Occupational Mortality Associated with Inflammatory Bowel Disease in the United States 1984–1998

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Background: The occurrence of Crohn's disease (CD) and ulcerative colitis (UC) is shaped by environmental influences. Many such environmental risk factors vary potentially with occupational exposure. We used a large national database to study the occupational variation of mortality associated with CD and UC.

Methods: The National Occupational Mortality Surveillance database contains data from the death certificate linked with information about the occupation and industry of each deceased individual. Deaths were grouped by gender, ethnicity, disease type, occupation, and industry. Mortality by occupation and industry were expressed as age-adjusted proportional mortality ratio.

Results: A total of 3110 inflammatory bowel disease (IBD) patients were included in the present analysis. IBD mortality was low among blue collar workers and high among white collar workers. It was low among farming occupations, manufacturing occupations, and manual laborers. It was high among secretaries, professionals, sales workers, homemakers, managerial occupations, and teachers. There was a strong correlation between the occupational distribution of CD and UC that applied to men and women alike. The overall distribution among different industries corroborated the patterns observed with respect to the occupational distribution.

Conclusions: The correlations between the occupational distribution of CD and UC support the contention that environmental influences shape the occurrence of both diseases. Such influence must vary by occupation and, to a lesser extent, also by industry. It must be similar for both types of IBD.

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Key Words: Crohn's disease, environmental risk factors, epidemiology, industry, occupation, occupational mortality statistics, proportional mortality ratio, ulcerative colitis

The occurrence of Crohn's disease (CD) and ulcerative colitis (UC) is shaped by environmental influences. The incidence of both types of inflammatory bowel disease (IBD) has risen markedly during the past century.[1] IBD has been rare in the developing countries of Asia and Africa, but relatively common in Europe and North America.[2,3] In countries where IBD is common, it tends to affect predominantly urban as compared to rural populations and the more educated and affluent socioeconomic strata of the population.[4–8] The study of IBD epidemiology is carried out to elucidate environmentally relevant risk factors and obtain clues about the yet unknown disease etiology. Many such environmental risk factors vary potentially with occupational exposure. The National Institute for Occupational Safety and Health (NIOSH) maintains the National Occupational Mortality Surveillance (NOMS) database of death certificate data with coded occupation and industry information. We used this large national database to study the occupational variation of CD and UC.

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MATERIALS AND METHODS

The NOMS database contains data from the death certificate linked with information about the occupation and industry of each deceased individual. We used these data to survey the association between cause-specific mortality and occupation or industry. Cause of death was coded according to the 9th Revision of the International Classification of Diseases (ICD9).[9] The ICD9-code 555 (including all its 4-digit subcodes) represented CD, and the ICD9-code 556 (including its 4-digit subcodes) represented UC. Depending on date of death, the usual occupation and industry of the decedent were coded according to the 1980 Bureau of the Census classification system.[10] For a given year, each state contributing data to the NOMS database provided mortality and demographic data, including industry and occupation, for all deaths occurring within the state. Twenty-eight states participated in the project for 2 or more years from 1984 through 1998. These states included: Alaska, Colorado, Georgia, Hawaii, Idaho, Indiana,

TABLE 1. Total Population Stratified by Diagnosis, Gender, and Race

	CD (555)	UC (556)	All ICD9 codes
Men	633	668	4,540,975
Whites	584	612	3,987,668
Blacks	49	56	553,307
Women	992	817	3,975,784
Whites	926	755	3,514,700
Blacks	66	62	461,084
Total	1,625	1,485	8,597,398
Whites	1,510	1,367	7,502,368
Blacks	115	118	1,014,391

Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York (except New York City), North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin.

Because the total number of subjects with a given occupation or industry is generally unknown, in the analysis of occupational mortality a proportionate mortality ratio (PMR) was used as a measure of association.[11] The PMR indicated whether the *observed* number of deaths from a specific cause of death was higher or lower than the *expected* age-standardized number of deaths for a particular occupation or industry. To calculate the expected number of deaths, the sum of deaths from all ICD-codes 1-999 per individual occupation was expressed as a proportion of all deaths in all occupations combined. This occupation-specific proportion was then multiplied by the sum of all deaths from CD to obtain the expected number of deaths from CD in this particular occupational group. This calculation was carried out separately for each age group, with the age-specific numbers added up to yield the overall expected number of deaths for a particular occupation. The ratio of observed over expected number of deaths (multiplied by 100) corresponded with the PMR. Age stratification and adjustment of the PMR was done by 5-year age groups for ages 15–90 years. To test for statistical significance of individual PMR, two-sided 95% confidence intervals (95% CI) were calculated, based on the Poisson distribution for observed deaths,[12] and using the normal approximation to the Poisson for large numbers.[13] The PMRs were calculated separately for white men and women, as well as black men and women. The industrial and occupational distributions of mortality from CD were compared with those of UC using a least-square regression analysis of the PMR.

RESULTS

A total of 3110 IBD patients were included in the present analysis. Table 1 contains a stratification of the patient population by gender and race. CD was more common in women than men (odds ratio 1.79, 95% CI 1.62–1.98) and more common in whites than blacks (1.78, 1.47–2.15). Similarly, UC was also more common in women than men (1.40, 1.26–1.55) and more common in whites than blacks (1.57, 1.30–1.89).

There are over 900 occupational codes, of which fewer than 250 were associated with deaths from CD and UC. Table 2 shows all individual occupational codes and their official groupings that were associated with 30 or more deaths among white men and women. The occupations were sorted according to their rising average PMR. Overall, IBD mortality was low among blue collar workers and high among white collar workers. It was low among farming occupations, manufacturing occupations, and manual laborers. It was high among secretaries, professionals, sales workers, homemakers, managerial occupations, and teachers. There was a strong correlation between the occupational distribution of CD and UC that applied to both men and women alike (Fig. 1). Men and women were generally characterized by different occupational distributions. Due to their different underlying occupational distributions, there were no significant correlations between the variations of occupational mortality in the two gender groups. Among blacks, IBD mortality was similarly low among blue collar workers and high among white collar workers. Because of the overall smaller numbers of death among blacks, hardly any of the individual occupations were associated with more than 10 deaths.

Table 3 contains the PMRs among white men and women stratified by industry. There are over 900 individual codes representing different types of industry, of which over 200 were associated with deaths from CD or UC. The table was restricted to individual industries or their official groupings associated with 30 or more deaths. The industries were ordered according to their rising PMRs. The overall distribution among different industries corroborated the patterns observed with respect to the occupational distribution. Mortality from IBD was low in agriculture, manufacturing industries, transportation, and construction. It was high in administration, sales and retail, and sanitary services. The correlations between the distributions of CD and UC among different industries were weaker than those observed among different occupations (Fig. 2). Because of their underlying different industrial distributions, IBD mortality between the two gender groups did not correlate with each other. The numbers of deaths among blacks associated with individual industries were too small for a meaningful statistical analysis.

DISCUSSION

The analysis of mortality from CD and UC among different occupations and industries revealed a characteristic pattern. IBD mortality was relatively more common in

TABLE 2. Proportional Mortality Ratios for Crohn's Disease and Ulcerative Colitis by Occupational Group

Occupation	Men CD	UC	Women CD	UC	Total number of subjects
Farming, forestry, & fishing occupations [473–499]	60	80	96	39	70
Transportation & material moving occupations [803–859]	82	94	40	-	79
Food preparation & service occupations [433–444]	61	36	74	121	55
Textile, apparel, & furnishing machine operators [738–749]	66	73	81	74	52
Handlers, equipment cleaners, helpers, & laborers [863–889]	80	101	33	101	98
Fabricators, assemblers, and hand working occupations [783–795]	44	113	98	64	30
Machine operators, assorted materials [753–779]	77	76	107	86	52
Cleaning & building service occupations, exc priv household [448–455]	69	107	81	91	42
Construction trades [553–599]	85	94	-	-	93
Executive and administrative occupations [003–019]	111	79	97	101	150
Miscellaneous administrative support occupations [379–389]	49	136	105	103	48
Health diagnosis and treatment occupations [084–106]	113	105	104	78	50
Precision production occupations [633–699]	104	90	94	115	111
Technicians & related support occupations [203–235]	142	73	72	136	40
Mechanics & repairers [503–549]	82	100	170	-	60
Protective service occupations [006, 413–427]	118	129	109	-	34
Teachers, counselors, and teachers' aides [113–159, 163, 387]	137	96	132	126	107
Management related occupations [023–037]	188	149	86	95	57
Supervisors & proprietors, sales occupations [243]	161	110	168	129	106
Sales workers, retail and personal services [263–278]	189	154	142	84	111
Homemaker [914]	203	187	101	93	783
Sales representatives, finance and business services [253–257]	133	125	172	255	38
Financial records processing occupations [305, 337–344]	194	227	127	144	49
Engineers [044–062]	134	98	207	354	31
Secretaries, stenographers, & typists [313–315]	512	-	107	133	84
Broad grouped categories					
White collar occupations [003–389]	130	108	113	116	1034
Blue collar occupations [503–889]	84	91	76	86	630

white than blue collar workers. It was low among farming occupations, manufacturing occupations, and manual laborers. It tended to be high among professionals, managerial, and administrative occupations. CD and UC showed similar occupational and industrial distributions.

The correlation between the occupational distributions of CD and UC supports the contention that some strong environmental influence shapes the occurrence of both diseases. Such influence must vary by occupation and, to a lesser extent, also by industry. Lastly, this influence must be similar for both types of IBD. Besides their resembling natural histories, the similarity between the two diseases is supported by many other epidemiologic studies that show resembling geographic variations and interrelated time trends.[1,14] The epidemiology of IBD suggests that some basic environmental influence must be shared by both diagnoses.

Although the overall pattern revealed by the occupational distribution is relatively distinct, its meaning is far from clear. The generally protective influence of farming and agricultural occupations has been observed in several previous studies.[7,15,16] Similarly, the protective influences associated with physically demanding occupations and the risks associated with professional, sedentary, and administrative occupations were also borne out by these previous studies. Somehow, exposure to the outdoors or its "dirty environments" appears to confer a protective influence against both types of IBD. This occupational distribution fits well with the general epidemiologic patterns of IBD and its more frequent occurrence among the economically advanced, educated, and urban sections of society. It appears as if higher standards of living result either in a peculiar risk for IBD or in a lack of exposure to a protective influence, common to environments characterized by outdoor, agricultural, or physical activity.

It remains unclear whether the occupation itself or socioeconomic factors associated with a given occupation

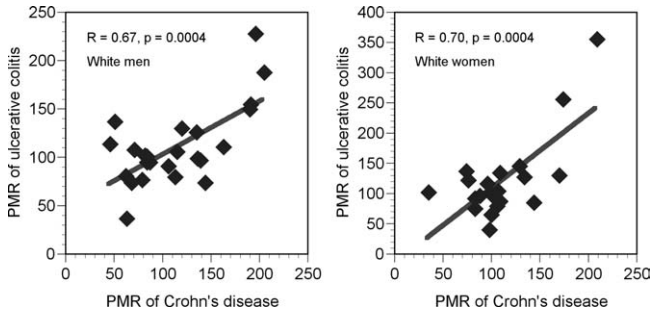

FIGURE 1. Correlation between the PMRs of CD and UC among different occupations in men (left panel) and women (right panel).

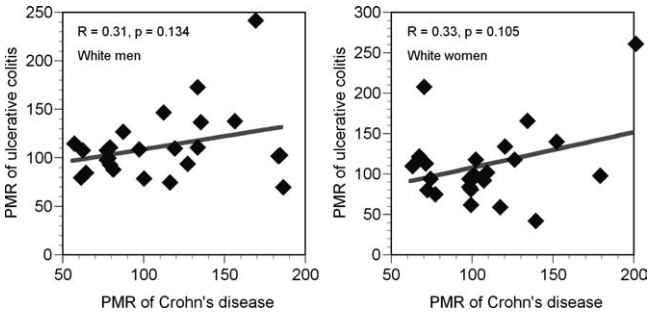

FIGURE 2. Correlation between the PMRs of CD and UC among different industries in men (left panel) and women (right panel).

confer the increased or decreased risks for IBD. Within individual occupations, a large variation may exist among individuals in what type of work they actually do and the type of risks they are exposed to while performing their job. This argument becomes even more applicable to individual industries. In the present analysis, no single occupation or industry was associated with an excessively high risk for IBD that would point at a particular environmental influence. If one tries to fine-tune the analysis by stratifying the occupational distribution into very narrowly defined occupational codes, the numbers of deaths associated with each individual occupational entity become too small for any reliable statistical analysis. By assembling individual occupations into larger groups with more representative numbers, on the other hand, regression toward the mean sets in with a tendency for the influences from heterogeneous occupations to cancel each other out. This phenomenon could explain the weaker regressions observed among

TABLE 3. Proportional Mortality Ratios for Crohn's Disease and Ulcerative Colitis by Industry

Industry	Men CD	UC	Women CD	UC	Total number of subjects
Transportation equipment [351–370]	63	84	76	74	34
Agriculture, forestry, & fisheries [010–031]	60	79	98	61	69
Textile and apparel manufacturing [132–152]	61	107	71	79	78
Metal industries [270–301]	99	78	73	93	57
Not specified manufacturing industries [392]	77	99	62	109	40
Transportation [400–432]	78	92	97	83	92
Construction [060]	76	97	138	41	127
Health services [812–840]	76	107	98	80	115
Business & repair services [721–760]	80	87	100	98	60
Eating & drinking places (retail) [641]	115	74	70	112	60
Industry not reported [990]	78	110	66	121	49
Personal services [761–791]	126	93	97	93	80
Finance, insurance, & real estate [700–712]	96	108	101	117	79
Department, variety, general merchandise [591–600]	185	69	106	91	33
Machinery, except electrical [310–332]	134	136	66	120	51
Education [842–860]	86	126	119	133	166
Communications [440–442]	56	114	133	165	31
Food stores [601–611]	132	172	116	58	47
Public administration [900–932]	132	110	125	117	122
Electrical machinery [340–350]	155	137	108	101	46
Food manufacturing [100–122]	111	146	69	207	49
Not specified retail trade [691]	182	101	178	97	37
Wholesale trade [500–571]	183	102	151	139	61
None, never worked, unpaid workers [961]	168	241	100	95	859
Utilities and sanitary services [460–472]	118	109	200	260	34

different industries as opposed to different occupations. In general, however, both types of stratification tended to reveal similar epidemiologic patterns.

Previous epidemiologic studies have shown CD to be relatively more common in women than men and UC to be more equally distributed among the sexes.[17] Although our data also support such a general pattern of a more pronounced female prevalence in CD than UC, in our study the overall female predominance among both IBD types was more marked than previously reported. In the present study, mortality from CD or UC was compared with mortality from all causes. Our data may thus have been biased toward a relatively more severe outcome of IBD as compared to all other diagnoses, especially among women. In other words, IBD among women may have been more commonly associated with death than other diagnoses.

Although the NOMS database lacks information on length of employment, specificity about the type of occupation and industry, or estimates of workplace exposure, its advantages over other studies include its larger size, its broader geographic coverage, and the more recent date of death of the cases. A statistically significantly elevated PMR alone cannot be interpreted directly as indicating a causal relationship between the occupation or industry and the cause of death. When a very large number of PMRs were tested for statistical significance, some of the elevated or decreased PMRs may have occurred due to chance, especially among single occupational or industrial codes with only few cases assigned to them. The present analysis confirmed and expanded the occupational distribution of IBD revealed by previous analyses. The significant correlations across different occupations and industries provide additional credence for the general patterns observed by the present analysis.

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