Mortality among Laboratory Workers Employed at the U.S. Department of Agriculture

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We evaluated the mortality of 835 white male and 36 female laboratory workers employed by the U.S. Department of Agriculture who died between January 1, 1970, and December 31, 1979. For males, the mortality odds ratio for all cancers was 1.0 (95% confidence interval = 0.8–1.2). Colon cancer, lymphosarcoma and reticulosarcoma, nonmalignant diseases of the blood and blood-forming organs, and suicide showed elevated mortality odds ratios. Only colon cancer showed an association with duration of employment as a laboratory worker. In an accompanying case-control study, the risk of colon cancer rose to 3.2 among those who had 20 or more years of employment as a laboratory worker. Among females, breast cancer was elevated (mortality odds ratio = 5.3; 95% confidence interval = 2.8–10.1). (Epidemiology 1992;3:258–262)

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Several studies indicate that laboratory workers may have excess mortality from certain types of cancer and other occupational diseases,[1–15] including lymphoma,[1–5] leukemia,[2–5] malignant melanoma,[7,12,13] and cancers of the pancreas,[1,4,6] colon,[1,7] prostate,[5,7,8] stomach,[4] liver,[1] breast,[4] ovary,[4] brain,[9] lower urinary tract,[10] and thyroid,[11] urogenital tumors,[3] cerebrovascular disease,[7] asthma,[14] and suicide.[4] To investigate further the mortality patterns of laboratory workers, we examined the causes of death among chemists and other laboratory professionals employed at the U.S. Department of Agriculture.

Methods

We identified U.S. Department of Agriculture (USDA) employees with at least 5 years of government experience who were eligible for life insurance benefits and who died during the period of January 1, 1970, to December 31, 1979 (N = 9,555 deaths) from the Office of Personnel Management. We obtained complete work histories for all decedents from the personnel folders stored at the Civilian Record Center in St. Louis, Missouri. The average number of USDA jobs was five and of non-USDA jobs, three. We obtained death certificates either from the Office of Personnel Management files or from state offices of vital statistics. A nosologist coded the underlying and contributing causes of death listed on the death certificates using the International Classification of Diseases, 8th revision. We selected decedents who may have worked in a laboratory (for example, chemist, biological scientist, medical scientist, bacteriologist, life scientist, chemistry and biology teacher, chemistry laboratory technician, chemical engineer) for the study (N = 835 for males and N = 36 for females). We used all circulatory diseases as a control population for each of the cancer categories.[15] Confidence interval and *P*-values were determined by Miettinen's methods.[16]

Because colon cancer showed an elevated risk and there were 25 exposed cases among the laboratory workers, we conducted a more detailed case-control study of colon cancer (219 cases and 3,503 matched controls) among all USDA employees. Controls were selected from individuals in the total data set for whom colon cancer was not listed as an underlying or contributing cause of death. For each case, 16 controls

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were randomly selected from the same 2-year age group as the case. Duration of employment as a laboratory worker at the USDA was the exposure variable in the analysis. For a more conservative definition of being a laboratory worker, we excluded from the analyses individuals in occupations that are not usually involved in laboratory bench work, such as chemistry teachers and chemical engineers. The maximum likelihood estimate was used to compute common odds ratios[17] in these analyses, and confidence limits for the odds ratios were calculated according to the method of Gart and Thomas.[18] Trend for exposure-disease association was assessed by means of Mantel's two-tailed linear trend test.[19] In the calculation of test statistics for linear trend, we used midpoints of duration categories (0, 10, and 30 years) as exposure scores. We evaluated the possibility of confounding according to level of physical activity using an assignment of physical activity level based on a rating system developed by Hettinger *et al.*[20] No confounding was observed; therefore, the odds ratios were adjusted only for age.

Results

Table 1 shows the mortality odds ratios (MOR) of male laboratory workers from cancers and other major causes of death. The MOR for all cancers was 1.0 [95% confidence interval (CI) = 0.8–1.2]. For individual cancer sites, we observed excesses for cancer of the colon (MOR = 1.4), lymphosarcoma, and reticulosarcoma (MOR = 2.6). Cancers of the rectum, pancreas, prostate, kidney, and multiple myeloma also showed slight excesses. We observed significant deficits for lung cancer (MOR = 0.7), allergic-endocrine-metabolic disorders (MOR = 0.5), and diseases of the digestive system (MOR = 0.5). The deficit for digestive diseases was primarily due to cirrhosis of the liver (MOR = 0.4). We observed elevated MORs for diseases of the blood and blood-forming organs (MOR = 3.2) and for suicide (MOR = 1.5). For females, we observed twofold risk for all cancers, with 13 cases (MOR = 2.0; 95% CI = 1.1–3.7), mostly accounted for by an excess of breast cancer (7 cases; MOR = 5.3; 95% CI = 2.8–10.1). Results of the analyses for female workers are not presented as a table because of the small number of deaths.

Table 2 presents mortality from individual cancer sites by duration of employment as a laboratory worker among males. We observed elevated MORs for lymphosarcoma-reticulosarcoma among those employed less than 20 years as laboratory workers. MORs increased with duration of employment for cancers of the colon, skin, and kidney and were significantly elevated among those employed for 20 years or more (MOR = 3.3, MOR = 3.9, MOR = 3.6, respectively). All cancers combined and cancers of the stomach, rectum, pancreas, brain, and multiple myeloma showed slightly larger MORs for the greater-than-20-year category than for the less-than-20-year category.

Table 3 presents data from the case-control study of colon cancer. Subjects ever employed as a laboratory worker showed an elevated risk (OR = 2.3; 95% CI = 1.3–4.3) for duration of employment of 20 or more years, with an exposure-response trend test giving a *P*-value of 0.057. When we excluded subjects who did not work full-time as a laboratory worker (for example, chemical engineers and chemistry teachers), the *P*-

TABLE 1. Mortality Odds Ratios from Cancer and Other Major Causes of Death among Male Laboratory Workers

Cause of Death (ICD 8)	Observed	MOR	95% CI
Infective and parasitic disease (000–136)	1	0.2	0.1–1.2
Malignant neoplasm (140–209)	186	1.0	0.8–1.2
Buccal cavity and pharynx (140–149)	5	0.9	0.4–2.1
Esophagus (150)	4	0.9	0.4–2.5
Stomach (151)	5	0.6	0.3–1.5
Colon (153)	25	1.4	1.0–2.1
Rectum (154)	6	1.2	0.5–2.6
Liver (155)	3	1.0	0.3–3.1
Pancreas (157)	11	1.1	0.6–2.0
Larynx (161)	2	0.8	0.2–2.9
Lung (162)	42	0.7	0.5–0.9
Skin (173)	3	1.0	0.3–3.1
Prostate (185)	22	1.4	0.9–2.2
Bladder (188)	2	0.3	0.1–1.2
Kidney (189)	6	1.4	0.7–2.8
Brain (191)	3	0.7	0.2–2.1
Lympho- and reticulosarcoma (200)	8	2.6	1.3–5.1
Multiple myeloma (203)	4	1.6	0.6–4.1
Leukemia (204–207)	6	0.9	0.4–1.9
Allergic, endocrine, and metabolic disorders (240–279)	7	0.5	0.2–0.9
Diseases of blood and blood-forming organs (280–289)	6	3.2	1.5–6.9
Diseases of circulatory system (400–449)	469	n/a*	n/a
Respiratory diseases (460–519)	46	0.8	0.6–1.0
Emphysema (492)	13	0.8	0.5–1.4
Diseases of digestive system (520–577)	20	0.5	0.4–0.9
Cirrhosis of the liver (571)	7	0.4	0.2–0.8
Suicide (950–959)	20	1.5	1.0–2.4

* n/a, not available.

TABLE 2. Mortality Odds Ratios from Selected Cancer Sites by Duration of Employment as a Male Laboratory Worker

Cancer Sites	Duration of Employment as Laboratory Worker (Years)					
	<20			20+		
	Observed	MOR	95% CI	Observed	MOR	95% CI
All cancers	141	0.9	0.8–1.1	45	1.2	0.9–1.7
Cancer of						
Buccal cavity and pharynx	4	0.9	0.4–2.2	1	1.0	
Esophagus	4	1.2	0.4–3.0	0		
Stomach	3	0.5	0.2–1.4	2	1.2	0.4–4.1
Colon	13	0.9	0.5–1.6	12	3.3	2.0–5.4
Rectum	4	1.0	0.4–2.6	2	1.9	0.6–6.4
Liver	2	0.8	0.2–3.3	1	1.6	
Pancreas	8	1.0	0.5–1.9	3	1.5	0.5–4.3
Larynx	2	0.8	0.2–3.3	0		
Lung	34	0.7	0.5–0.9	8	0.7	0.4–1.3
Skin	1	0.4		2	3.9	1.0–14.2
Prostate	17	1.5	0.9–2.3	5	1.3	0.6–3.0
Bladder	1	0.2		1	0.7	
Kidney	3	0.8	0.3–2.1	3	3.6	1.2–10.6
Brain	2	0.8	0.3–2.0	1	1.5	
Lympho- and reticulosarcoma	7	2.8	1.3–5.7	1	1.8	
Multiple myeloma	3	1.5	0.5–4.5	1	2.0	
Leukemia	5	0.9	0.4–2.2	1	0.7	

value for trend was 0.026, with an OR of 3.2 for duration of employment of 20 and more years.

Discussion

In general, laboratory workers have lower mortality than the general U.S. population,[3,7,8] but excesses have been reported for several cancer sites (for example, stomach, colon, pancreas, prostate, brain, lymphatic system, and leukemia).[1–14] We observed excesses for cancer of colon, pancreas, prostate, and lymphatic system among males and for breast cancer among females, in accord with other reports.[1–8] The risk of colon cancer rose with increasing duration of employment as a laboratory worker. We did not find strong evidence for excess mortality from leukemia or from cancers of the stomach or brain, as found in previous studies.[2–5,9]

In the case-control study, the risk of colon cancer rose with duration of employment. Colon cancer is generally thought to be diet related,[21–23] but it has been associated with a number of occupations and occupational exposures.[24–55] Reports have linked colon cancer with asbestos,[24–33] solvents,[33–37] dyes,[35,37] fuel oil,[34] abrasives,[34,38] synthetic fibers,[35,39,40] grain dust,[39,41] cutting oil,[35,37,42] wood dust,[39,42,43] rubber production,[44–46] metal and wood works,[34,36,38,39,43,47–49] textile production,[40,50] printing works,[37,42,51,52] oil refinery,[53] pattern makers,[42,54] food preparation,[35] and pharmaceutical production.[55] Laboratory workers may share some of these exposures, particularly to solvents. Given the complex nature of the laboratory environments and the number of chemicals used, it was not possible to single out specific substances that might account for the excess.

TABLE 3. Age-Adjusted Relative Risks for Colon Cancer by Duration of Employment as Laboratory Workers

	Duration of Employment as Laboratory Workers (Years)			
	Nonlaboratory Workers	<20	20+	Chi (2-tail P)
For all laboratory workers:				
Odds ratios (95% CI)	1.0	0.7 (0.40–1.31)	2.3 (1.26–4.31)	1.91 (0.057)
(Cases; Controls)	(194; 3,136)	(13; 283)	(12; 84)	
For laboratory bench workers only:				
Odds ratios (95% CI)	1.0	1.0 (0.54–1.96)	3.2 (1.33–7.46)	2.23 (0.026)
(Cases; Controls)	(194; 3,136)	(10; 156)	(6; 31)	

Diet and life-style of laboratory workers may influence the colon cancer findings. Laboratory workers may have a higher socioeconomic standing than the general population, and this bias may contribute to the excess in the MOR analyses. The case-control study, however, included only U.S. Department of Agriculture employees; these employees are mainly white collar workers, and they should all have a reasonably comparable socioeconomic status. Thus, it seems unlikely that socioeconomic and dietary differences could entirely account for the excess of colon cancer. Various studies have shown that physical activity is inversely associated with colon cancer,[22,56-65] but we found that it did not confound our effect estimates.

One earlier study found an excess of breast cancer among female chemists.[4] This excess may reflect a tendency to be nulliparous or to have children at later ages.[66] We did not have information on these and other possible risk factors for breast cancers (for example, reproductive variables, body build, oral contraceptives, estrogen replacement therapy, diethylstilbestrol, diet, alcohol consumption, radiation, familial aggregation, endogenous hormones), but the fivefold risk of breast cancer among female laboratory workers observed in this study is quite striking.

This study supports the results of previous studies[1,4,7,67,68] on the excess mortality from suicides. Although the reason for this excess is unclear, the accessibility of potentially lethal chemicals in the laboratory environment may be important.

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