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Nutritional Factors and Non-Hodgkin Lymphoma Survival in an Ethnically Diverse Population: The Multiethnic Cohort Study

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Abstract

Background/Objectives—To understand the possible effect of modifiable health behaviors on the prognosis of the increasing number of non-Hodgkin lymphoma (NHL) survivors, we examined the pre-diagnostic intake of major food groups with all-cause and NHL-specific survival in the Multiethnic Cohort (MEC).

Subjects/Methods—This analysis included 2,339 participants free of NHL at cohort entry and diagnosed with NHL as identified b cancer registries during follow-up. Deaths were ascertained through routine linkages to state and national death registries. Cox proportional hazards regression was applied to estimate hazard ratios (HR) and 95% confidence intervals (CI) for overall and NHL-specific mortality according to prediagnostic intake of vegetables, fruits, red meat, processed meat, fish, legumes, dietary fiber, dairy products, and soy foods assessed by food frequency questionnaire.

Results—The mean age at diagnosis was 71.8±8.5 years. During 4.5±4.1 years of follow-up, 1,348 deaths, including 903 NHL-specific deaths, occurred. In multivariable models, dairy intake was associated with higher all-cause mortality (highest vs. lowest tertile: HR=1.14, 95% CI 1.00–1.31, p_{trend}=0.03) and NHL-specific (HR=1.16, 95% CI 0.98–1.37) mortality. Legume intake above the lowest tertile was related to significant 13–16% lower all-cause and NHL-specific mortality, while red meat and fish intake in the intermediate tertiles was associated with lower NHL-specific mortality. No association with survival was detected for the other food groups.

Conclusion—These data suggest that pre-diagnostic dietary intake may not appreciably contribute to NHL survival although the higher mortality for dairy products and the better prognosis associated with legumes agree with known biologic effects of these foods.

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Keywords

Non-Hodgkin Lymphoma; Ethnicity; Nutrition; Survival; Prognosis

Introduction

Non-Hodgkin lymphoma (NHL) is the seventh most commonly diagnosed cancer among men and women in the USA.[1] NHL survival has improved over the past decade with the addition of rituximab to traditional therapies.[2] Recent data indicate a 5-year relative survival rate for NHL patients as high as 71%.[1] Well established factors predicting poor prognosis include 60 years of age or older at diagnosis, advanced stage at diagnosis, elevated serum lactate dehydrogenase (LDH) as a marker of increased tumor burden, poor performance status, and extranodal involvement.[3] With the rising number of NHL survivors, the possible effect of modifiable health behaviors on prognosis has emerged as a topic of interest. Obesity has been associated with higher all-cause and NHL-specific mortality in several reports.[4–6] Dietary factors have also been examined in relation to NHL survival.[7–9] Phytochemicals and antioxidants in fruits and vegetables may inhibit tumor progression via antioxidant pathways, influence on immune system function, and modulation of detoxification enzymes,[8] while meat intake may contribute to chronic antigenic stimulation and immune system impairment,[10] thereby contributing to the development and progression of NHL. Previous studies have largely focused on dietary factors in relation to NHL risk. Higher intake of fruits and vegetables appears to be protective,[11,12] whereas meat, fat and sweets,[13–15] as well as milk and dairy products,[16–18] have been associated with a higher risk. The limited evidence on NHL survival is conflicting. One study reported better survival in women with high pre-diagnostic intakes of vegetables, green vegetables, and citrus fruits,[8] while others found no association between pre-diagnostic fruit and vegetable intake[9] and pre-diagnostic nitrite intake.[7] The current analysis examined whether intake of several major food groups were associated with survival among white, African American, Native Hawaiian, Japanese American, and Latino NHL patients in Hawaii and Los Angeles who participated in the Multiethnic Cohort (MEC). Specifically, we hypothesized that higher intakes of fruits, vegetables and legumes, and lower intake of meat and dairy would be associated with better all-cause and NHL-specific survival.

Methods

Study population

The MEC is a longitudinal study designed to investigate associations of dietary, lifestyle, and genetic factors with the incidence of cancer and has been described previously in detail.[19] Briefly, 215,831 men and women who were aged 45–75 years at the time of recruitment and resided in Hawaii or California (primarily Los Angeles County) entered the cohort between 1993 and 1996. Potential participants were identified through drivers' license files, voter registration lists, and Health Care Financing Administration data files to obtain a multiethnic sample of African Americans, Japanese Americans, Latinos, Native Hawaiians, and whites. Participants completed a self-administered 26-page baseline questionnaire that asked about demographic characteristics, anthropometric measures, medical history, family history of cancer, reproductive history, cancer screening, physical activity, and detailed questions on diet. The study protocol was approved by the Institutional Review Boards of the University of Hawaii and the University of Southern California.

All participants included in the current analysis were free of a self-reported or registry-detected NHL diagnosis at the time of cohort entry and completion of the baseline questionnaire. Incident cases of NHL were identified by routine linkages with the Los Angeles County Cancer Surveillance Program, the State of California Cancer Registry, and the statewide Hawaii Tumor Registry, all part of the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program,[20] which has achieved high completeness and follow-up rates.[21;22] Given the low out-migration of <5% in MEC participants,[23] the number of missed cases is expected to be low; for rapidly fatal cancers, cases would also be captured through death records. NHL types were defined according to the adaptation of the World Health Organization classification for epidemiologic studies using the International Classification of Disease Oncology version 3:[24;25] diffuse large B-cell lymphoma (DLBCL) (9679, 9680, 9684), follicular (FL) (9690, 9691, 9695, 9698), chronic lymphocytic leukemia (CLL) (9823) and small lymphocytic lymphoma (SLL) (9670), marginal zone lymphoma (MZL) (9689, 9699), T-cell lymphoma (9700–9719, 9675 (T), 9827, 9831, 9834, 9948), plasma cell myeloma/plasma cell leukemia (PCM) (9732, 9733) and all other types (9671, 9673, 9675, 9687, 9761, 9826, 9832, 9833, 9835, 9836, 9940). Deaths were identified by computer linkages with the California and Hawaii vital records and also through the National Death Index. Therefore, death ascertainment is considered close to 100%. The causes of death were coded according to the International Classification of Diseases (ICD)-9 or ICD-10. NHL-specific deaths were defined by ICD version 8 and 9 codes describing NHL or related conditions (2001, 2002, 2021, 2028, 2030 2040, 2041, 2049, 2078, 2080, 2089, 2387, C829–C831, C833, C837, C840, C844, C845, C850, C851, C859, C880, C900, C910, C911, C915, C917, C947, C951, C959).

Dietary Assessment

Dietary intake was assessed at baseline using a quantitative food-frequency questionnaire (QFFQ) that obtained frequency and quantity of more than 180 food items consumed during the preceding year (20). Items included were the minimum set that could capture 85% or higher of the intake of key nutrients for each racial or ethnic group. The QFFQ was developed from 3-day measured food records collected from each of the 5 ethnic groups (20) and was validated in a calibration study.[26] Food and nutrient intakes were calculated using food composition tables maintained by the University of Hawaii Cancer Center and the MyPyramid Equivalents Database, a standardized food-grouping system developed by the United States Department of Agriculture that disaggregates most foods into their ingredients and allocates each ingredient to one of 32 food groupings.[27] Food groups examined for the current analysis were vegetables, fruits, red meat (beef, pork and lamb), processed red meat, fish, legumes, dairy products, and soy foods. Dairy intake was estimated from milk, cheese, and mixed dishes. Legume intake included single legumes and mixed dishes. Soy intake was estimated from miso, tofu, and vegetarian meats. Dietary fiber was computed by aggregating grams of fiber contained in fruits, vegetables, grains, legumes, and mixed dishes.

Statistical Analysis

Daily dietary intake was expressed as food density (daily intake per 4,184 kJ) because a calibration study within the MEC found a stronger correlation between the QFFQ and multiple 24-h recalls after energy adjustment than with absolute nutrient intakes.[26] We investigated the intake of each food group as tertiles of energy-adjusted food groups. Hazard ratios (HR) and 95% confidence intervals (CI) were estimated using Cox proportional hazards models with age as the time metric. For all-cause mortality, survival was modeled starting at diagnosis and ending at age of death from any cause or censored at the end of the observation period (12/31/2010). For NHL-specific survival, age of death due to NHL was modeled; everyone else was censored at the time of death from other causes or at the end of the observation period.

To account for their known association with survival,[4–6] age at NHL diagnosis (continuous) BMI (<22.5, 22.5–24.9, 25.0–29.9, ≥30 kg/m^2), sex, ethnicity, SEER summary stage (local, regional, distant, and unstaged/unknown), type (DLBCL, FL, CLL/SLL, MZL, PCM, T-cell, others), chemo-, radio-, immuno-, and steriodtherapy (yes, no/unknown), smoking status at baseline (never, former, current), alcohol use (0, <1, ≥1 drink/day), education status (≤12, >12 years), energy intake (log transformed), and the number of comorbidities (hypertension, diabetes, heart attack/angina/stroke) were included into the models as covariates (Supplemental Table 1). Linear trends were tested by entering the median value of each tertile into regression as a continuous variable. Heterogeneity of risk across ethnic groups and NHL type was assessed using a global Wald test of the cross-product terms for the respective food group variable, parameterized as tertile indicators, with ethnic group or NHL type. In addition, a covariate only model for all-cause mortality and stratified analyses according to major NHL types and by stage at diagnosis were performed. The number of NHL cases provided reasonable power as computed according to established methods.[28] The minimum detectable risk ratio (MDHR) in survival estimates, assuming 2339 cases, α=0.05 (two-sided), β=0.20, the proportion exposed as $\pi_1 = 0.33$ (assuming tertiles), and average survival estimates of 58% for all deaths and 39% for NHL-specific death, are 1.25 and 1.21, but they would be smaller for ethnic- and type-specific analyses.

Results

A total of 2,339 NHL cases were identified among cohort members and included in this analysis. The mean age at diagnosis was 71.8 ± 8.5 years with 53% men and 47% women (Table 1). African Americans, Caucasians, Native Hawaiians, Japanese Americans and Latinos comprised 20%, 26%, 6%, 23%, and 24% of the study population, respectively. The NHL types diagnosed included PCM (24.4%), DLBCL (21.1%), CLL/SLL (15.5%), FL (11.0%), MZL (8.4%), T-cell lymphomas (5.1%) and others (14.5%). During a mean follow-up of 4.5±4.1 years with 10,545 person-years, a total of 1,348 deaths and 903 NHL-specific deaths occurred. The unadjusted overall 5-year survival rate was 50% with better survival in whites and Japanese Americans than the other three groups. Dietary intake differed significantly by ethnicity for most food groups except fruit (Table 2). Latinos and Native Hawaiians reported the highest vegetable density-adjusted intake. Native Hawaiians had the highest consumption of red meat, processed red meat and fish, while Latinos had the highest intake of legumes and dietary fiber. Caucasians and Latinos reported the highest consumption of dairy products and Japanese Americans consumed the most soy foods.

In a covariate-only model, strongest predictors of survival were age, NHL type, and stage at diagnosis; comorbidity, BMI, smoking status, steroid treatment but not the other types of therapy were also significantly associated with mortality, while the HRs for sex, education, and alcohol intake were relatively small (Supplemental Table 1). In multivariable analyses (Table 3), the highest tertile for density-adjusted intake of dairy products was associated with a 14% (95% CI 1.00–1.31) higher risk of all-cause mortality compared with the lowest tertile. A statistically significant linear trend was observed between all-cause mortality and intake of dairy products (P_{trend} =0.03). A similar elevated risk of NHL-specific mortality, although not statistically significant (HR 1.16, 95% CI 0.98–1.37), was observed for patients in the highest tertile of dairy products.

Compared to the lowest tertile, the risk for all-cause and NHL-specific mortality was 14–17% lower for participants in the second and tertile for legume intake. The risk estimates were statistically significant for the second tertile (HR 0.83, 95% CI 0.71–0.98 and HR 0.86, 95% CI 0.72–1.02). After combining participants in the two upper tertiles; the resulting HRs were 0.87 (95% CI 0.77–0.98) for all-cause and 0.84 (95% CI 0.73–0.98) for NHL-specific mortality. For red meat and fish, survival was significantly (20 and 16%) better in the intermediate tertiles without statistically significant trends (p=0.72 and 0.36). The other food groups, i.e., vegetables, fruits, processed meat, dietary fiber, and soy foods, did not predict survival.

Stratification by stage at diagnosis resulted in stronger associations with localized/regional than distant disease. For example, the respective HRs for the highest intake of dairy products and all-cause survival were 1.25 (95% CI 0.92–1.70) and 1.11 (95% CI 0.94–1.30). No significant interactions with ethnicity (data not shown) or NHL type (Supplemental Table 2) were found. Only the interaction of dietary fiber with NHL-specific mortality was borderline (p=0.09) and for FL, a higher intake of fiber was associated with higher mortality (HR 2.59, 95% CI 1.12–5.99).

Discussion

In this ethnically diverse cohort of NHL patients, few associations between dietary intake and all-cause or NHL-specific survival were detected. A higher risk of all-cause and NHL-specific mortality was seen for dairy products, while lower all-cause and NHL-specific mortality was detected for legume intake in the two highest tertiles as well as for intermediate intakes of fish and red meat. Previous investigations of NHL survival have not examined the association with the consumption of dairy products and legumes,[7–9] but dairy products have been described as risk factors for developing NHL.[16–18] Our results agree with a previous study that did not observe a survival benefit with greater pre-diagnostic consumption of fruits and vegetables[9] and disagree with a report of better overall survival in female patients consuming high intakes of green leafy vegetables and citrus fruits.[8]

Dairy products have been associated with NHL risk[16–18] and calcium in dairy products may increase the risk of NHL-specific mortality through inhibition of 1,25-dihydroxyvitamin D (1,25$(OH)_2$D) production; this metabolite is involved in differentiation and apoptosis and inhibits cell growth of neoplastic cells. Lower levels of 1,25$(OH)_2$D were associated with worse survival for DLBCL and T-cell lymphoma cases in a prospective cohort of NHL patients.[29] Elevated all-cause mortality was observed with higher milk intake in a Swedish population. A potential mechanism offered by the authors is an increase in oxidative stress and inflammation related to the high amount of lactose and, therefore D-galactose, in milk.[30] Our finding of lower mortality with higher legume intake without a significant dose-response relation suggests that any protective effect of legumes plateaus at a relatively low level. It has been hypothesized that a variety of constituents in legumes, such as selenium, protease inhibitors, inositol and saponins, may have protective effects against cancer.[31] Similar to fish intake, red meat consumption in moderate amounts predicted better survival, whereas red meat intake appears to increase NHL incidence.[13–15] Given the borderline significance of the interaction term, the association of FL with fiber intake is likely a chance finding.

A strength of this study is the population-based, prospective design comprised of a large number of ethnically diverse individuals. The detailed information collected at cohort entry allowed adjustment of potential confounding factors, such as smoking, and comorbidities. Furthermore, the dietary data were collected using a common QFFQ, tailored for use in each ethnic group, which allowed for a meaningful comparison of results across the ethnic groups. An additional strength is the ascertainment of incident NHL diagnoses and deaths through linkages with high-quality population-based tumor registries[21] that provided detailed information on tumor characteristics, as well as treatment within 6 months of diagnosis. Based on the reliability of the National Death Index linkage, misclassification of vital status is unlikely.

Several limitations should be considered. The multiple statistical comparisons may have led to chance findings. Given the number of deaths, the statistical power to investigate individual NHL types was limited. The MDHRs for the entire study population were estimated at 1.21–1.25 but would be considerably lower for individual ethnic groups and NHL types. Dietary modifications before diagnosis due to early symptoms or following cancer diagnosis would not have been captured by the present study and may have introduced bias.[31;32] Reporting errors impacting the accuracy of estimates of usual dietary intake may also have influenced the results by attenuating the risk estimates. The lack of more detailed treatment data is serious weakness; coding in the SEER registries does not specify types and dosing of chemo- and radiotherapy. This may explain the weak associations with most modalities of treatment. Also, SEER registries record therapy only for the first course of treatment and rituximab use could not be adequately identified due to coding changes.

The current data suggest that dietary composition patterns have only limited impact on the prognosis of NHL patients; obesity may remain the strongest nutritional predictor at this time.[4–6] On the other hand, multiple weaknesses, in particular the limited statistical power for subgroup analyses, biases and changes in dietary intake, and residual confounding due to lack of details for treatment and other disease-related information, may have obscured any beneficial influence of foods on survival. Several food items may only affect NHL incidence but not mortality because of longer exposure times or different biologic mechanisms. As has been suggested for obesity and colorectal cancer, caution is warranted when transferring findings from risk to survival studies.[33] The small increase in risk for dairy products and the better prognosis associated with legumes may be chance findings, although known biologic effects of these foods agree with the observed results.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Characteristics of NHL cases by ethnicity, Multiethnic Cohort, 1993–2010

Characteristic[a]	All cases	African American	White	Native Hawaiian	Japanese American	Latino	P[b]
Cases, n	2339	472	616	149	538	564	
Person-years	10,545	2,000	3,187	625	2,422	2,311	
Deaths, n							
All-causes	1348	310	310	94	292	342	
NHL-specific	903	212	196	56	203	236	
Age at cohort entry, years	63.0 (8.0)	63.6 (7.9)	62.7 (8.3)	60.1 (9.0)	64.4 (7.9)	62.3 (7.3)	0.94
Age at diagnosis, years	71.8 (8.5)	72.1 (8.4)	71.4 (8.9)	69.0 (9.3)	73.4 (8.3)	71.2 (8.0)	0.39
Sex, n (%)							
Male	1240 (53.0)	212 (44.9)	354 (57.5)	81 (54.4)	286 (53.2)	307 (54.4)	
Female	1099 (47.0)	260 (55.1)	262 (42.5)	68 (45.6)	252 (46.8)	257 (45.6)	0.001
5 year survival, %	50.2	45.2	58.7	43.9	52.2	45.1	<0.001
BMI, kg/m^2, n (%)							
<22.5	361 (15.4)	36 (7.6)	114 (18.5)	15 (10.1)	150 (27.9)	46 (8.2)	
22.5–24.9	559 (23.9)	91 (19.3)	171 (27.8)	24 (16.1)	179 (33.3)	94 (16.7)	
25.0–29.9	946 (40.3)	207 (43.9)	229 (37.2)	65 (43.6)	182 (33.8)	263 (46.6)	
>30.0	473 (20.2)	138 (29.2)	102 (16.6)	45 (30.2)	27 (5.0)	161 (28.6)	<0.001
Education, n (%)							
≤12 years	1072 (45.8)	190 (40.3)	172 (27.9)	87 (58.4)	247 (45.9)	376 (66.7)	
13–15 years	668 (28.6)	172 (36.4)	182 (29.6)	44 (29.5)	148 (27.5)	122 (21.6)	
≥ 16 years	599 (25.6)	110 (23.3)	262 (42.5)	18 (12.1)	143 (26.6)	66 (11.7)	<0.001
Comorbidity, n (%)[c]							
None	1162 (49.7)	176 (37.3)	385 (62.5)	68 (45.6)	226 (42.0)	307 (54.4)	
1	868 (37.1)	211 (44.7)	171 (27.8)	64 (43.0)	237 (44.1)	185 (32.8)	
≥2	309 (13.2)	85 (18.0)	60 (9.7)	17 (11.4)	75 (13.8)	72 (12.8)	<0.001
NHL type, n (%)							
DLBCL	494 (21.1)	55 (11.7)	110 (17.9)	29 (19.5)	146 (27.1)	154 (27.3)	
FL	258 (11.0)	26 (5.5)	76 (12.3)	10 (6.7)	78 (14.5)	68 (12.1)	
CLL/SLL	362 (15.5)	84 (17.8)	159 (25.8)	26 (17.5)	38 (7.1)	55 (9.8)	

Characteristic[a]	All cases	African American	White	Native Hawaiian	Japanese American	Latino	*p*[b]
MZL	197 (8.4)	28 (5.9)	48 (7.8)	11 (7.4)	58 (10.8)	52 (9.2)	
PCM	570 (24.4)	212 (44.9)	112 (18.2)	37 (24.8)	72 (13.4)	137 (24.3)	
T-cell	120 (5.1)	26 (5.5)	26 (4.2)	8 (5.4)	43 (8.0)	17 (3.0)	
Others	338 (14.5)	41 (8.7)	85 (13.8)	28 (18.8)	103 (19.1)	81 (14.4)	<0.001
SEER stage, n (%)							
Local	425 (18.2)	50 (10.6)	108 (17.5)	31 (20.8)	136 (25.3)	100 (17.7)	
Regional	191 (8.2)	18 (3.8)	51 (8.3)	8 (5.4)	58 (10.8)	56 (9.9)	
Distant	1567 (67.0)	378 (80.1)	428 (69.5)	100 (67.1)	311 (57.8)	350 (62.1)	
Unstaged/unknown	156 (6.6)	26 (5.5)	29 (4.7)	10 (6.7)	33 (6.1)	58 (10.3)	<0.001
Chemotherapy, n (%)	1193 (51.0)	252 (53.4)	294 (47.7)	80 (53.7)	272 (50.6)	295 (52.3)	<0.001
Radiotherapy, n (%)	359 (15.4)	60 (12.7)	87 (14.1)	32 (21.5)	110 (20.5)	70 (12.4)	<0.001
Surgery, n (%)	427 (18.3)	53 (11.2)	110 (17.9)	27 (18.1)	125 (23.2)	112 (19.9)	<0.001
Immunotherapy, n (%)	104 (4.5)	15 (3.2)	29 (4.7)	10 (6.7)	28 (5.2)	22 (3.9)	<0.001
Steroid treatment, n (%)	655 (28.0)	130 (27.5)	172 (27.9)	49 (32.9)	167 (31.0)	137 (24.3)	<0.001
Smoking status, n (%)							
Never	1003 (42.9)	168 (35.6)	230 (37.3)	60 (40.3)	274 (50.9)	271 (48.0)	
Former	1000 (42.8)	211 (44.7)	301 (48.9)	60 (40.3)	216 (40.2)	212 (37.6)	
Current	336 (14.4)	93 (19.7)	85 (13.8)	29 (19.5)	48 (8.9)	81 (14.4)	<0.001
Alcohol intake, drink/day							
None	1147 (49.0)	267 (56.6)	186 (30.2)	72 (48.3)	329 (61.2)	293 (52.0)	
≤1	791 (33.8)	137 (29.0)	252 (40.9)	54 (36.2)	140 (26.0)	208 (36.9)	
>1	401 (17.1)	68 (14.4)	178 (28.9)	23 (15.4)	69 (12.8)	63 (11.2)	<0.001

[a] Unless specified, means (SD) presented; percentages may not add to 100 because of rounding

[b] p-value based on ANOVA for continuous variables, χ^2 test for categorical variables, and χ^2 for log-rank test for 5-year survival

[c] Includes heart attack/angina, hypertension, and diabetes

Table 2

Intake of major food groups among NHL cases, Multiethnic Cohort, 1993–2010

Food group[a] (g/4,184 kJ*day^{-1})	All cases	African American	Caucasian	Native Hawaiian	Japanese American	Latino	*P*[b]
Vegetables							
<120.8	783 (33.5)	175 (37.1)	219 (35.6)	56 (37.6)	169 (31.4)	164 (29.1)	
120.8–<179.9	769 (32.9)	161 (34.1)	202 (32.8)	36 (24.2)	190 (35.3)	180 (31.9)	
≥179.9	787 (33.7)	136 (28.8)	195 (31.7)	57 (38.3)	179 (33.3)	220 (39.0)	0.005
Fruits							
<98.6	700 (29.9)	147 (31.1)	171 (27.8)	54 (36.2)	149 (27.7)	179 (31.7)	
98.6–<201.3	809 (34.6)	167 (35.4)	211 (34.3)	51 (34.2)	196 (36.4)	184 (32.6)	
≥201.3	830 (35.5)	158 (33.5)	234 (38.0)	44 (29.5)	193 (35.9)	201 (35.6)	0.33
Red meat							
<12.0	814 (34.8)	185 (39.2)	256 (41.6)	30 (20.1)	190 (35.3)	153 (27.1)	
12.0–<22.1	773 (33.1)	134 (28.4)	201 (32.6)	56 (37.6)	196 (36.4)	186 (33.0)	
≥22.1	752 (32.2)	153 (32.4)	159 (25.8)	63 (42.3)	152 (28.3)	225 (39.9)	<0.0001
Processed meat							
<4.1	821 (35.1)	141 (29.9)	268 (43.5)	35 (23.5)	178 (33.1)	199 (35.3)	
4.1–<8.9	771 (33.0)	137 (29.0)	194 (31.5)	47 (31.5)	178 (33.1)	215 (38.1)	
≥8.9	747 (31.9)	194 (41.1)	154 (25.0)	67 (45.0)	182 (33.8)	150 (26.6)	<0.0001
Fish							
<4.2	830 (35.5)	185 (39.2)	207 (33.6)	20 (13.4)	93 (17.3)	325 (57.6)	
4.2–<9.2	778 (33.3)	170 (36.0)	203 (33.0)	51 (34.2)	194 (36.1)	160 (28.4)	
≥9.2	731 (31.3)	117 (24.8)	206 (33.4)	78 (52.4)	251 (46.7)	79 (14.0)	<0.0001
Dietary fiber							
<9.5	687 (29.4)	135 (28.6)	172 (27.9)	76 (51.0)	205 (38.1)	99 (17.6)	
9.5–<13.2	819 (35.0)	178 (37.7)	215 (34.9)	33 (22.2)	189 (35.1)	204 (36.2)	
≥13.2	833 (35.6)	159 (33.7)	229 (37.2)	40 (26.9)	144 (26.8)	261 (46.3)	<0.0001
Dairy products							
<52.4	699 (29.9)	157 (33.3)	117 (19.0)	67 (45.0)	242 (45.0)	116 (20.6)	
52.4–<117.7	766 (32.8)	157 (33.3)	198 (32.1)	49 (32.9)	166 (30.9)	196 (34.8)	
≥117.7	874 (37.4)	158 (33.5)	301 (48.9)	33 (22.2)	130 (24.2)	252 (44.7)	<0.0001

Food group[a] (g/4,184 kJ*day^{-1})	All cases	African American	Caucasian	Native Hawaiian	Japanese American	Latino	p^b
Legumes							
<9.3	794 (34.0)	196 (41.5)	327 (53.1)	62 (41.6)	107 (19.9)	102 (18.1)	
9.3–<19.2	776 (33.2)	174 (36.9)	184 (29.9)	55 (36.9)	242 (45.0)	121 (21.5)	
≥19.2	769 (32.9)	102 (21.6)	105 (17.1)	32 (21.5)	189 (35.1)	341 (60.5)	<0.0001
Soy foods							
0	1172 (50.1)	364 (77.1)	384 (62.3)	18 (12.1)	13 (2.4)	393 (69.7)	
0.1–>3.0	476 (20.4)	90 (19.1)	128 (20.8)	47 (31.5)	61 (11.3)	150 (26.6)	
≥3.0	691 (29.5)	18 (3.8)	104 (16.9)	84 (56.4)	464 (86.3)	21 (3.7)	<0.0001

[a] Unless specified, means (SD) presented; percentages may not add to 100 because of rounding

[b] p-values based on χ^2 tests

Table 3

Dietary intake and mortality for NHL cases, Multiethnic Cohort, 1993–2010[a]

Food group tertiles (g/4184 kJ*day^{-1})	Medians	Cases	Deaths	All-cause mortality HR (95% CI)	p^b	Deaths	NHL-specific mortality HR (95% CI)	p^b
Vegetables								
<120.8	92.5	783	457	1.00		302	1.00	
120.8–<179.9	148.0	769	426	0.92 (0.80–1.05)		293	0.96 (0.81–1.13)	
≥179.9	230.0	787	465	0.98 (0.85–1.12)	0.83	308	0.98 (0.83–1.16)	0.86
Fruits								
<98.6	56.1	700	387	1.00		260	1.00	
98.6–<201.3	144.7	809	464	0.99 (0.87–1.14)		310	0.98 (0.83–1.17)	
≥201.3	287.6	830	497	1.03 (0.90–1.19)	0.60	333	1.04 (0.88–1.24)	0.57
Red meat								
<12.0	7.0	814	468	1.00		327	1.00	
12.0–<22.1	16.7	773	436	0.91 (0.79–1.04)		275	0.80 (0.68–0.95)	
≥22.1	29.7	752	444	1.00 (0.87–1.15)	0.88	301	0.95 (0.81–1.13)	0.72
Processed meat								
<4.1	2.1	821	458	1.00		298	1.00	
4.1–<8.9	6.3	771	457	1.04 (0.91–1.19)		324	1.13 (0.96–1.33)	
≥8.9	13.0	747	433	0.94 (0.82– 1.08)	0.32	281	0.94 (0.79–1.12)	0.32
Fish								
<4.2	2.1	830	503	1.00		350	1.00	
4.2–<9.2	6.4	778	436	0.92 (0.80–1.05)		276	0.84 (0.71–0.99)	
≥9.2	13.7	731	409	0.90 (0.78–1.03)	0.15	277	0.91 (0.76–1.08)	0.36
Dietary fiber								
<9.5	7.7	687	378	1.00		255	1.00	
9.5–<13.2	11.3	819	463	0.96 (0.83–1.11)		321	0.98 (0.83–1.16)	
≥13.2	16.0	883	507	1.02 (0.88–1.18)	0.70	327	0.98 (0.82–1.17)	0.84
Dairy products								
<52.4	28.2	699	398	1.00		263	1.00	
52.4–<117.7	81.0	766	421	0.99 (0.86–1.14)		287	1.03 (0.87–1.22)	
≥117.7	175.2	874	529	1.14 (1.00–1.31)	0.03	353	1.16 (0.98–1.37)	0.07

Food group tertiles (g/4184 kJ*day^{-1})	Medians	Cases	Deaths	All-cause mortality HR (95% CI)	P^b	Deaths	NHL-specific mortality HR (95% CI)	P^b
Legumes								
<9.3	5.5	794	459	1.00		306	1.00	
9.3–<19.2	13.4	776	428	0.86 (0.75–0.99)		288	0.83 (0.71–0.98)	
≥19.2	31.7	769	461	0.88 (0.76–1.01)	0.15	309	0.86 (0.72–1.02)	0.17
Soy foods								
0	0	1172	674	1.00		451	1.00	
0.1–>3.0	0.5	476	299	1.14 (0.99–1.32)		204	1.17 (0.98–1.40)	
≥3.0	8.1	691	375	0.93 (0.76–1.14)	0.20	248	0.92 (0.72–1.18)	0.21

[a] Hazard ratios (HR) and 95% confidence intervals (CI) from Cox proportional hazards models adjusted for all covariates in Table 1

[b] p-values were calculated using a two-sided test for linear trend modeling the midpoint of each tertile as a continuous variable