Construction Occupations, Asbestos Exposure, and Cancer of the Colon and Rectum

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Colorectal cancer affects more than 157,000 Americans annually. Occupational risk from exposure to asbestos dust has been implicated, leading us to explore further the possible association between colorectal cancer and asbestos. Two hundred sixty-one cases of colon and rectal cancer and 183 control cases were identified within a large, population-based case-control study conducted in southeast Michigan. Employment in occupations historically known to involve heavy exposure to asbestos was used as a surrogate for asbestos exposure. Cancers of the colon showed reduced odds ratios. Our findings differ substantially from those of the previous studies showing elevated risk. Further study is needed to address the same question, with specified asbestos exposure assessment and control for potentially significant confounders such as physical activity and diet.

Colorectal cancer is the second leading incident cancer in adults in the United States, having affected more than 157,000 Americans and proving fatal for more than 60,000 people during 1991.[1] There is substantial worldwide variation in incidence rates for this cancer, and rates in the United States and Europe greatly exceed those in the Far East and Africa.[2,3] This fact suggests that etiology involves environmental factors, but no such factors have definitely been identified. Colorectal cancer remains a public health problem of major proportions because of its high incidence rates in the United States and the fact that the currently known risk factors account for only a small portion of these cancers. Persuasive evidence regarding elevated risk exists for dietary intake patterns and physical activity. High-fat diets are frequently associated with elevated risk for this cancer, whereas high fiber consumption is shown to have a protective effect.[4,5] High levels of physical activity reduce the risk for colorectal cancer.[6]

Although colon cancer is not commonly considered to be occupational in etiology, there have been some associations reported, the most controversial being asbestos. Since the initial identification of an association between asbestos exposure among insulation workers and colon cancer in 1964 by Selikoff et al,[7] numerous studies have followed, with mixed results. Incidence and mortality studies, utilizing case-control, cohort, and other study designs have concluded that there may exist such an association.[8-12] For example, a case-control study recently published by Garabrant et al,[13] studying the general popula-

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tion of southern California, found no such association. Conversely, a recent study by Gerhardsson de Verdier et al,[14] also utilizing a case-control design with incident cases in Sweden, found a positive association between asbestos exposure and the development of colon cancer. Gerhardsson de Verdier et al[14] also found a positive dose-response relationship, particularly with latency of greater than 39 years. Also noteworthy are studies of pattern- and modelmakers. No less than four large-scale studies in the 1980s identified a positive association between work in the trade of pattern- and modelmaking and an excess of colorectal neoplasia.[15-18] Although the specific carcinogenic exposure has not been identified, asbestos is not a common material used in the trade of pattern- and modelmaking, and is not considered a likely candidate to explain the excess risk for colorectal cancer in members of this trade.

An opportunity for a unique approach to the study of the association between cancers of the colon and rectum and occupations is available using data from the Occupational Cancer Incidence Surveillance Study (OCISS).[19] By identifying a set of occupations in which asbestos exposure was likely to have occurred and using duration of work in high-exposure trades as a surrogate for asbestos exposure, the following research question was addressed: Is employment in an asbestos-exposed occupation a risk factor for colorectal cancer?

Methods

The OCISS is a study of occupational risk factors for selected cancers diagnosed from November 1984 through August 1991 among residents of the metropolitan Detroit area. Ascertainment of colon and rectum cancer cases ended in June 1987. Study subjects, incident cases of 11 types of cancer, were identified through the Metropolitan Detroit Cancer Surveillance System, a participant in the National Cancer Institute Surveillance, Epidemiology, and End Results program.[20] Cases were selected through the Metropolitan Detroit Cancer Surveillance System rapid reporting system, which enables investigators to enroll patients into studies within 2 to 6 weeks after diagnosis. Incident cancers occurring among white and black men and women between the ages of 40 and 84 are enrolled into the study. Data on lifetime work history as well as smoking history, medical history, demographic information, and residential history were obtained through telephone interviews. Occupations and industries were coded using the 1980 US Census Bureau classification codes.[21] Among the types of cancers included in this data base were those of the colon and rectum; the total number interviewed was 4369. In addition, population control subjects were selected using random-digit dialing.[22] Potential control subjects were contacted using lists of randomly generated telephone numbers. Once interviewers contacted a working residential number, they recorded the age, sex, and race of all eligible adults in the household. One subject from the household was selected randomly to be interviewed. Ninety-seven percent of eligible control subjects selected were successfully interviewed. The main trades that have involved asbestos exposure have been dominated by white men in Michigan; therefore, the present analysis was restricted to white men.

No exposure information was obtained as part of the interview. To identify asbestos-exposed subjects, we selected a set of occupations and industries that were most likely to be associated with high levels of asbestos exposure. Members of these occupations were assumed to be exposed to asbestos over a lifetime of work, and for the purpose of this study constitute the exposed study group. Based on recent findings of local and national studies,[23-27] the following occupations were defined as having high levels of asbestos exposure: insulation workers, sheetmetal workers, boilermakers, pipefitters, and plumbers. Furthermore, the industry included in the analysis was restricted to construction. These industry/occupation combinations are quite common in southeast Michigan. Each of these trades is known historically to have both applied and removed asbestos-containing materials as a routine component of their work, and the insulation workers are known to be at highest exposure. Construction boilermakers, pipefitters, and sheetmetal workers historically have worked side by side with asbestos insulators, also commonly referred to as pipecoverors, on construction sites. As a result, they would be exposed to "second hand" sources of asbestos dust, airborne through the process of applying insulation.

The study population consisted of case and control subjects ever employed in these "exposed" trades as compared with case and control subjects solely employed in unexposed occupations that are not expected to result in significant asbestos exposure. The unexposed were defined as workers who had worked in occupations that were selected as being unlikely to involve asbestos exposure and to represent roughly the same socioeconomic status as the asbestos-exposed occupations. Table 1 shows the list of selected unexposed occupations.

TABLE 1
Occupations Selected as Unlikely To Involve Significant Exposure to Asbestos Dust

Police officers and guards
Morticians
Construction administrators
Environmental workers
Driver sales
Bookkeepers, accounting clerks
Dance/sports
Library/museum workers
Writers
Pilots and navigators
Sales workers
Clerical workers
Communication operators
Postal workers
Stock clerks
Assemblers
Production inspectors
Janitors
Optical workers
Apparel and fabric workers
Printers
Machine operators
Drivers
Material movers
Military workers
Garbage collectors
Shoe repairers and machine operators
Food workers

Duration of employment was calculated by summing all years a subject had been employed in any exposed occupation. Unprotected asbestos exposure in the United States has been rare beyond 1980; therefore, any years of employment beyond this year were excluded from the analysis. Latency was calculated by subtracting the first year employed in a particular occupation from the date of interview. Occupations that began after 1980 were excluded from the latency calculation.

Unconditional logistic regression was used to obtain maximum likelihood estimates of the odds ratio.[28] Ninety-five percent confidence intervals (CIs) were calculated for each odds ratio. The potential confounding effects of age and smoking were controlled for in the model. We performed the analyses looking at colon cancer cases individually and colon and rectum cancer cases combined.

As a quality control measure, we carried out an analogous analysis of mesothelioma using the same study population. If this analysis failed to detect an elevated risk for mesothelioma we would question the validity of the asbestos exposure effects upon colorectal cancer. Analyses performed were parallel to those in the colorectal cancer analyses, using duration and latency in dose-response analyses.

Results

Two hundred sixty-one cases of incident cancers of the colon and rectum and 183 control subjects were included. Smoking status, age at diagnosis, and education characteristics for case and control subjects along with exposure status are shown in Table 2. Colorectal cancer case subjects have a higher proportion of never smokers than do control subjects, and there is a marked difference between unexposed and exposed case subjects (36% vs 7% never smokers, respectively). This is probably reflective of high rates of smoking in the construction trades. Control subjects are younger than case subjects for both exposed and unexposed groups. The apparent difference in education level in exposed case and control subjects may be a function of small sample size (15 exposed case subjects, 22 exposed control subjects).

Table 3 summarizes case/control odds ratios for cancers of colon and rectum combined, showing an overall odds ratio of 0.5 (CI, 0.3 to 1.0). Duration and latency of work in high-risk trades reveals no apparent trend. Table 4 presents identical analyses for colon cancer alone, again revealing a significantly reduced risk among workers exposed to asbestos. Data on latency and duration provided little additional information; hence they are not presented in this paper.

Table 5 summarizes elevated mesothelioma rates among asbestos-exposed construction workers. Twenty-one cases of mesothelioma were observed in the identified occupations. The overall odds ratio was 14.4 (CI, 5.0 to 41.4). A significant dose response was noted for both duration of work in the trade and latency, and there were particularly high risks for those exposed for more than 20 years (odds ratio, 29.2; CI, 8.4 to 101.0).

Discussion

The findings of this study suggest a diminished risk of cancers of the colon and rectum among men employed in trades with known asbestos exposure. Our identification of high and low asbestos exposure populations seems to be validated by the comparative analyses of mesothelioma, with an odds ratio of 29.2 among men employed 20 or more total years in high-risk trades. These findings are somewhat unexpected because other studies utilizing incident colorectal cancer case subjects and case-control designs have typically shown odds ratios approximating 1 or greater.[13,14] A possible reason for the diminished odds

TABLE 2
Smoking Status, Age, and Education by Case-Control Status and Exposure Status

	Colorectal Cancer Case Subjects	Control Subjects	Unexposed Subjects		Exposed Subjects	
			Case	Control	Case	Control
Never smoked	34%	22%	36%	24%	7%	9%
Age under 65 y	30%	40%	30%	40%	27%	36%
Education (>12 y)	22%	22%	22%	21%	27%	36%

TABLE 3
Colon and Rectum Cancer Risk among Asbestos-Exposed Workers in the Construction Industry*

	Subjects		OR†	95% CI‡
	Case	Control		
Total	261	183		
Unexposed	246	161	1.0	
Exposed	15	22	0.5	0.3, 1.0
Duration				
Unexposed	246	161		
Exposed				
<20 y	9	12	0.6	0.3, 1.5
20+ y	6	10	0.4	0.1, 1.2
Latency				
Unexposed	246	161		
Exposed				
<40 y	5	11	0.4	0.1, 1.3
40+ y	10	11	0.6	0.2, 1.4

* Excluding any years of employment beyond 1980.
† OR, odds ratio. Adjusted for age at interview and pack-years of cigarette smoking.
‡ 95% CI, 95% confidence interval.

TABLE 4
Colon Cancer Risk among Asbestos-Exposed Workers in the Construction Industry*

	Subjects		OR†	95% CI
	Case	Control		
Total	211	183		
Unexposed	201	161	1.0	
Exposed	10	22	0.4	0.2, 0.9
Duration				
Unexposed	201	161		
Exposed				
<20 y	5	12	0.4	0.1, 1.2
20+ y	5	10	0.4	0.1, 1.3
Latency				
Unexposed	201	161		
Exposed				
<40 y	3	11	0.3	0.1, 1.2
40+ y	7	11	0.5	0.2, 1.3

* Excluding any years of employment beyond 1980.
† Adjusted for age at interview and pack-years of cigarette smoking.

TABLE 5
Mesothelioma Cancer Risk among Asbestos-exposed Workers in the Construction Industry*

	Subjects		OR†	95% CI
	Case	Control		
Total	21	183		
Unexposed	8	161	1.0	
Exposed	13	22	14.4	5.0, 41.4
Duration				
Unexposed	8	161		
Exposed				
<20 y	2	12	3.7	0.7, 20.5
20+ y	11	10	29.2	8.4, 101.0
Latency				
Unexposed	8	161		
Exposed				
<40 y	6	11	12.4	3.2, 47.9
40+ y	7	11	16.5	4.4, 62.3

* Excluding any years of employment beyond 1980.
† Adjusted for age at interview and pack-years of cigarette smoking.

ratios in our study compared with the above two may be that the results of these studies were diluted by utilizing all other occupations as the comparison group, rather than by identifying a specific group of low-risk occupations.

Limitations of this study must be considered. Occupational title does not always reflect specified exposures and asbestos exposure data were not collected for the OCISS project. Sample sizes were small as evidenced by only 15 exposed men among the 261 cases of cancers of the colon and rectum. Information on important potential confounders is unavailable. Those include diet, physical activity, family history, and other risk factors that might have explained the reduced odds ratios or have diminished a possible positive relationship between asbestos-related occupations and colorectal cancer risk. The potential confounding effect of physical activity warrants special consideration. The protective effect of occupational physical activity on colorectal cancer risk has been shown repeatedly.[29-32] The construction trades, particularly those selected as high asbestos exposure groups for the current study, are known to involve high levels of physical exertion. This level of physical exertion may serve to protect an otherwise high-risk population from developing this cancer. One possible mechanism is a decrease in asbestos fiber contact time with colorectal mucosa due to increased peristalsis.

The plausibility of a link between asbestos and colorectal cancer cannot be ignored. The translocation of inhaled asbestos fibers to other tissues has been demonstrated.[33] Inhaled asbestos fibers are commonly swallowed, providing access to colorectal mucosa. Mechanisms for carcinogenesis involving asbestos fibers also are consistent with a carcinogenic effect on the colorectal mucosa.[34] Added to the presence of biological plausibility is the epidemiological evidence of positive association cited earlier in this paper.

Although we have shown a reduced risk of cancers of the colon and rectum among workers most likely to be exposed to asbestos dust, our study is limited because of small numbers of exposed cases, unavailable data on potential confounders (physical activity in particular), and lack of precise exposure information. Further study should involve quantification of exposure to asbestos dust, along with attainment of colorectal cancer outcomes. Access to exposure data, particularly accurate industrial hygiene data, may not be possible. A clearly defined study group with biological evidence of asbestos exposure may serve as a substitute. For instance, such a study group could be defined as persons with reliable radiological evidence of asbestos-related disease. In addition to more valid exposure assessment, accurate documentation and control for other risk factors such as diet and physical activity are necessary. In the absence of further study, one cannot conclude with certainty that asbestos either is or is not a risk factor for development of colorectal cancer.

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