

# Comments on Occupational and Environmental Factors in the Origin of Non-Hodgkin's Lymphoma<sup>1</sup>

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## Abstract

The review of the literature regarding non-Hodgkin's lymphoma and occupational and environmental factors presented at this workshop suggested associations with viruses, solvents, and hair dyes. A population-based case-control study among men from Iowa and Minnesota notes similar associations. Workers engaged in metal working, hair care, painting, and dry cleaning experienced nonsignificant excesses. Risks from specific exposures showed some variation by histological type. Both follicular and diffuse non-Hodgkin's lymphoma were associated with benzene. The diffuse type was linked to solvents other than benzene and formaldehyde, while the follicular was excessive among workers exposed to oils and greases.

## Introduction

Pearce and Bethwaite (1) noted in their review of occupational and environmental factors for non-Hodgkin's lymphoma possible associations with viruses, solvents, and hair dyes. We have recently completed analysis of occupational data from a case-control study of non-Hodgkin's lymphoma that provides additional information on occupational exposures, and a short summary is presented here. A more complete presentation of these analyses will appear elsewhere (2).

## Methods

The study was a population-based case-control study of 622 white men with non-Hodgkin's lymphoma over the age of 30 who resided in Iowa or Minnesota (3). Controls ( $n = 1245$ ) were frequency-matched to the cases on age, state, and vital status and were selected by random digit dialing (for cases under the age of 65), from Health Care Finance Administration files (for cases 65 years or older), and from state death certificates (for deceased cases). Tissue blocks or slides were obtained on the cases for review by a panel of pathologists.

Occupational information used in these analyses consisted of all jobs held and industries where employed, obtained at interview and a job exposure-matrix for 27 different nonagricultural occupational exposures, developed by the study industrial hygienist.

Relative risks were estimated using polychotomous logistic regression that adjusted for age, state of residence, direct or surrogate respondent, use of agricultural pesticides, education, use of hair dyes, family history of cancer, and tobacco use.

## Results

No significant excesses were seen among occupational groups, but were seen for the industries of industrial machinery production, real estate, and personal service (Table 1). The personal service excess was concentrated among dry cleaners, among whom excesses of lymphatic and hematopoietic cancer have been noted previously (4). Several industry and occupa-

tional excesses were not statistically significant (Tables 2 and 3). These excesses occurred in industries in which exposures to paints, dusts, solvents, metals, and hair dyes could play a role. Nonsignificant occupational associations may be related to hair dyes, solvents, cooking emissions, and metals. Associations with metals, benzene, and other solvents were noted in the

Table 1 Statistically significant associations between non-Hodgkin's lymphoma and employment by industry and occupation

Title (code)	No. of exposed case/control	Odds ratio <sup>a</sup>	95% Confidence interval
Industry			
Special industrial machinery (355)	7/1	9.6	1.1-80.6
Real estate (651)	8/4	3.9	1.01-14.8
Personal services (72)	31/31	1.9	1.1-3.2
Occupation (no significant associations observed)			

<sup>a</sup> Odds ratio adjusted for age, state, smoking, family history of lymphopoietic cancer, agricultural exposure to pesticides, use of hair dyes, and direct or surrogate respondent.

Table 2 Nonsignificant associations ( $OR > 1.5$ ) between non-Hodgkin's lymphoma and employment by industry (based on 2 or more exposed cases)

Title (code)	No. of exposed case/control	Odds ratio <sup>a</sup>	95% Confidence interval
Agricultural production (01)	11/10	2.3	0.9-5.8
Painting/paper hanging (172)	16/16	1.9	0.9-3.8
Masonry, tile setting (174)	9/16	2.6	0.9-3.8
Apparel (23)	7/6	2.4	0.7-8.0
Paper/paperboard (264)	8/8	1.6	0.6-4.2
Concrete/gypsum/plaster (327)	7/9	1.5	0.5-4.1
Fabricated metal (34)	54/89	1.4	0.96-2.0
Metalworking machinery (354)	8/4	3.0	0.9-10.2
Transportation by air (45)	7/6	1.8	0.6-16.9
Air transport (certif.) (451)	4/2	3.1	0.6-5.5
Laundry/garment services (721)	16/14	2.0	0.97-4.3
Barber shops (724)	6/8	2.7	0.9-8.7
Funeral service (726)	6/4	2.1	0.5-7.9

<sup>a</sup> Odds ratio adjusted for age, state, smoking, family history of lymphopoietic cancer, agricultural exposure to pesticides, use of hair dyes, and direct or surrogate respondent.

Table 3 Nonsignificant associations ( $OR > 1.5$ ) between non-Hodgkin's lymphoma and employment by occupation (based on 2 or more exposed cases)

Title (code)	No. of exposed case/control	Odds ratio <sup>a</sup>	95% Confidence interval
Occupations in life sciences (04)	6/5	1.6	0.5-5.4
Chefs and cooks (313)	13/11	1.5	0.7-3.4
Barbering, cosmetology (33)	7/10	2.1	0.7-5.9
Apparel and furnishing (36)	9/11	1.8	0.7-4.3
Plant life (408)	6/6	1.5	0.3-3.8
Cooking and baking (526)	6/9	1.6	0.5-4.9
Toolmakers (601)	8/5	2.6	0.8-8.8
Printing press occupations (651)	6/5	1.5	0.4-5.1
Metal unit assignment (706)	8/7	1.6	0.5-4.7

<sup>a</sup> Odds ratio adjusted for age, state, smoking, family history of lymphopoietic cancer, agricultural exposure to pesticides, use of hair dyes, and direct or surrogate respondent.

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Table 4 Odds ratios for non-Hodgkin's lymphoma by intensity of exposure to selected factors

Exposure	Lower intensity			Higher intensity		
	Odds ratio <sup>a</sup>	No. case/control	95% Confidence interval	Odds ratio	No. case/control	95% Confidence interval
Benzene	1.1	141/283	0.8-1.4	1.5	12/18	0.7-3.1
Solvents other than benzene	1.1	334/648	0.8-1.4	1.4	25/38	0.8-2.5
Formaldehyde	1.2	78/128	0.9-1.7	1.3	6/9	0.5-3.8
Paints	1.1	107/204	0.9-1.5	1.1	9/17	0.5-2.6
Oils and greases	1.1	168/328	0.8-1.4	1.2	112/189	0.9-1.7
Metals	1.3	215/362	1.03-1.6	0.7	6/19	0.3-1.8
Solder	0.8	114/260	0.6-1.1		0/3	
Wood dust	0.9	88/173	0.7-1.2		0/2	
Asbestos	1.3	181/313	0.99-1.6	1.1	21/47	0.6-1.9

<sup>a</sup> Adjusted for state, age, vital status, agricultural exposure to pesticides, social class, use of hair dyes, smoking, and relative with cancer by polychotomous logistic regression.

Table 5 Odds ratios for histological types of non-Hodgkin's lymphoma by intensity of exposure to selected factors

Exposure	Lower intensity			Higher intensity		
	Odds ratio <sup>a</sup>	No. case/control	95% Confidence interval	Odds ratio	No. case/control	95% Confidence interval
Benzene						
Follicular	1.3	53/283	0.9-1.9	1.9	5/18	0.7-5.3
Diffuse	1.2	45/283	0.8-1.8	1.8	4/18	0.6-5.4
Other	0.8	43/283	0.5-1.2	0.9	3/18	0.3-3.1
Solvents other than benzene						
Follicular	1.4	116/648	0.9-2.0	1.1	6/38	0.4-2.7
Diffuse	1.0	98/648	0.7-1.5	2.4	12/38	1.2-5.0
Other	1.0	120/648	0.7-1.4	1.1	7/38	0.4-2.5
Formaldehyde						
Follicular	1.4	27/128	0.9-2.2	0.6	1/9	0.1-5.1
Diffuse	1.3	27/128	0.8-2.2	2.3	3/9	0.6-8.6
Other	1.0	24/128	0.6-1.6	1.2	2/9	0.3-5.8
Oils and greases						
Follicular	1.2	51/328	0.8-1.8	2.0	52/189	1.3-3.1
Diffuse	0.9	49/328	0.6-1.4	0.8	24/189	0.6-1.4
Other	1.1	68/328	0.8-1.6	1.0	36/189	0.7-1.6

job-exposure matrix (Table 4). Risks rose with estimated intensity of exposure to benzene and other solvents, but not with metals. Benzene appeared to be associated with follicular and diffuse lymphoma, while other solvents were more strongly associated with diffuse lymphoma (Table 5). Two other categories that were not associated with non-Hodgkin's lymphoma overall were related to specific histological types. Formaldehyde, which has previously been associated with non-Hodgkin's lymphoma in a study of embalmers (5), was linked to diffuse lymphoma, and oils and greases were associated with follicular lymphoma.

### Discussion

We found few statistically significant associations with jobs or occupational exposures. Associations with occupations engaged in metal working, hair care, and dry cleaning suggest a role for solvents, which has been reported by others (1). Differences in risk were found by histological type, particularly for benzene, other solvents, formaldehyde, and oils and greases.

Whether these findings represent clues or chance findings is unclear, but they do suggest that it might be profitable to focus on histological types in future efforts to evaluate occupational causes of non-Hodgkin's lymphoma.

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