	16.7	1.45(1.22–1.73)
Subtotal	6124		-	15.3	-
All Stages					
Racial/Ethnic Groups					
Caucasians	11868	52.4	1.00	24.3	1.00
African-Americans	533	43.2	0.68(0.56–0.83)	18.2	0.79(0.62–1.00)
Others	920	54.7	1.32(1.12–1.55)	26.6	1.02(0.85–1.23)
Socioeconomic Status (quartile)					

Race and Socioeconomic Status, and Stage	Number of patients (n=13321)	Receipt of Chemotherapy		Receipt of Radiotherapy	
		%	Odds ratio* (95% CI)	%	Odds ratio* (95% CI)
1 st (high)	3329	52.4	1.00	25.9	1.00
2 nd	3332	52.3	1.04(0.94–1.15)	25.4	0.98(0.87–1.10)
3 rd	3329	52.7	1.08(0.97–1.20)	23.8	0.90(0.79–1.01)
4 th (low)	3331	51.6	1.04(0.93–1.16)	21.9	0.84(0.74–0.95)
Stage					
I	4026	45.4	1.00	39.8	1.00
II	1919	61.2	1.81(1.61–2.03)	26.0	0.57(0.51–0.65)
III	1660	59.7	1.61(1.42–1.82)	11.4	0.23(0.20–0.27)
IV	4464	56.0	1.39(1.26–1.52)	16.7	0.35(0.32–0.39)
Unstaged	1252	37.0	0.74(0.65–0.85)	15.1	0.31(0.26–0.36)
Total	13321	52.2	-	24.2	-

* Odds ratio adjusted for sex, age, marital status, **socioeconomic status**, stage, site, comorbidity, year of diagnosis, and SEER region.

Table 5.

All-cause and NH-Lymphoma-specific mortality in association with race/ethnicity and other factors in patients with NH-Lymphoma, stratified by stage

Race/ethnicity and other factors	Hazard ratio (95% confidence interval) of mortality [†]					
	All-cause mortality			NH-Lymphoma-specific mortality		
	Stage I–II	Stage III–IV	All stages	Stage I–II	Stage III–IV	All stages
Race/ethnicity						
Caucasians	1.00	1.00	1.00	1.00	1.00	1.00
African-Americans	0.90(0.75–1.08)	1.07(0.93–1.22)	0.97(0.88–1.08)	0.84(0.62–1.14)	1.17(0.96–1.41)	1.07(0.92–1.25)
Others	1.28(1.12–1.46)	1.02(0.90–1.17)	1.13(1.03–1.23)	1.43(1.15–1.78)	1.08(0.90–1.30)	1.19(1.04–1.36)
Sex						
Male	1.00	1.00	1.00	1.00	1.00	1.00
Female	0.78(0.73–0.84)	0.83(0.78–0.88)	0.80(0.77–0.84)	0.83(0.74–0.93)	0.94(0.86–1.02)	0.91(0.85–0.97)
Age						
65–69	1.00	1.00	1.00	1.00	1.00	1.00
70–74	1.29(1.16–1.43)	1.23(1.12–1.34)	1.26(1.18–1.35)	1.22(1.03–1.45)	1.22(1.08–1.39)	1.23(1.12–1.36)
75–79	1.63(1.47–1.81)	1.52(1.39–1.66)	1.59(1.49–1.70)	1.48(1.25–1.75)	1.41(1.24–1.61)	1.46(1.32–1.61)
80	2.66(2.41–2.94)	2.07(1.90–2.26)	2.39(2.25–2.55)	2.18(1.86–2.56)	1.91(1.69–2.16)	2.09(1.90–2.29)
Marital status						
Married	1.00	1.00	1.00	1.00	1.00	1.00
Unmarried	1.21(1.12–1.30)	1.17(1.10–1.25)	1.20(1.15–1.26)	1.25(1.12–1.41)	1.09(1.00–1.20)	1.18(1.10–1.26)
Unknown	0.94(0.78–1.14)	0.67(0.57–0.80)	0.73(0.65–0.81)	0.72(0.50–1.04)	0.54(0.41–0.71)	0.54(0.45–0.66)
Stage						
I	1.00	-	1.00	1.00	-	1.00
II	1.29(1.20–1.39)	-	1.28(1.19–1.37)	1.49(1.33–1.66)	-	1.45(1.30–1.61)
III	-	1.00	1.52(1.42–1.63)	-	1.00	1.86(1.67–2.08)
IV	-	1.20(1.13–1.28)	1.83(1.73–1.93)	-	1.19(1.09–1.31)	2.21(2.03–2.40)
Un-staged	-	-	1.61(1.50–1.74)	-	-	1.86(1.65–2.09)
Lymph node site						
Nodal	1.00	1.00	1.00	1.00	1.00	1.00
Extranodal	0.91(0.86–0.98)	0.85(0.79–0.92)	0.87(0.83–0.91)	0.94(0.84–1.04)	0.80(0.72–0.90)	0.83(0.77–0.89)
Comorbidity scores						
0	1.00	1.00	1.00	1.00	1.00	1.00
1	1.35(1.25–1.46)	1.26(1.18–1.35)	1.31(1.25–1.37)	1.23(1.09–1.39)	1.21(1.10–1.33)	1.23(1.14–1.32)
2	1.59(1.44–1.75)	1.60(1.46–1.74)	1.62(1.52–1.72)	1.42(1.21–1.67)	1.37(1.20–1.56)	1.44(1.31–1.58)
3	2.44(2.19–2.72)	1.86(1.69–2.05)	2.08(1.94–2.22)	2.11(1.78–2.51)	1.58(1.37–1.81)	1.73(1.56–1.92)
Therapy						
None	1.00	1.00	1.00	1.00	1.00	1.00
Radiation only	0.80(0.72–0.88)	1.11(0.98–1.26)	0.87(0.81–0.94)	0.81(0.69–0.96)	1.08(0.90–1.29)	0.87(0.78–0.98)
Chemotherapy only	1.00(0.93–1.09)	0.82(0.77–0.88)	0.88(0.84–0.92)	1.11(0.98–1.27)	0.87(0.79–0.95)	0.94(0.87–1.00)
Both	0.84(0.76–0.93)	0.93(0.84–1.03)	0.85(0.79–0.91)	1.02(0.88–1.19)	1.07(0.94–1.23)	1.01(0.91–1.11)

Race/ethnicity and other factors	Hazard ratio (95% confidence interval) of mortality [†]					
	All-cause mortality			NH-Lymphoma-specific mortality		
	Stage I–II	Stage III–IV	All stages	Stage I–II	Stage III–IV	All stages
SES (quartile) [†]						
1 st (high)	1.00	1.00	1.00	1.00	1.00	1.00
2 nd	1.07(0.98–1.17)	1.05(0.97–1.14)	1.04(0.98–1.10)	1.07(0.92–1.24)	1.05(0.94–1.19)	1.06(0.97–1.16)
3 rd	1.12(1.02–1.23)	1.16(1.06–1.26)	1.13(1.07–1.20)	1.10(0.94–1.28)	1.26(1.12–1.43)	1.20(1.09–1.31)
4 th (low)	1.31(1.19–1.44)	1.22(1.12–1.33)	1.23(1.16–1.31)	1.22(1.04–1.43)	1.17(1.03–1.33)	1.18(1.08–1.30)

* Denotes significance level p<0.05,

** p<0.01.

[†] SES denotes socioeconomic status. Hazard ratio adjusted for variables listed in the tables plus the year of diagnosis and SEER areas.

Table 6.

All-cause and NH-Lymphoma-specific mortality in association with race/ethnicity, stratified by subtypes of NH-Lymphoma

Race/ethnicity and other factors	Hazard ratio (95% confidence interval) of mortality,* by subtypes of NH-Lymphoma			
	Diffuse large B-cell lymphoma(DLBCL)	Chronic lymphocytic leukemia or small lymphocytic lymphoma	Follicular lymphoma	All other subtypes or unknown
All-cause mortality				
Race/ethnicity				
Caucasians	1.00	1.00	1.00	1.00
African-Americans	1.05(0.88–1.25)	0.95(0.69–1.31)	1.00(0.71–1.43)	0.94(0.80–1.10)
Others	1.11(0.97–1.26)	1.00(0.73–1.37)	0.71(0.47–1.09)	1.12(0.97–1.28)
Sex				
Male	1.00	1.00	1.00	1.00
Female	0.88(0.82–0.94)	0.73(0.64–0.82)	0.74(0.63–0.86)	0.76(0.71–0.82)
Age				
65–69	1.00	1.00	1.00	1.00
70–74	1.19(1.07–1.32)	1.43(1.20–1.70)	1.53(1.20–1.96)	1.19(1.07–1.32)
75–79	1.43(1.29–1.58)	1.85(1.54–2.21)	1.77(1.38–2.26)	1.55(1.40–1.72)
80	1.78(1.61–1.97)	2.94(2.46–3.52)	3.11(2.46–3.92)	2.34(2.12–2.59)
Marital status				
Married	1.00	1.00	1.00	1.00
Unmarried	1.06(0.99–1.14)	1.36(1.19–1.55)	1.17(0.99–1.38)	1.24(1.15–1.33)
Unknown	0.94(0.77–1.14)	0.92(0.65–1.30)	1.09(0.79–1.51)	0.58(0.49–0.69)
NH-Lymphoma-specific mortality				
Race/ethnicity				
Caucasians	1.00	1.00	1.00	1.00
African-Americans	1.19(0.95–1.50)	1.00(0.59–1.69)	0.70(0.33–1.49)	1.04(0.82–1.33)
Others	1.14(0.95–1.37)	0.87(0.51–1.48)	0.79(0.33–1.91)	1.15(0.92–1.43)
Sex				
Male	1.00	1.00	1.00	1.00
Female	0.92(0.84–1.02)	0.76(0.62–0.95)	0.77(0.57–1.05)	0.91(0.82–1.02)
Age				
65–69	1.00	1.00	1.00	1.00
70–74	1.16(1.01–1.33)	1.20(0.91–1.59)	1.67(0.99–2.79)	1.23(1.04–1.45)
75–79	1.32(1.15–1.52)	1.36(1.01–1.84)	2.44(1.48–4.02)	1.42(1.20–1.67)
80	1.38(1.20–1.58)	2.31(1.73–3.09)	4.28(2.66–6.89)	2.12(1.81–2.48)
Marital status				
Married	1.00	1.00	1.00	1.00
Unmarried	1.09(0.99–1.21)	1.25(1.00–1.56)	1.13(0.82–1.55)	1.19(1.06–1.34)
Unknown	0.80(0.59–1.08)	0.67(0.34–1.32)	0.54(0.26–1.15)	0.44(0.32–0.60)

* SES denotes socioeconomic status. Hazard ratio adjusted for variables listed in the tables plus tumor stage, lymph node site, comorbidity score, therapy, socioeconomic status, the year of diagnosis and SEER areas.

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