

Non-Hodgkin's lymphoma and occupation in Sweden: a registry based analysis

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Abstract

Incidence of non-Hodgkin's lymphoma in different employment categories was evaluated from the Swedish Cancer-Environment Registry, which links cancer incidence during 1961 to 1979 with occupational information from the 1960 census. New associations were found for men employed in shoemaking and shoe repair, porcelain and earthenware industries, education, and other white collar occupations. Several findings supported associations found in other countries, including excesses among woodworkers, furniture makers, electric power plant workers, farmers, dairy workers, lorry drivers, and other land transport workers. Risks were not increased among chemists, chemical or rubber manufacturing workers, or petrochemical refinery workers. Caution must be used in drawing causal inferences from these linked registry data because information on exposure and duration of employment is not available. Nevertheless, this study has suggested new clues to possible occupational determinants of non-Hodgkin's lymphoma.

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During the past few decades, incidence of non-Hodgkin's lymphoma has been increasing in many countries including Sweden, particularly among the elderly.¹⁻⁴ Although some of this increase may reflect diagnostic improvements, environmental and occupational factors have also been implicated.⁵ The relation of occupational exposures to non-Hodgkin's lymphoma has not been extensively evaluated,

although excess risks have been reported among farmers in several geographical areas.⁶⁻¹¹ Among the agricultural exposures implicated in non-Hodgkin's lymphoma are pesticides, fertilisers, and livestock.^{7 12-15} Not all studies have found an increased occurrence among persons in agriculture related occupations or those exposed to pesticides, however.¹⁶⁻¹⁹ Workers exposed to organic solvents such as chemical manufacturing workers,^{12 13 17 22 23} chemists,²⁴ and petrochemical workers,^{17 25} may also have an increased incidence.^{20 21} To evaluate a possible role for these occupations in the aetiology of non-Hodgkin's lymphoma, we utilised the Swedish Cancer-Environment Registry (CER), a national linked registry of cancer and employment data. Because earlier reports²⁶⁻²⁸ have examined agricultural and forestry workers with this linked registry, our focus is on employment outside these areas.

Materials and methods

The CER merges incidence reports from the National Swedish Cancer Registry (NSCR) for the period 1961 to 1979 with occupational information from the 1960 census.²⁹ The unique 10 digit number assigned to each Swedish citizen allows linkage of these two data sources for individual subjects. According to Swedish law, all malignant tumours and certain precancerous conditions and benign lesions must be reported to the NSCR.³⁰

The CER employs the International Classification of Diseases (ICD) 7th revision for coding of site and a modified World Health Organisation coding system for histopathological classification. During the past 25 years, numerous morphology based classification schemes have been proposed for non-Hodgkin's lymphoma and at present no single system is in widespread use.³¹ The problems related to reproducibility for a given pathologist or in attaining agreement among pathologists, using either a single classification or different schemes, have been documented.³² These difficulties in conjunction with the failure of the ICD coding system to reflect the rapid changes in non-Hodgkin's lymphoma classification over time make it difficult to assess occupational association by subtype over a long

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period of follow up. Thus in this analysis non-Hodgkin's lymphoma will be considered as a single entity.

The standardised cumulative incidence ratio (SIR) was used to estimate the risk of non-Hodgkin's lymphoma for each occupational and industrial group. The SIR is the ratio of observed to expected number of cases in a specific employment category. The expected number was calculated by applying five year birth cohort, sex, and region specific non-Hodgkin's lymphoma incidence rates in the Swedish male population for 1961-79 to the birth cohort and sex specific distributions of the industrial and occupational categories. To evaluate statistical significance it was assumed that the observed number of cases of non-Hodgkin's lymphoma followed a Poisson distribution.³³

The employment classifications, derived from international standards, and used in the 1960 census were taken to define industrial and occupational groups.^{34,35} The SIRs were calculated for all major (one digit code), general (two digit code), and specific (three digit code) industrial and occupational categories.

Results

There were 4496 employed Swedish men diagnosed with non-Hodgkin's lymphoma (all microscopically verified) during the 19 year follow up (1961 to 1979).

The SIRs for non-Hodgkin's lymphoma were initially evaluated by the 10 major (one digit code) industry and occupational categories. Incidence was

not significantly increased or decreased in any of the major industrial or occupational employment categories (data not shown).

There were few significantly increased SIRs among the 46 general (two digit) industries, or among the 60 general (two digit) occupations. For general industries, moderately increased risks were seen in the furniture and furnishings industry (SIR 1.3; 55 cases; $p < 0.05$) and in the electrical power industry (SIR 1.3; 81 cases; $p < 0.05$). For the general (two digit) occupation categories, non-Hodgkin's lymphoma was moderately increased among men working in education (SIR 1.3; 86 cases; $p < 0.05$).

Table 1 presents results for specific (three digit) industries and occupations with statistically significant ($p < 0.05$) SIRs. Workers in the dairy, shoe repair, and porcelain and earthenware industries had significantly increased SIRs for non-Hodgkin's lymphoma, as did those in the wholesale paper industry, banking, research and scientific institutes, and in other public jobs. The significant excess of non-Hodgkin's lymphoma at the two digit level for the furniture and furnishings industry was not seen at the three digit level, although furniture making was still increased (Industrial code (Ind) 250; SIR = 1.3; 44 cases) as was other related furniture work (Ind 252; SIR = 1.9; four cases). The significant excess for the electrical power industry at the two digit level was not seen at the three digit level, although the SIR for electrical power plants was still increased (Ind 500; SIR = 1.3; 52 cases), as were SIRs for gas plants (Ind 501; SIR = 2.0; eight cases) and waterworks

Table 1 Statistically significant ($p < 0.05$) SIRs for non-Hodgkin's lymphomas by specific industries and occupations among Swedish men, 1961-79

Code		Cases	Number expected	SIR†
	<i>Industry</i>			
201	Dairy	25	15.2	1.6*
232	Shoe repair	23	12.6	1.8*
332	Porcelain and earthenware	14	7.2	1.9*
616	Wholesale paper	16	7.9	2.0*
670	Banking	25	14.1	1.8**
830	Research and scientific institute	13	3.7	3.5**
837	Other public jobs	10	3.7	2.7**
	<i>Specific Occupation</i>			
005	Engineers, technicians in mining	20	10.3	1.9*
050	School teachers	14	6.8	2.1*
052	Special teachers	24	14.8	1.6*
203	Bank cashier	5	1.5	3.3*
290	Secretaries, typists	11	5.4	2.1*
297	Health insurance clerks	6	1.9	3.2**
721	Shoemakers	23	13.4	1.7*
875	Lorry drivers	42	29.2	1.4*

* $p < 0.05$; ** $p < 0.01$.

†Adjusted for age and region.

(Ind 502; SIR = 1.8; nine cases). For specific occupations (table 1, lower panel), significantly raised SIRs were seen for mining engineers and technicians, school and special teachers, bank cashiers, secretaries, health insurance clerks, shoemakers, and lorry drivers.

To further examine non-Hodgkin's lymphoma and employment, we evaluated risks for non-Hodgkin's lymphoma for occupations within industries. Table 2 lists the occupations within industry having significantly high SIRs. Of interest and not already identified in table 1 were the increased risks for engineers and technicians employed in power plants, mechanical engineers and technicians in car factories, and other woodworkers in sawmill and planing mills.

Discussion

This CER survey for non-Hodgkin's lymphoma has uncovered new associations among shoemakers and workers in the porcelain and earthenware industry. There have been some links between shoe workers and leukaemia, aplastic anaemia,^{36,37} and non-Hodgkin's lymphoma (two cases)³⁸ in clinical reports, but no excess of non-Hodgkin's lymphoma has been found in analytical studies in the United States,³⁹⁻⁴¹ the United Kingdom,⁴² or Italy.⁴³ Shoemakers and shoe repair workers have been exposed to a large number of agents including benzene, other solvents, glues, adhesives, polishes, and stains.⁴⁴ Workers in the porcelain and earthenware industry have been found to be at increased risk for silicosis, and to have increased rates of lung cancer (although not in Sweden) but non-Hodgkin's lymphoma has not previously been linked with this industry.⁴⁵⁻⁴⁸ Risk of non-Hodgkin's lymphoma was significantly increased among men in Iowa and Minnesota residing near earthenware and pottery factories, however.⁴⁹

Workers in the porcelain and earthenware industry are exposed to fine dust particles and also to dyes, paints, arsenic, lead, and other compounds.⁵⁰

The excesses we found for office workers and bank employees have not been previously described⁵¹⁻⁵³ although these associations may reflect a relation of non-Hodgkin's lymphoma to higher socioeconomic state,^{53,54} rather than a role for specific occupational exposures.

The increased risks of lymphoma among workers in the furniture and furnishings industry and among woodworkers in sawmills and planing mills are consistent with the excesses of non-Hodgkin's lymphoma previously reported for carpenters, sawmill workers, and pulp and paper mill workers in Washington state⁵⁵ and British Columbia.⁵⁶ Potential exposures include not only wood dusts, but also paints, lacquers, varnishes, thinning solvents, and in some situations, antifungal agents, insecticides, and dioxin.⁵⁷

Significantly increased risks were found among engineers and technicians in the electrical power industry. Occupational exposures to electric and magnetic fields have been associated with increased occurrence of non-Hodgkin's lymphoma among Swedish workers in a large telecommunications company,⁵⁸ United States telephone company employees,^{59,60} Canadian power and telephone linemen,⁶¹ and electrical engineers and technicians in surveys in Massachusetts⁶² and Washington State.⁶³ No significant excesses were reported among Swedish electrical engineering graduates,⁶⁴ Swedish electric power linemen and power station operators,⁶⁵ or Swiss electricians.⁶⁶ Residential exposures to magnetic fields have been associated with increased risk of lymphomas in Denver⁶⁷ and the United Kingdom.⁶⁸ As well as possible exposures to magnetic and electrical fields, the Swedish workers may have had

Table 2 Significant ($p < 0.05$) SIRs for non-Hodgkin's lymphomas by specific occupations within industries among Swedish men, 1961-79

Code Occ/Ind	Specific occupation within industry	Cases	Number expected	SIR [†]
203/670	Bank cashier in banking industry	5	0.9	5.8**
201/613	Bookkeeper in wholesale fules	4	0.8	4.8*
001/500	Engineer or technician in electric power plants	4	0.9	4.7*
635/620	Messenger in food business	4	0.9	4.3*
883/233	Warehouse worker in ready made garment industry	5	1.2	4.3*
883/642	Warehouse worker in hardware and machine business	4	1.0	3.9*
050/813	School teacher in other education	5	1.3	3.8*
005/340	Mining engineer or technician in iron and steel industry	10	3.0	3.4**
297/674	Health insurance clerk in health insurance industry	6	1.9	3.2*
003/363	Mechanical engineer or technician in car factories	8	2.5	3.2**
321/614	Travelling salesman in wholesale tools	6	2.1	2.9*
827/201	Dairy worker in dairies	15	8.1	1.8*
778/240	Other woodworkers in sawmills and planing mills	17	9.4	1.8*
721/232	Shoemaker in shoe repairs	22	12.3	1.8*

* $p < 0.05$; ** $p < 0.01$.

†Adjusted for age and region.

contact with various solvents, other chemicals, and non-chemical exposures.⁶⁵ In the absence of specific information on exposures of engineers and technicians in the electric power industry, however, it is difficult to determine the role of any agents in the increased risk for non-Hodgkin's lymphoma.⁶⁹

Although we found a significant excess risk among dairy farmers, earlier case-control⁷⁰ and CER²⁸ studies in Sweden found no increased risk of non-Hodgkin's lymphoma among farmers overall or various subgroups of agricultural workers including owners and tenant farmers employed in land or animal husbandry, horticulture, and related occupations (reindeer husbandry, fur farming, care of animals other than livestock, and miscellaneous).²⁶ Some studies from the United States,^{6-9 62 71-73} the United Kingdom,⁷⁴ Italy,⁷⁵ New Zealand,¹⁰ and Tasmania¹¹ have reported an increased risk for non-Hodgkin's lymphoma among farmers and other agricultural workers, although no excesses were found in other United States^{16 52 76 77} or United Kingdom¹⁸ investigations. The exposures linked to non-Hodgkin's lymphoma among farmers include pesticides, herbicides, fertilisers, and livestock.^{7 13 15} Also, slaughterhouse workers in New Zealand have been reported to be at excess risk of non-Hodgkin's lymphoma,⁷⁸ suggesting that zoonotic agents may have an aetiological role.⁷⁹

HHfle Hcess risk we found among lorry drivers supports earlier reports of significantly increased non-Hodgkin's lymphoma among highway and road transport workers.^{71 80 81} Recognised exposures in this type of work include exhausts from petrol and diesel driven vehicles, benzene, and various solvents.^{82 83}

The raised SIRs for teachers and those employed in research and scientific institutes are consistent with findings from other occupational surveys.^{62 63 84} Whether carcinogenic exposures occur among these workers is not clear, although socioeconomic and dietary factors may also be important.^{53 54 85}

We found no excess of non-Hodgkin's lymphoma among chemists, chemical or rubber manufacturing workers, or in men working in petrochemical refineries as described in other investigations.^{17 22-25 86 87} Also, no excess risk of non-Hodgkin's lymphoma was seen among physicians and dentists as reported in other surveys,^{62 63 71} among postal workers or maintenance workers as reported elsewhere.^{62 63 84}

The shortcomings of the CER such as the lack of direct information on exposures and duration of employment have been previously described.^{26 88} Nevertheless, the CER has identified known high risk occupational activities—for example, mesothelioma among shipyard workers, nasal adenocarcinoma among furniture makers, and liver angiosarcoma among certain chemical workers.^{88 89} Our results, however, may be affected by the problem of multiple comparisons, with some findings reflecting chance

events rather than true occupational associations.

In summary, this nationwide survey of occupation and non-Hodgkin's lymphoma has shown new aetiological leads as well as associations reported in other studies. The overall results, however, suggest that occupational risk factors have a limited role in non-Hodgkin's lymphoma and the rising incidence trends reported for this tumour.

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