An Analysis of Occupational Risks for Brain Cancer

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Abstract: We evaluated the risks of brain cancer in relation to employment history in a case-control study of 312 cases and 1,248 cancer controls. Subjects were identified through the Missouri Cancer Registry for the period 1984 through 1988. Job classification was based on data routinely abstracted from hospital records. Elevated risks were identified for certain white collar occupations: for men employed in engineering, the odds ratio (OR) = 2.1; 95% confidence interval (CI) = 0.4, 10.3; for social science professionals, the OR = 6.1; 95% CI = 1.5, 26.1. Among occupations with potential exposure to occupational carcinogens, increased risks were observed for men employed in agricultural crop production (OR = 1.5; 95% CI = 1.0, 2.4), printing and publishing (OR = 2.8; 95% CI = 1.0, 8.3), and brickmasons and tilesetters (OR = 2.5; 95% CI = 0.5, 11.5). Most of elevated brain cancer risks were due to astrocytic cancers, but the excess among agricultural workers occurred in other cell types. No increase in risk was noted for current cigarette smokers (OR = 0.9; 95% CI = 0.7, 1.5) or ex-smokers (OR = 1.0; 95% CI = 0.7, 1.5). This exploratory study indicates a need for further studies of occupational risks of brain cancer. (*Am J Public Health* 1990; 80:169–172.)

Introduction

Cancer of the brain has been the focus of relatively few epidemiologic studies. Increased risks have been noted for several white collar occupations including accountants,[1] sales managers,[2] engineers,[2,3] teachers,[1] lawyers and judges,[2] and postal clerks.[3] Among occupations with potential carcinogenic exposures on the job, excess brain cancer risk has been suggested for workers employed in the rubber industry,[4,5] polyvinyl chloride production,[6–9] farming,[10–13] electrical industries,[14–16] pharmaceutical production,[17] and production of petroleum and petrochemicals.[18,19] Cigarette smoking has also been linked to brain cancer risk.[20]

Most previous studies of occupation and brain cancer have relied on mortality data, with concomitant potential for misclassification of brain cancer on death certificates.[21] Few previous studies have evaluated differences in occupational risks by histologic type of brain cancer. The current study was based on data from a statewide cancer registry.

Methods

Cases and controls were identified through the Missouri Cancer Registry, maintained by the Missouri Department of Health. The Registry has been collecting data on cancer cases from public and private hospitals since 1972, with reporting mandated by law since 1984.

The case group consisted of White males diagnosed with histologically confirmed brain and other central nervous system cancer (*International Classification of Diseases for Oncology* [ICD-O] codes 191 and 192)[22] between January 1984 and December 1988. Selection was limited to White males due to the small number of non-Whites and the lack of reported occupational diversity among females. The mean age among cases was 54.6 years.

A frequency-matched sample of controls was chosen from all other white male patients diagnosed with cancers in the same time period, excluding cancers of ill-defined or unknown primary sites (ICD-O site codes 195 and 199). For each case, four controls were randomly selected within each of six age strata. The mean age of controls was 55.6 years. The analyses included a total of 312 cases and 1,248 controls. The distribution of cancer sites among controls is shown in Table 1.

Data on occupation and tobacco use are routinely abstracted from the hospital medical record at the time of diagnosis and submitted to the Missouri Cancer Registry as part of cancer incidence reporting. Hospital registrars record information for cancer patients using a standardized protocol and the occupational data are subsequently coded by trained cancer registry specialists using the three-digit 1980 US Census codes.[23] The occupational history reported to the Registry is intended to represent the usual or longest held job of the cancer patient. Smoking history for each patient is characterized according to status (i.e., never, former, or current use) and, among current smokers, according to the number of packs smoked per day.

The present analysis was based on subjects who had codable occupational information (i.e., either occupation or industry or both variables). The remaining subjects had no occupational information or noninformative job titles such as "retired." Duration of employment was only occasionally recorded and not used in these analyses. Of the initially eligible subjects, 34 percent of potential cases and 38 percent of potential controls were excluded due to missing occupational information.

The odds ratio (OR) was the measure of association between occupation and brain cancer. Gart's method[24] was used to calculate maximum likelihood estimates of the OR

TABLE 1—Distribution of Cancer Sites in Control Group, Missouri, 1984–88

Site of Cancer	Number	Percent
Lip, oral cavity, and pharynx	57	5
Digestive organs and peritoneum	276	22
Respiratory system and intrathoracic organs	356	29
Skin	21	2
Bones and connective tissue	24	2
Genitourinary organs	305	24
Leukemia	35	3
Lymphoma and multiple myeloma	63	5
Other sites	111	9
Total	1,248	100

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and corresponding 95 percent confidence intervals (CI). For each occupation and industry with two or more cases, age- and smoking-adjusted ORs were computed. The reference category consisted of all persons not in the occupation of interest.

Separate analyses were conducted for the astrocytic series (ICD-O morphology codes 93803, 93823, 94003-94413) and for "other" cell types of brain cancer. The astrocytic series was comprised primarily of unspecified astrocytomas (31 percent), unspecified glioblastomas (51 percent), and anaplastic astrocytomas (7 percent). "Other" cell types included oligodendrogliomas (31 percent), unspecified cell types (20 percent), and unspecified ependymomas (14 percent). All controls were used in each cell type analysis.

For analyses by smoking history, we excluded controls with cancers of smoking-related sites (lip, oral cavity, esophagus, larynx, lung, and bladder—ICD-O site codes 140-141, 143-145, 150, 161, 162, and 188).

Results

Risk of brain cancer according to industry of employment is shown in Table 2. Men employed in agricultural crop production had a moderately elevated risk (OR = 1.5; 95% CI = 1.0, 2.4). An OR of 2.8 (95% CI = 1.0, 8.3) was observed for workers in printing and publishing. Several other industries were associated with risks of 2.0 or greater, although estimates were based on small numbers. These included men employed in miscellaneous repair services (OR = 2.6; 95% CI = 0.5, 13.0), engineering services (OR = 2.1; 95% CI = 0.4, 10.3), and justice, public order, and safety (OR = 2.1; 95% CI = 0.9, 4.8).

As shown in Table 3, excess risks were found for social science professionals (OR = 6.1; 95% CI = 1.5, 26.1) and for police and fire protection services (OR = 2.2; 95% CI = 1.0, 4.7). The excess among police and fire protection services included an OR of 2.9 (95% CI = 0.8, 11.0) for police and detectives and an OR of 2.0 (95% CI = 0.4, 9.6) for firefighters. An OR of 2.5 (95% CI = 0.5, 11.5) was observed for brickmasons and tilesetters, although there were only three cases in that job category.

Evaluation of risks according to histologic type of brain cancer showed that the elevated risk in agricultural workers was confined to "other" cell types (OR = 5.3; 95% CI = 1.9, 14.3). The elevated overall risk for workers in printing and publishing was equally distributed between astrocytic and "other" cell types. Elevated risks of astrocytomas were observed for automobile repair work (OR = 1.9; 95% CI = 1.0, 4.1) and justice, public order, and safety (OR = 2.4; 95% CI = 1.0, 5.6).

Social science professionals showed elevated risks for both astrocytomas (OR = 4.7; 95% CI = 1.0, 22.9) and "other" cell types (OR = 19.0; 95% CI = 2.1, 145.6). The

TABLE 2—Age- and Smoking-Adjusted Odds Ratios* (OR) and 95% Confidence Intervals (CI) for Brain Cancer by Industry, Missouri, 1984–87

US Census Codes	Industry	Number		OR (95% CI)
		Cases	Controls	
010	Agriculture—crop production	22	62	1.5 (1.0,2.4)
060	Construction	26	135	0.8 (0.5,1.3)
100–122	Food manufacturing	6	36	0.7 (0.3,1.7)
171–177	Printing and publishing	7	10	2.8 (1.0,8.3)
180–192	Chemical manufacturing	4	14	1.1 (0.3,3.6)
270–301	Metal manufacturing	7	22	1.3 (0.5,3.2)
351–370	Transportation equipment manufacturing	20	83	0.9 (0.6,1.6)
391–392	Miscellaneous and unspecified manufacturing	9	46	0.8 (0.4,1.7)
400–432	Transportation	31	121	1.1 (0.7,1.7)
440–442	Communications	5	15	1.4 (0.5,4.1)
460–472	Utilities and sanitary services	3	26	0.5 (0.1,1.7)
591	Department stores	4	12	1.3 (0.4,4.5)
601	Grocery stores	5	12	1.6 (0.5,5.1)
641	Eating and drinking places	2	6	1.6 (0.2,8.9)
700–712	Finance, insurance, real estate	10	38	1.0 (0.5,2.2)
751	Automotive repair shops	11	28	1.7 (0.8,3.7)
760	Miscellaneous repair services	3	5	2.6 (0.5,13.0)
842, 850	Schools	13	37	1.3 (0.6,2.5)
880	Religious organizations	3	9	1.0 (0.2,4.1)
882	Engineering services	3	5	2.1 (0.4,10.3)
910	Justice, public order, safety	10	19	2.1 (0.9,4.8)
999	Industry not reported	21	93	0.9 (0.5,1.5)

*Odds ratios are reported for job categories that contained two or more cases.

TABLE 3—Age- and Smoking-Adjusted Odds Ratios* (OR) and 95% Confidence Intervals (CI) for Brain Cancer by Occupation, Missouri, 1984–87

US Census Codes	Occupation	Number		OR (95% CI)
		Cases	Controls	
003–037	Managers, administrators, executives	34	146	0.9 (0.6,1.3)
043, 063–083	Science professionals	2	11	0.6 (0.1,3.2)
044–059	Engineers	7	20	1.2 (0.5,3.2)
084–089	Physicians and dentists	3	13	0.8 (0.2,3.2)
113–159	Teachers	6	26	0.8 (0.3,2.1)
163–175, 183–184, 195–197	Social science professionals	6	4	6.1 (1.5,26.1)
176–177	Clergy	2	9	0.7 (0.1,3.3)
178–179	Lawyers, judges	3	10	1.1 (0.2,4.5)
185–194, 198–199	Artists, entertainers, athletes	3	9	1.2 (0.3,5.1)
213–235	Technicians, except health	11	27	1.6 (0.8,3.5)
243–285	Sales	25	90	1.1 (0.7,1.8)
303–389	Office supervisors and workers	16	43	1.4 (0.7,2.6)
413–427	Police, fire protection services	12	22	2.2 (1.0,4.7)
448–454	Building services	6	28	0.9 (0.3,2.3)
473–489	Farming	21	80	1.1 (0.6,1.7)
503–549, 864	Mechanics and repairers	22	68	1.4 (0.8,2.4)
553, 563–565	Brickmasons and tilesetters	3	6	2.5 (0.5,11.5)
554, 567–569	Carpenters	6	43	0.6 (0.2,1.5)
557, 585–587	Plumbers and pipefitters	3	12	1.2 (0.3,4.5)
558, 566, 588–589, 599, 863, 865, 866, 869	Construction, not elsewhere classified	11	36	1.3 (0.6,2.7)
594, 843–859	Pavers, surfacers, material movers	4	14	1.2 (0.3,3.9)
633–639, 644–655, 689–693, 796–799, 873	Precision production/tool and die makers, machinists, sheet metal workers	12	43	1.2 (0.6,2.4)
686–688	Food production	3	8	1.6 (0.3,6.8)
753–779	Machine operators, miscellaneous	12	72	0.7 (0.4,1.4)
785	Assemblers	5	15	1.4 (0.4,4.2)
803–814	Motor vehicle operators	22	83	1.2 (0.7,2.0)
889	Laborers, except construction	7	46	0.6 (0.2,1.4)
905–999	Unemployed/last job armed forces/unknown	24	119	0.8 (0.5,1.4)

*Odds ratios are reported for job categories that contained two or more cases.

excess risk among police and fire protection workers was confined to the astrocytic cell series (OR = 2.3; 95% CI = 1.0, 5.1). Farmers had an increased risk for "other" cell types (OR = 3.7; 95% CI = 1.4, 9.8). Machinists had an OR of 1.8 (95% CI = 0.6, 5.2) for astrocytomas.

There were 33.7 percent current smokers and 19.9 percent ex-smokers among cases, compared with 34.4 percent current smokers and 18.5 percent ex-smokers among controls. Current smokers had an OR of 0.9 (95% CI = 0.7, 1.3) and ex-smokers had an OR of 1.0 (95% CI = 0.7, 1.5).

Discussion

The present study confirmed previously reported occupational associations[2,3,25] between brain cancer risk and employment in certain white collar occupations. These increased risks may be related in part to better access and utilization of medical services and, hence, a greater likelihood of brain cancer diagnosis.[26]

An increased risk of brain cancer among agricultural workers has been reported in a number of recent studies,[10–13,27] although several others have failed to identify such a relationship.[21,28,29] In the current study, the elevated risk among farmers was confined to "other" cell types. Mussico, *et al,*[30] recently found an increased risk of brain gliomas in relation to use of insecticides or fungicides. Animal studies[31] and elevated levels of organochlorine compounds in adipose tissue of glioblastoma patients[32] adds biological plausibility to the hypothesis that agricultural chemical exposure may be partially responsible for the excess risk of brain cancer in farmers.

The increased risk seen in this study among workers in the printing and publishing industry was unexpected, although one previous study[33] suggested an elevated brain cancer risk in commercial pressmen. Since printers are exposed to a variety of chemicals, this relationship deserves further scrutiny.

Several *a priori* suspected high-risk occupations showed indications of elevated risks in our study; however, some of these comparisons were limited by small numbers. For example, we found slight elevations in risk for chemical manufacturers, mechanics and repairers, and precision metal workers such as machinists, all of which have been reportedly previously.[1,25,29,34] We identified an elevated risk of astrocytomas for automobile mechanics, who are potentially exposed to solvents, lubricating oils, and hydrocarbons.[25] Rushton, *et al,*[35] found elevated brain cancer mortality among bus mechanics in the United Kingdom. Our data suggested an increase in risk of astrocytomas for brickmasons and tilesetters. This association was also reported in a death certificate study from Massachusetts.[34]

We found no indication of an increased risk among smokers. This contrasts with a recent study[21] but is consistent with two earlier studies.[36,37]

The current study has several limitations. We relied on occupational information collected in conjunction with cancer incidence reporting. Of the initially eligible study subjects, over one-third had missing occupational information. The Registry obtains job information based on the hospital medical record at the time of diagnosis and some degree of misclassification is likely. A recent study that compared risk factor information contained in the Missouri Cancer Registry record with information obtained by interview found an agreement of 70 percent between Registry-reported occupation and usual occupation reported by interview.[38] In addition, occupational misclassification was apparently random and would therefore bias relative risk estimates toward unity.[39]

We selected controls from other cancer patients recorded on the Registry, with the attendant advantages and disadvantages.[40,41] We compensated for the relation between smoking and other cancers in sub-selection of controls and adjustment in the analyses.

The strengths of our study included greater accuracy in hospital-reported tumor diagnosis, compared with death certificates,[21] and the ability to analyze by histologic type.

This exploratory study suggests leads for future investigations with more information on occupational exposures and other possible confounders.

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