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OCCUPATION/INDUSTRY AND RISK OF NON HODGKIN LYMPHOMA IN THE UNITED STATES

Maryjean Schenk¹, Mark P. Purdue², Joanne S. Colt², Patricia Hartge², Aaron Blair², Patricia Stewart², James R. Cerhan³, Anneclaire J. De Roos⁴, Wendy Cozen⁵, and Richard K. Severson¹

¹ Department of Family Medicine and Public Health Sciences, and Karmanos Cancer Institute, Wayne State University, Detroit, MI USA

² Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services, Bethesda, MD USA

³ Department of Health Sciences Research, Mayo Clinic College of Medicine, Rochester, MN, USA

⁴ Program in Epidemiology, Fred Hutchinson Cancer Research Center and Department of Epidemiology, University of Washington, Seattle, WA USA

⁵ Department of Preventive Medicine, Norris Comprehensive Cancer Center, University of Southern California School of Medicine, Los Angeles, CA USA

Abstract

Aims—To identify occupations and industries associated with non-Hodgkin lymphoma in a large population-based case-control study in the United States.

Methods—Cases ($n = 1,189$) of histologically confirmed malignant NHL ages 20–74 were prospectively identified in four geographic areas covered by the National Cancer Institute SEER Program. Controls ($n = 982$) were selected from the general population by random digit dialing (< 65 years of age) and from residents listed in Medicare files (65–74 years of age). Odds ratios and 95% confidence intervals for occupations and industries were calculated by unconditional logistic regression analyses, adjusting for age, gender, ethnicity, and study center. Further analyses stratified for gender and histological subtype were also performed.

Results—Risk of NHL was increased for a few occupations and industries. Several white collar occupations, with no obvious hazardous exposures, had elevated risks, including purchasing agents and buyers, religious workers, physical therapists, and information clerks. Occupations with excesses that may have exposures of interest include launderers and ironers, service occupations, food/beverage preparation supervisors, hand packers and packagers, roofing and siding, leather and leather products, transportation by air, nursing and personal care facilities, and specialty outpatient clinics. Significantly decreased risks of NHL were found for a number of occupations and industries including post secondary teachers and chemical and allied products.

Conclusions—The results of this study suggest that several occupations and industries may alter the risk of NHL. Our results support previously reported increased risks among farmers, printers, medical professionals, electronic workers, and leather workers. These findings should be evaluated further in larger studies that have the power to focus on specific exposures and histologic subtypes of NHL.

Keywords

Non Hodgkin lymphoma; occupation; industry

INTRODUCTION

The non-Hodgkin lymphomas (NHL) are a heterogeneous group of malignant neoplasms that account for about 4.4% of all newly diagnosed cancer cases and 3.3% of all deaths due to cancer in the United States (US) in 2007(1). The age-adjusted incidence rate (per 100,000) for NHL in the US increased 78.4% from 11.1 in 1975 to 19.8 in 2003(2). Known risk factors for NHL, such as immune dysfunction/suppression(3), family history of hematopoietic malignancy(4) and variation in some inflammatory response genes(5), are unlikely to account for a large proportion of the cases, and cannot account for the pattern of changing incidence over the last several decades.

Occupational exposures may result in chromosomal damage, oxidative stress, or immune dysfunction and epidemiologic studies have noted some associations between occupational factors and NHL. Farming and agricultural work have been most consistently associated with an increased incidence and mortality of NHL(6,7). Other occupations associated with NHL in more than one study include funeral directors and embalmers(8,9), medical professionals(10,11), teachers(7,10), painters and construction workers(8,12,13), printers(7,8,14), transport workers(15,16), secretaries(10,15), post office employees(10,17), electrical workers(14,18) and glass formers(12,19). A recent study(13) observed an increased risk of diffuse large B cell lymphoma (DLBCL) in metal processors and an increased risk of follicular lymphoma for medical/dental/veterinary workers, sales workers, machinery fitters, and electrical fitters. To date, no workplace exposures have been conclusively identified as risk factors for NHL(20). Occupational studies, however, have suggested a possible role for specific workplace exposures in the development of NHL including specific pesticides, solvents, oils, hair dyes, various organic and inorganic dusts, aromatic amines, and paints and varnishes(21–23).

These observations led to an assessment of occupation in relation to the development of NHL in adults as part of a population-based, multi-center case-control study examining a wide range of postulated risk factors. We evaluated NHL risk among individuals in various occupations and industries. We also explored whether these factors were related to gender and selected subtypes of NHL.

METHODS

Study participants

Details on the National Cancer Institute Surveillance, Epidemiology, and End Results (NCI-SEER) case-control study of NHL have been published previously(24). Briefly, cases were residents at the time of diagnosis within four geographic areas covered by the NCI SEER Program: the state of Iowa, Los Angeles County in California, the Detroit metropolitan area (Macomb, Oakland, and Wayne counties), and the Seattle metropolitan area (King and Snohomish counties). Eligible cases were newly diagnosed with histologically confirmed NHL (ICD-O-3 codes 967–972)(25), 20 to 74 years of age at diagnosis, diagnosed between July 1998 and June 2000. Individuals identified by themselves or their physician as being infected with human immunodeficiency virus (HIV) were excluded from the study. Cases were classified as to histologic subtype according to the International Classification of Diseases for Oncology, 3rd edition, using information from pathology reports. For the

purpose of our analysis, cases were categorized on the basis of histology into four subgroups (follicular, DLBCL, other, and histology unknown).

Controls were selected from the general population by random digit dialing(26) (< 65 years of age) and from residents listed in Medicare files (65–74 years of age). Controls were frequency matched to the cases by age (in 5-year groups), gender, and race within each study center. Individuals with a previous diagnosis of NHL or of HIV infection were ineligible to participate as controls.

Out of 2,248 eligible cases, 520 were not pursued for interviews due to death, inability to locate, physician refusal, or relocation outside of the study area. Out of the remaining 1,728, interviews were completed on 1,321 (participation rate, 76.4%). Of 2,409 eligible controls, 363 were not pursued for interviews (because of death, unlocatable or moved out of the area). Of the remaining 2,046, interviews were completed on 1,057 (participation rate, 51.7%).

The study was approved by the institutional review boards at NCI and each participating registry, and all participants provided written, informed consent.

Data collection

Study subjects completed a computer-assisted personal interview, typically at their home. The occupational portion of the questionnaire gathered information on each job held by the subject for six months or longer during their lifetime. Questions regarding each job included where the subject was employed, dates of employment, job title, and number of hours (full or part time) worked. Each job reported for a subject was assigned a four-digit occupation code (SOC) and a four-digit industry code (SIC) according to standard classification manuals(27,28). These occupation and industry codes were assigned without knowledge of the subject's case/control status.

Of the 1,321 cases and 1,057 controls that were interviewed, 132 cases (10.0%) and 75 (7.6%) controls were never employed or had only unknown occupations. These subjects were excluded, leaving 1,189 cases and 982 controls for this analysis.

Statistical analyses

Odds ratios (OR) and 95% confidence intervals (CI) were computed using unconditional logistic regression adjusted for age group (20–34, 35–44, 45–54, 55–64, 65–74), gender, ethnicity (Caucasian, African American, Other) and study center (Detroit, Iowa, Los Angeles, Seattle). To examine the association between occupation/industry and the subsequent development of NHL, we started with occupations and industries aggregated into two-digit SOC and SIC codes, and then proceeded to analyses of more detailed three- and four-digit SOC and SIC codes, where numbers permitted. Subjects were considered exposed if they were ever employed in the specific occupation/industry of interest and unexposed if they were never employed in that occupation/industry. We also performed analyses of two-digit SIC and SOC codes stratified by gender and histological subtypes (follicular and DLBCL). Within these gender or histology stratified analyses, only those SOC and SIC codes that showed statistically significant results for all subjects combined or showed significantly different strata specific odds ratios are shown. We tested for odds ratio heterogeneity between follicular lymphoma and DLBCL, the two most common histologic subtypes in our study, by constructing contrast tests between polytomous regression model coefficients. Because of small numbers, tests for trend were not globally applied. Analyses of SIC and SOC codes for which there are only cases were performed using Fisher's exact test. The findings from analyses restricted to Caucasians were not appreciably different from those for all subjects combined and are not presented.

Although we had several a priori hypotheses, we evaluated all 2 digit SOC and SIC codes. We present results for those SIC and SOC codes that are: 1) statistically significant; or 2) have 20+ cases and 20+ controls; or 3) assist in the interpretation of findings.

This study collected data on a substantial number of potential confounding variables, including family history of malignancy, smoking, alcohol consumption, and ultraviolet light exposure. Most of these factors have been examined (29–32) and none of them were strong risk factors for NHL. In addition, the small numbers associated with most of the occupations and industries precluded the addition of these variables to the statistical models in this analysis.

RESULTS

The demographic characteristics of the cases and controls are shown in Table 1. Cases were significantly younger and were less likely to be a minority than controls. There were no significant differences between the cases and controls in terms of gender, education, and geographic area. The cases were grouped by pathologic subtypes including: 1) follicular (24.6%), 2) DLBCL (30.8%), and 3) all other subtypes and unknown (44.6%).

Tables 2 and 3 show the risk of NHL for employment (ever/never) by occupational and industrial groups. A total of 86 occupations and 97 industries are shown in these tables. For occupations (Table 2), significantly increased risks of NHL were found for purchasing agents and buyers, not elsewhere classified (NEC) (SOC 1449), religious workers (SOC 204 and 2042), physical therapists (SOC 3033), information clerks (SOC 464), launderers and ironers (SOC 503), service occupations, except private household and protective (SOC 52), food/beverage preparation supervisors (SOC 5211), carpet and soft tile installers (SOC 6462), metal patternmakers and model makers (SOC 6817), drilling machine operators (SOC 7518), miscellaneous manual occupations (SOC 876) and hand packers and packagers (SOC 8761).

Risk of NHL was greater than or equal to 2.0 for purchasing agents and buyers (SOC 144), licensed practical nurses (SOC 366), insurance sales occupations (SOC 4122), hairdressers and cosmetologists (SOC 5253) and printing machine operators and tenders (SOC 764 and 7643). Occupations with larger ORs that might be of interest include reservation agents and transportation clerks (4644), kitchen workers (5217), cleaning and building service supervisors (5241), barbers (5252 and precision grinders, fitters, and tool sharpeners (6816).

Significantly decreased risks of NHL were found for industrial production managers (SOC 132), postsecondary teachers (SOC 224 and 2249), editors, reporters, public relations specialists, and announcers (SOC 33), financial record processors (SOC 471) and administrative support occupations, including clerical (SOC 46 & 47, 479 and 4799).

The increased risk for subjects employed in service occupations (SOC 52) was largely accounted for by females (1.42, 1.07–1.86). The decreased risk for subjects employed in administrative support occupations (SOC 46 & 47) was also largely accounted for by females (0.71, 0.54–0.93).

There were four occupational categories for which the risk of NHL in males was significantly greater than that in females, although none were statistically significant among men. These include sales occupations, retail (SOC 43), construction trades (SOC 64), supervisors, production occupations (SOC 71) and transportation occupations (SOC 82).

For industries (Table 3), significant excesses were observed for roofing, siding, and sheet metal work (SIC 176), leather and leather products (SIC 31), transportation by air (SIC 45),

arrangement of transportation of freight and cargo (SIC 473), deposit banking (SIC 6099), computer maintenance and repair (7378), automotive body repair and paint shops (SIC 7532), motion picture services (SIC 7819), nursing and personal care facilities (SIC 805 and 8051), and specialty outpatient clinics, NEC (SIC 8093). Relative risks of 2.0 or greater occurred for those employed in the scheduled air transportation industry (SIC 4512). Industries with larger ORs that might be of interest include photofinishing laboratories (7384), animal specialties (027), carpentry and floor work (175), and lumber and other construction materials (503).

Significantly decreased risks of NHL were found for chemicals and allied products (SIC 28), electronic and other electrical equipment, except computer (SIC 36), general merchandise stores (SIC 53 and 531), security and commodity brokers, dealers, exchanges, and services (SIC 62), accident and health insurance and medical (SIC 632 & 6321) and personnel supply services (SIC 736). Risk of NHL was less than or equal to 0.5 for household appliances (SIC 363) and hardware stores (SIC 525).

There were two industries for which the risk of NHL in males was significantly different from that in females. For building materials, hardware, garden supply, and mobile home dealers (SIC 52), the risk in males and females was 1.56 (0.80–3.05) and 0.22 (0.05–1.05), respectively. For those employed in the health services industry (SIC 80), the risk in males and females was 0.80 (0.51–1.24) and 1.46 (1.08–1.98), respectively.

There were two industries for which the risk of NHL differed significantly by histologic subtype. Subjects who had ever been employed in the wholesale trade-durable goods industry (SIC 50) were at decreased risk of follicular NHL (0.28, 0.08–0.94) and at increased risk of DLBCL (1.71, 0.94–3.10). Subjects who had ever been employed in hotels, rooming houses, camps, and other lodging places (SIC 70) were at increased risk of follicular NHL (1.61, 0.78–3.32) and at decreased risk of DLBCL (0.53, 0.20–1.43).

DISCUSSION

We present a number of occupational and industrial risk estimates to provide clues to chemicals that might contribute to the development of NHL. We were able to assess differences in risk of NHL between males and females and between follicular and DLBCL subtypes, which has not been possible in many other studies. NHL has been associated with a number of occupations, including farmers, woodworking, rubber manufacture, mechanics, textile workers, janitors, printers, meat processors, and hair dressers in epidemiologic studies, although inconsistencies exist between studies(33,34). These studies suggest that pesticides, benzene, polychlorinated biphenyls, and dyes might contribute to the etiology of NHL(35,36). Our analysis revealed an increased risk for NHL among subjects in several employment groups. Some were in predominately white collar occupations (e.g., purchasing agents and buyers, religious workers, physical therapists, and information clerks), which are not typically thought to expose workers to hazardous chemical, physical, or biologic agents. On the other hand, decreased risks occurred among other white collar occupations including production managers, postsecondary teachers, editors, reporters, public relations specialists, and announcers, financial workers, and administrative support positions.

We found significantly increased risks of NHL among individuals employed as launderers and ironers, service occupations except household and protective groups, pattern and model makers, drilling and boring machine operators, carpet and soft tile installers, miscellaneous manual workers, and hand packers and packagers and employment in several industries including roofing and siding, leather and leather products, arrangement of air transportation, freight and cargo, computer maintenance and repair, auto repair and paint shops, and nursing

and personal care facilities. There are few previous reports of a risk of NHL in subjects employed in these occupations(33,34). Persons employed in laundry and garment services had a borderline significant excess in a study from Iowa and Minnesota(8). Launderers and ironers might include some dry cleaners, which have been studied because of possible exposure to dry cleaning solvents. Some cancer excesses have been noted in studies of dry cleaning industry workers, though NHL is not one of them(37). Work in the leather and leather products industry can lead to a number of exposures including benzene and other solvents, glues, organic and inorganic dyes, and leather dusts(38). Several previous studies have reported an increased risk of lymphomas in subjects employed in the leather industry(23,39), including follicular NHL(13). An increased risk was also reported in shoe manufacturing workers, but only among those exposed to high levels of solvents(40). A study of leather tannery workers reported a decreased risk of deaths due to all hematopoietic cancers, but did not evaluate lymphomas separately(41). Decoufle(39) suggested that the increased risk may be accounted for by exposure to synthetic dyes, which is notable given the current interest in the potentially increased risk of NHL in people who use hair dyes(42).

We found an increased risk of NHL in subjects employed in industries of air transportation and the arrangement of air transport. Several studies have looked at various segments of the aircraft industry. Figgs et al.(10) found excess mortality among air transport workers in the U.S. and Siemiatycki reported an increased risk of NHL in air transport workers in Montreal(23). It is not clear what exposures might be of concern in arrangement of air transportation industry because many jobs are essentially white collar in nature. Other studies have evaluated cancer among aircraft maintenance workers, including an excess among aircraft mechanics(10) and civilian aircraft maintenance workers at an Air Force base(43), but these studies may not be relevant to the largely white-collar category where we observe excesses. We found weak evidence of an increased risk in printing machine operators and tenders, as has been reported in other studies(7,8,13,14,33). Boffetta and de Vocht(33) report an excess risk in a meta-analysis of printers. However, unlike previous studies, we did not find an excess risk in females (7) or for the NHL follicular subtype(33). The solvents and other exposures experienced by workers in the printing industry are likely to be considerably different than those for air transport workers.

Several studies have reported an increased risk of NHL among farmers and those employed in agricultural industries(6–8,13,16,33). We found some weak evidence of an increased risk for several specific agricultural industries including crop farming, poultry and egg production, and animal specialties, but the odds ratio for farmers overall was slightly less than 1.0. Excesses have been reported among electric power plant workers(16) and electronic product workers and repairers(10,23) in previous studies. We found weak evidence of an excess in the electric service industry but a decreased risk of NHL in subjects employed in the electrical equipment industry.

We found an increased risk of NHL among subjects employed in service occupations, including food/beverage preparation supervisors, kitchen workers, barbers, and hairdressers. Previous studies have reported an increased risk in professional and related services(10), hairdressers/beauticians(8,10,44), cooks(8,45), and meatworkers(33,46,47). Several previous studies have reported an increased risk of NHL in female pharmacy technicians(48), female physicians(11) and medical professionals(10,11,13). Our findings of an increased risk in physical therapists, licensed practical nurses, employees in nursing, personal care facilities, specialty outpatient clinics, and in women (but not men) employed in the health services industry are similar to these reports. We also noted a difference in the gender specific risk of NHL among pharmacists, dietitians, therapists, and physician's assistants (with an increased risk in females and a decreased risk in males). Men and women may differ in the tasks they

perform even though they have the same job title(49), but it is not clear what exposures might be of concern in these occupations.

We found a significantly decreased risk of NHL associated with a number of occupations and industries. Several of these have not been reported previously. We are not aware of any biological mechanisms that might explain these associations. For example, we found a decreased risk of NHL in post secondary teachers, while some previous studies have reported excesses in these occupations(7,10,50). The increased risk of NHL in chemical workers reported in previous studies(51,52) contrasts with our findings of a reduced risk in subjects employed in the chemicals and allied products industry. The decreased risk of NHL we observed in administrative support occupations (including clerical) contrasts with previous findings of a significantly increased risk of NHL in secretaries(10,15). This lack of consistency suggests these observations may simply be chance findings.

A limitation of this study is the large number of analyses performed and the associated problem of false positive findings, but the purpose of these analyses was to provide leads for a more probing evaluation of specific exposures. This study has limited statistical power to detect significant associations due to the small number of study subjects in detailed occupations and industries. Use of occupation and industry as an indicator of occupational exposures is a surrogate approach and there is variation in exposure within many specific occupations or industries. Selection bias is also a concern because of the relatively low participation rate in this study. Our group recently completed an analysis (53) indicating that the SES differences between respondents and non-respondents did not result in an appreciable bias in the risk of NHL associated with education. Although this does not pertain directly to occupations and industries, we suggest that a similar conclusion is not unreasonable for these variables as well.

This study has several strengths, including detailed information on a variety of possible risk factors for NHL, classification of NHL by histologic subtypes, differentiation by gender, and a substantial number of cases and controls. Subjects were recruited from population-based NCI SEER cancer registries and associated geographic areas representing urban, suburban, and rural populations. In addition, occupational information was collected systematically through in person interviews with the study subjects. Further, there was a central pathologic review of a representative sample of tumor material to verify not only the original diagnosis of NHL but also the specific histologic subtype.

The results of this study suggest that employment in a few occupations and industries may alter the risk of NHL, including agriculture, food service, barbers and hair dressers, and leather workers. Our results add to the literature about several white collar occupations that may decrease the risk of NHL. Because of the small number of studies with well characterized exposures and the continual changing of work environments, larger case-control and cohort studies that can focus on specific exposures, specific histologic subtypes, and gender are needed.

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Table 1

Description of Study Subjects, NCI-SEER NHL Study, 1998–2000

Category	Cases (N=1189)	Controls (N=982)	P-Value
Gender			
Male	666 (56.0)	524 (53.4)	0.22
Female	523 (44.0)	458 (46.6)	
Age at diagnosis or selection, years			
20–34	68 (5.7)	53 (5.4)	0.0002
35–44	153 (12.9)	98 (10.0)	
45–54	261 (22.0)	185 (18.8)	
55–64	316 (26.6)	230 (23.4)	
65–74	391 (32.9)	416 (42.4)	
Race			
White	1014 (85.3)	787 (80.1)	<0.0001
African American	91 (7.7)	132 (13.4)	
Other	84 (7.1)	63 (6.4)	
Center			
Detroit	209 (17.6)	144 (14.7)	0.13
Iowa	352 (29.6)	273 (27.8)	
Los Angeles	310 (26.1)	273 (27.8)	
Seattle	318 (26.8)	292 (29.7)	
Education, years			
0–11	118 (9.9)	97 (9.9)	0.47
12–15	734 (61.8)	584 (59.5)	
16 or more	336 (28.3)	301 (30.7)	
Histology			
Follicular	293 (24.6)		
DLBCL	366 (30.8)		
Other	487 (41.0)		
Unknown	43 (3.6)		

Table 2

Odds Ratios and 95% Confidence Intervals for NHL by Standard Occupation Categories, NCI-SEER Study 1998–2000

	SOC	SOC Description	Cases	Controls	OR	95% CI
All Subjects	11	Officials and Administrators, Public Administration	21	23	0.71	0.39 1.30
	12 & 13	Officials and Administrators, Other (12–13)	218	201	0.82	0.66 1.03
	132	Production Managers, Industrial	11	17	0.41	0.19 0.89
	14	Management Related Occupations	73	62	0.97	0.68 1.39
	144	Purchasing Agents And Buyers	20	7	2.33	0.98 5.58
	1449	Purchasing Agents And Buyers, NEC	17	5	2.79	1.02 7.66
	16	Engineers, Surveyors and Architects	59	55	0.82	0.55 1.21
	17	Computer, Mathematical, and Operations Research Occupations	20	22	0.72	0.39 1.35
	204	Religious Workers	8	0		
	2042	Clergy	7	0		
	22	Teachers; College, University and Other Postsecondary Institution	86	82	0.87	0.63 1.20
	224	Postsecondary Teachers	51	64	0.66	0.45 0.97
	2249	Teachers; Postsecondary, NEC	47	60	0.65	0.44 0.97
	23	Teachers, Except Postsecondary Institution	57	45	1.05	0.70 1.58
	29	Registered Nurses	34	29	1.08	0.64 1.81
	3033	Physical Therapists	6	0		
	32	Writers, Artists, Performers, and Related Workers	65	43	1.23	0.82 1.84
	33	Editors, Reporters, Public Relations Specialists, and Announcers	6	18	0.27	0.11 0.69
	36	Health Technologists and Technicians	34	26	1.10	0.65 1.87
	366	Licensed Practical Nurses	14	6	2.53	0.94 6.79
	37	Engineering and Related Technologists and Technicians	29	26	0.87	0.50 1.51
	39	Technicians; Except Health, Engineering, and Science	40	31	0.93	0.57 1.51
	41	Insurance, Securities, Real Estate, and Business Service Sales Occupations	42	37	0.89	0.57 1.41
	4122	Insurance Sales Occupations	16	5	2.64	0.96 7.30
	42	Sales Occupations, Commodities Except Retail	63	41	1.14	0.76 1.71
	43	Sales Occupations, Retail	159	138	0.90	0.70 1.16
	45	Supervisors; Administrative Support Occupations, Including Clerical	33	28	0.96	0.57 1.61

SOC	SOC Description	Cases	Controls	OR	95% CI
46 & 47	Administrative Support Occupations, Including Clerical (46–47)	452	430	0.80	0.66 0.96
464	Information Clerks	44	21	1.83	1.07 3.14
4644	Reservation Agents And Transportation Ticket Clerks	9	1	6.62	0.83 52.69
471	Financial Record Processing Occupations	47	57	0.65	0.43 0.98
479	Miscellaneous Administrative Support Occupations, Including Clerical	170	186	0.72	0.55 0.93
4799	Administrative Support Occupations, Including Clerical, NEC	129	159	0.61	0.46 0.82
50	Private Household Occupations	54	37	1.27	0.81 1.97
503	Launderers And Ironers	12	3	3.89	1.06 14.20
51	Protective Service Occupations	34	37	0.76	0.47 1.24
52	Service Occupations, Except Private Household and Protective	317	231	1.26	1.03 1.55
5211	Supervisors; Food/Beverage Preparation And Service Occupations	6	0		
5217	Kitchen Workers, Food Preparation	9	1	7.75	0.97 61.90
5241	Supervisors; Cleaning And Building Service Workers	8	2	3.31	0.69 15.78
5252	Barbers	6	2	2.26	0.45 11.29
5253	Hairdressers And Cosmetologists	17	7	2.09	0.84 5.17
55	Farm Operators and Managers	77	67	0.91	0.63 1.31
56	Other Agricultural and Related Occupations	71	48	1.23	0.83 1.81
61	Mechanics and Repairers	109	78	1.13	0.82 1.55
64	Construction Trades	104	72	1.15	0.83 1.60
6462	Carpet And Soft Tile Installers	5	0		
68	Precision Production Occupations	106	66	1.26	0.91 1.74
6816	Precision Grinders, Fitters, And Tool Sharpeners	7	1	5.07	0.62 41.72
6817	Patternmakers And Model Makers (Metal)	6	0		
75	Machine Operators and Tenders (75–76)	37	24	1.17	0.69 1.98
7518	Drilling And Boring Machine Operators And Tenders	6	0		
76	Machine Operators and Tenders (75–76)	82	62	1.07	0.75 1.51
764	Printing Machine Operators And Tenders	17	6	2.02	0.79 5.17
7643	Printing Machine Operators And Tenders	16	5	2.31	0.84 6.37
77	Fabricators, Assemblers, and Hand Working Occupations	97	82	0.97	0.71 1.33

	SOC	SOC Description	Cases	Controls	OR	95% CI
	78	Production Inspectors, Testers, Samplers, and Weighers	29	30	0.78	0.46 1.32
	82	Transportation Occupations	139	106	1.10	0.83 1.46
	83	Material Moving Occupations, Except Transportation	42	37	0.91	0.57 1.45
	87	Handlers, Equipment Cleaners and Laborers	166	118	1.17	0.90 1.53
	876	Miscellaneous Manual Occupations	30	10	2.73	1.31 5.68
	8761	Hand Packers And Packagers	22	7	3.00	1.26 7.14
	91	Military Occupations	85	80	0.88	0.63 1.23
	99	Miscellaneous Occupations	70	59	0.97	0.68 1.40
Males	30	Pharmacists, Dietitians, Therapists, and Physician's Assistants	5	6	0.61	0.18 2.07
	33	Editors, Reporters, Public Relations Specialists, and Announcers	4	12	0.27	0.09 0.87
	43	Sales Occupations, Retail	90	56	1.27	0.88 1.83
	46 & 47	Administrative Support Occupations, Including Clerical (46-47)	167	146	0.91	0.69 1.19
	52	Service Occupations, Except Private Household and Protective	122	93	1.08	0.79 1.47
	64	Construction Trades	103	67	1.25	0.89 1.75
	71	Supervisors: Production Occupations	10	2	4.36	0.94 20.21
	82	Transportation Occupations	134	90	1.34	0.99 1.83
Females	30	Pharmacists, Dietitians, Therapists, and Physician's Assistants	9	2	4.22	0.90 19.80
	33	Editors, Reporters, Public Relations Specialists, and Announcers	2	6	0.27	0.05 1.37
	43	Sales Occupations, Retail	69	82	0.65	0.45 0.92
	46 & 47	Administrative Support Occupations, Including Clerical (46-47)	285	284	0.71	0.54 0.93
	52	Service Occupations, Except Private Household and Protective	195	138	1.42	1.07 1.86
	64	Construction Trades	1	5	0.14	0.02 1.22
	71	Supervisors: Production Occupations	1	3	0.26	0.03 2.50
	82	Transportation Occupations	5	16	0.24	0.09 0.66
Follicular	33	Editors, Reporters, Public Relations Specialists, and Announcers	1	18	0.20	0.03 1.56
	46 & 47	Administrative Support Occupations, Including Clerical (46-47)	119	430	0.83	0.62 1.11
	52	Service Occupations, Except Private Household and Protective	78	231	1.21	0.88 1.66
DLBCL	33	Editors, Reporters, Public Relations Specialists, and Announcers	0	18		
	46 & 47	Administrative Support Occupations, Including Clerical (46-47)	140	430	0.84	0.64 1.10

	SOC	SOC Description	Cases	Controls	OR	95% CI
	52	Service Occupations, Except Private Household and Protective	96	231	1.19	0.89 1.59

Abbreviations: NEC, not elsewhere classified; OR, odds ratio; CI, confidence interval.

Odds ratios adjusted for age group, gender, ethnicity and study center.

Note: Statistically significant ($P < 0.05$) results are in bold face type.

Table 3
Odds Ratios and 95% Confidence Intervals for NHL by Standard Industry Categories, NCI-SEER Study 1998–2000

	SIC	SIC Description	Cases	Controls	OR	95% CI
All Subjects	01	Agricultural Production Crops	60	51	0.98	0.66 1.45
	02	Agriculture production livestock and animal specialties	43	26	1.38	0.83 2.29
	027	Animal Specialties	8	1	6.56	0.81 52.82
	15	Building Construction General Contractors And Operative Builders	72	53	1.09	0.75 1.58
	16	Heavy Construction Other Than Building Construction Contractors	28	23	0.99	0.56 1.75
	17	Construction Special Trade Contractors	71	43	1.24	0.83 1.85
	175	Carpentry And Floor Work	6	1	6.46	0.76 55.30
	176	Roofing, Siding And Sheet Metal Work	5	0		
	20	Food And Kindred Products	94	67	1.15	0.82 1.60
	24	Lumber And Wood Products, Except Furniture	22	23	0.78	0.43 1.42
	27	Printing, Publishing, And Allied Industries	59	50	0.90	0.61 1.34
	28	Chemicals And Allied Products	18	28	0.49	0.27 0.90
	31	Leather And Leather Products	10	0		
	34	Fabricated Metal Products, Except Machinery And Transportation Equipment	38	25	1.12	0.66 1.88
	35	Industrial And Commercial Machinery And Computer Equipment	102	73	1.07	0.77 1.47
	36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	63	71	0.68	0.48 0.97
	363	Household Appliances	9	15	0.47	0.20 1.08
	37	Transportation Equipment	182	147	1.04	0.80 1.34
	38	Measuring, Analyzing, And Controlling Instruments; Photographic, Medical & Optical Goods; Watches & Clocks	34	23	1.14	0.66 1.96
	39	Miscellaneous Manufacturing Industries	33	21	1.32	0.75 2.32
	42	Motor Freight Transportation And Warehousing	42	41	0.75	0.47 1.17
	45	Transportation By Air	20	9	2.39	1.06 5.39
	4512	Air Transportation, Scheduled	17	8	2.36	0.99 5.63
	473	Arrangement Of Transportation Of Freight And Cargo	16	5	3.02	1.07 8.52
	48	Communications	52	43	1.05	0.69 1.60
	49	Electric, Gas, And Sanitary Services	25	21	0.93	0.52 1.69
	50	Wholesale Trade-durable Goods	47	32	1.16	0.73 1.85

503	Lumber And Other Construction Materials	6	1	6.46	0.75	55.73
51	Wholesale Trade-non-durable Goods	86	75	0.91	0.65	1.26
52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	29	22	1.06	0.60	1.87
525	Hardware Stores	8	13	0.49	0.20	1.20
53	General Merchandise Stores	63	80	0.65	0.45	0.92
531	Department Stores	49	62	0.66	0.44	0.98
54	Food Stores	65	43	1.29	0.86	1.93
55	Automotive Dealers And Gasoline Service Stations	68	61	0.81	0.56	1.17
56	Apparel And Accessory Stores	38	29	1.09	0.66	1.80
58	Eating And Drinking Places	146	107	1.09	0.83	1.43
59	Miscellaneous Retail	83	77	0.86	0.62	1.20
60	Depository Institutions	66	43	1.28	0.86	1.92
6099	Functions Related To Deposit Banking	5	0			
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	3	12	0.19	0.05	0.70
63	Insurance Carriers	70	63	0.89	0.62	1.27
632	Accident And Health Insurance And Medical	8	16	0.38	0.16	0.90
6321	Accident And Health Insurance	5	14	0.27	0.10	0.76
65	Real Estate	36	33	0.88	0.54	1.44
70	Hotels, Rooming Houses, Camps, And Other Lodging Places	34	24	1.18	0.69	2.03
72	Personal Services	100	80	1.04	0.76	1.42
73	Business Services	105	83	1.03	0.76	1.41
736	Personnel Supply Services	5	13	0.34	0.12	0.99
7378	Computer Maintenance And Repair	5	0			
7384	Photofinishing Laboratories	9	1	7.22	0.90	57.65
75	Automotive Repair, Services, And Parking	45	26	1.40	0.85	2.31
7532	Top, Body Repair And Paint Shops	6	0			
76	Miscellaneous Repair Services	28	21	1.04	0.58	1.87
7819	Services Allied To Motion Pictures	7	0			
79	Amusement And Recreation Services	60	53	0.93	0.63	1.38
80	Health Services	191	139	1.20	0.94	1.55

	805	Nursing And Personal Care Facilities	45	17	2.49	1.39	4.44
	8051	Skilled Nursing Care Facilities	27	9	2.84	1.30	6.21
	8093	Specialty Outpatient Clinics, NEC	7	0			
	82	Educational Services	228	211	0.90	0.72	1.11
	83	Social Services	45	43	0.84	0.54	1.29
	86	Membership Organizations	36	36	0.75	0.47	1.21
	87	Engineering, Accounting, Research, Management, And Related Services	57	45	0.92	0.61	1.38
	91	Executive, Legislative, And General Government, Except Finance	33	37	0.78	0.48	1.27
	92	Justice, Public Order, And Safety	39	31	1.03	0.63	1.69
	97	National Security And International Affairs	199	196	0.78	0.61	1.00
	971	National Security	198	195	0.78	0.61	1.00
	99	Nonclassifiable Establishments	44	40	0.92	0.59	1.44
Males	28	Chemicals And Allied Products	11	18	0.45	0.21	0.98
	36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	36	39	0.65	0.40	1.05
	45	Transportation By Air	13	6	2.33	0.85	6.42
	52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	27	14	1.56	0.80	3.05
	53	General Merchandise Stores	19	19	0.80	0.41	1.56
	62	Security And Commodity Brokers, Dealers, Exchanges, And Services	2	6	0.26	0.05	1.33
	80	Health Services	46	46	0.80	0.51	1.24
Females	28	Chemicals And Allied Products	7	10	0.56	0.21	1.49
	36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	27	32	0.69	0.40	1.17
	45	Transportation By Air	7	3	2.40	0.60	9.59
	52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	2	8	0.22	0.05	1.05
	53	General Merchandise Stores	44	61	0.59	0.39	0.89
	62	Security And Commodity Brokers, Dealers, Exchanges, And Services	1	12	0.26	0.03	2.08
	80	Health Services	145	93	1.46	1.08	1.98
Follicular	28	Chemicals And Allied Products	4	28	0.47	0.16	1.38
	36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	11	71	0.49	0.25	0.94
	45	Transportation By Air	5	9	2.28	0.73	7.15
	50	Wholesale Trade-durable Goods	3	32	0.28	0.08	0.94

	53	General Merchandise Stores		18	80	0.74	0.43	1.28
	62	Security And Commodity Brokers, Dealers, Exchanges, And Services		1	12	0.26	0.03	2.08
	70	Hotels, Rooming Houses, Camps, And Other Lodging Places		12	24	1.61	0.78	3.32
DLBCL	28	Chemicals And Allied Products		6	28	0.56	0.23	1.38
	36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment		18	71	0.64	0.37	1.11
	45	Transportation By Air		3	9	1.33	0.35	5.11
	50	Wholesale Trade-durable Goods		20	32	1.71	0.94	3.10
	53	General Merchandise Stores		15	80	0.51	0.29	0.91
	62	Security And Commodity Brokers, Dealers, Exchanges, And Services		1	12	0.21	0.03	1.64
	70	Hotels, Rooming Houses, Camps, And Other Lodging Places		5	24	0.53	0.20	1.43

Abbreviations: NEC, not elsewhere classified; OR, odds ratio; CI, confidence interval.

Odds ratios adjusted for age group, gender, ethnicity and study center.

Note: Statistically significant ($P < 0.05$) results are in bold face type.