

Occupational Risks for Bladder Cancer among Men in Sweden

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ABSTRACT

With the use of the Swedish Cancer-Environment Registry, census data on employment in 1960 were linked with registry data on bladder cancer during 1961-79. This hypothesis-generating study revealed for the first time associations between bladder cancer and employment in pulp and fiberboard manufacturing, in rope and twine making, and work as a dental technician. Statistically significant increases in risk were also found for several occupations previously associated with bladder cancer, including barbers and beauticians, artistic painters, toolmakers and machinists, and physicians, and employment in butcher shops, industrial chemical making, apparel manufacturing, and plumbing. Etiologic inferences cannot be made from this investigation, but the findings from this large national resource provide further clues to the occupational determinants of bladder cancer.

INTRODUCTION

Almost 100 yr ago, dyestuffs manufacturing was linked to an increased risk of bladder cancer (1). Since that time numerous investigations have shown that occupational factors contribute to the etiology of this cancer (2, 3). The present study links cancer incidence data for Sweden with census employment information, the first time such an approach has been used to evaluate occupational bladder cancer risk using incidence data for an entire country. The primary purpose of this linked-registry analysis is to generate new hypotheses for occupational bladder cancer, although it also provides the opportunity to evaluate associations previously reported from other countries.

MATERIALS AND METHODS

The Cancer-Environment Registry and the statistical methods used in this analysis have been described in detail elsewhere (4-7). Briefly, the Cancer-Environment Registry links current employment information at the time of the 1960 census with cancer incidence data from the National Swedish Cancer Registry for the years 1961 to 1979. Each Swedish citizen has a unique 10-digit personal identification number which permits linkage between these two data sets. National law requires that all malignant tumors and certain precancerous lesions be reported to the National Swedish Cancer Registry (8).

A 19-yr SIR² was used to estimate the risk of bladder cancer for the various employment categories in Sweden. The SIR is the ratio of observed to expected bladder cancer cases in a particular occupational category. The number of expected cases is obtained by applying the 5-yr birth cohort- and sex-specific rate for bladder cancer in the general Swedish population (1961-1979) to the 5-yr birth cohort- and sex-specific distribution of the occupational and industrial categories. Due to geographical variation in bladder cancer incidence in Sweden, all SIR calculations were regionally adjusted for the three major cities and the remaining 24 counties (9). Statistical significance was evaluated using the Poisson distribution (10). Data on employment were from the 1960 national census (11). Occupational and industrial classifications were derived from revised versions of the standards of the International Labor Office (12) and the United Nations Statistical Office

(13). SIRs were computed for all major (1-digit) and general (2-digit) occupational and industrial codes. For specific (3-digit) employment groups, only those with 500 or more workers were examined, as there are over 300 occupational and 300 industrial categories at this level of coding. Due to the large number of bladder cancer cases and employment classifications, we have restricted our more detailed examination (2- and 3-digit level) to the craftsman-production process occupations and the manufacturing industries.

RESULTS

There were 11,702 cases of bladder cancer among employed Swedish men for the years 1961 to 1979. Ninety-eight% were microscopically confirmed: 86% were transitional cell cancers (including atypical transitional cell papillomas), 2% squamous cell cancers, 0.5% adenocarcinomas, 9% undifferentiated epithelial cancers, and 3% other or unspecified histologic types. Table 1 presents the SIRs for all major industries and occupations in Sweden. Small, but statistically significant, increases in risk were observed for manufacturing, trade and finance, and service industries. A significantly decreased risk was found for farming and related industries. For major occupations, significant but small increases in SIRs were seen among professional, administrative, clerical, sales, and service workers and craftsmen. Farmers and farm-related workers were at a significantly reduced risk for bladder cancer. Table 2 presents SIRs for general (2-digit) and specific (3-digit) manufacturing industries. The major industries of food processing, paper, printing, chemical, machining, and other building construction were associated with significantly increased SIRs for bladder cancer. At the specific (3-digit) level, significantly elevated risks were found for butcher shops and meat processing, rope and twine making, apparel making, pulp grinding, fiberboard making, industrial chemical manufacturing, machining industry, and plumbing. Elevated but nonsignificant SIRs were observed for sugar making, breweries, newspaper printing, bookbinding, skin processing, vulcanizing, pharmaceuticals, soap and perfume, porcelain and earthenware, railroad equipment, and glazier work.

SIRs for general (2-digit) craftsmen and production workers (Table 3) were significantly elevated for shop and construction metal workers, electrical workers, and food-related workers. At the 3-digit (specific) level, significantly raised SIRs were observed for dental technicians, toolmakers and machinists, and mechanics. Nonsignificantly increased risks were seen for carpet makers, shoe repairers, blacksmiths, electrical line workers, other electrical workers, glass molders, flour mill workers, brewery workers, and chemical workers.

In addition, there were a number of other 3-digit occupations of *a priori* interest (2-3) with significantly elevated risks for bladder cancer: barbers and beauticians (SIR = 1.50; 52 cases; $P < 0.01$); artistic painters (SIR = 1.70; 42 cases; $P < 0.01$); physicians (SIR = 1.43; 50 cases; $P < 0.05$); chemical engineers (SIR = 1.39; 84 cases; $P < 0.01$); and mechanical engineers (SIR = 1.19; 276 cases; $P < 0.01$).

Although data on smoking for individuals in the CER were unavailable, a 1963 national survey in Sweden estimated the

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² The abbreviation used is: SIR, standardized cumulative incidence ratio.

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Table 1 SIRs for bladder cancer among Swedish men by major industry and occupation, 1961–1979

Code	Major industry	Cases	SIR ^a	Code	Major occupation	Cases	SIR ^a
0	Farming, forestry, fishing, and hunting	1785	0.76 ^b	0	Professional, technical, and related workers	1406	1.12 ^b
1	Mining and quarrying	100	1.06	1	Administrative, executive, and managerial workers	506	1.13 ^b
2	Manufacturing I	1761	1.11 ^b	2	Clerical workers	559	1.24 ^b
3	Manufacturing II	2629	1.10 ^b	3	Sales workers	968	1.22 ^b
4	Construction	1529	1.02	4	Farmers, fishermen, and hunters	1757	0.76 ^b
5	Electric, gas, water, and sanitary services	195	1.13	5	Miners and quarrymen	72	1.01
6	Trade, finance, insurance, and real estate	1388	1.18 ^b	6	Transport and communication workers	827	1.03
7	Transportation and communication	918	1.04	7	Craftsmen and production process workers I	3274	1.06 ^b
8	Services	1366	1.14 ^b	8	Craftsmen and production process workers II	1758	1.07 ^b
9	Nonclassifiable establishments	31	0.90	9	Service, sports, and recreational workers	575	1.12 ^b

^a Adjusted for age and region.

^b $P < 0.01$.

Table 2 SIRs for bladder cancer among Swedish men by general (2-digit) and specific (3-digit) manufacturing industries, 1961–1979

Code	General industry	Cases	SIR ^a	Code	Specific industry	Cases	SIR ^a
20	Food processing	352	1.17 ^b	200	Butcher shops, meat processing	86	1.26 ^c
				204	Flour mill	30	1.19
				206	Sugar making	35	1.27
21	Beverage and tobacco	67	1.24	211	Breweries	46	1.28
22	Textile	147	1.08	221	Cotton	49	1.08
				225	Rope and twine	16	2.20 ^b
23	Garment	205	1.13	230	Shoe making	42	1.22
				232	Shoe repair	33	0.89
				233	Apparel	68	1.29 ^c
24	Lumber	325	1.03	260	Pulp grinding	18	1.94 ^c
25	Furniture	104	0.96	262	Paper mills	128	1.09
26	Paper	306	1.13 ^c	263	Fiberboard	32	1.69 ^b
				270	Newspaper printing	79	1.26
27	Printing	228	1.16 ^c	271	Book printing	83	1.03
				273	Bookbinding	24	1.42
28	Leather	27	1.10	280	Tanneries	11	1.07
				281	Skin processing	4	1.55
30	Rubber	60	1.14	300	Rubber goods	49	1.11
				301	Vulcanizing	11	1.26
31	Chemical	174	1.28 ^b	312	Industrial chemicals	64	1.40 ^c
				315	Pharmaceutical	14	1.51
				316	Soap and perfume	18	1.35
32	Petroleum and coal	22	0.85	330	Brick and tile	57	1.10
33	Earth and stones	233	1.08	332	Porcelain and earthenware	24	1.35
				335	Stone cutting and finishing	29	1.02
34	Metal	617	1.06	340	Iron and steel	182	1.07
				345	Fabricated metal products	231	1.05
35	Machine and electronics	938	1.17 ^b	350	Machining	681	1.20 ^b
36	Transport construction	500	1.03	362	Railroad equipment	60	1.25
37	Miscellaneous construction	82	0.92				
39	Unspecified fabrication	3	0.74				
40	Home building	764	0.97				
41	Other building and construction	765	1.08 ^c	410	Painting	163	1.04
				412	Glazier work	23	1.31
				413	Plumbing	127	1.22 ^c
				415	Highway construction	312	1.04

^a Adjusted for age and region.

^b $P < 0.01$.

^c $P < 0.05$.

prevalence of smoking for occupational but not for industrial categories (14). For the specific (3-digit) occupations at significantly elevated risk of bladder cancer, the percentages of regular smokers were 40% for the dental technicians, 59% for toolmakers and machinists, 55% for mechanics, 60% for mechanical engineers, 57% for chemical engineers, 34% for physicians, 55% for artistic painters, and 74% for barbers and beauticians. By contrast, 46% of men 50–69 yr of age in Sweden were reported to be regular smokers.

There were a number of occupational and industrial groups that have been associated with an increased risk of bladder cancer, which were not found to be at significantly high risk in our survey. We did not observe significantly elevated SIRs for men employed as shoe and leather workers (SIR = 1.12; 82

cases), rubber (SIR = 1.20; 30 cases) or textile (SIR = 0.91; 62 cases) workers, painters (SIR = 1.00; 186 cases), truck drivers (SIR = 0.89; 114 cases), or gas station workers (SIR = 1.34; 29 cases). Dye workers could not be assessed since there was no occupational and/or industrial code for this activity in the CER.

DISCUSSION

A number of statistically significant associations were revealed in this hypothesis-generating study of bladder cancer and employment in Sweden. Some of the findings appear new, while others are supportive of earlier findings in other countries. Among the new hypotheses generated are that work in rope and twine making, in the paper industry, and as a dental

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Table 3 SIRs for bladder cancer among Swedish men by general (2-digit) and specific (3-digit) craftsmen and tradesmen occupations, 1961-1979

Code	General occupation	Cases	SIR ^a	Code	Specific occupation	Cases	SIR ^a
70	Textile	62	0.91	711	Tailors	44	1.14
71	Sewing	98	1.18	714	Carpet makers	32	1.29
72	Shoe and leather	82	1.12	721	Shoe makers	43	1.09
73	Foundry and metal	222	1.06	722	Shoe repairers	33	1.35
74	Fine mechanical work	55	1.09	731	Smelters	29	0.84
75	Shop and construction metal work	1084	1.12 ^b	735	Blacksmiths	70	1.20
				741	Fine Instruments	17	0.93
				744	Dental technicians	13	2.48 ^b
				750	Toolmakers and machinists	322	1.19 ^b
				752	Mechanics	269	1.21 ^b
76	Electrical work	274	1.18 ^b	754	Plumbers	112	1.18
				761	Electrical installation	170	1.14
				767	Line workers	44	1.31
				768	Other electrical	25	1.46
77	Woodworking	701	1.00	771	Carpenters	334	1.00
78	Painting	213	1.02	772	Cabinet makers	239	1.11
79	Masonry work	483	0.99	781	Painters	186	1.00
80	Printing	119	1.12	801	Printers	103	1.13
81	Glass and ceramic work	61	1.08	806	Bookbinders	15	1.14
				812	Molders	12	1.35
				813	Kiln worker	9	0.89
				819	Unspecified glass workers	23	1.20
82	Food-related work	211	1.15 ^c	821	Flour mill workers	25	1.30
				822	Bakers and confectioners	73	1.06
				824	Brewery worker	20	1.54
				826	Butchers	48	1.11
				831	Chemical workers	51	1.26
83	Chemical and cellulose work	195	1.14	834	Pulp grinders	47	1.10
				836	Paper, card- and fiberboard	61	1.16
84	Tobacco	1	1.49	851	Rubber workers	30	1.20
85	Other fabrication work	140	1.06	856	Stone cutters	27	1.13
86	Heavy labor	339	0.93	871	Farm machine operators	76	1.17
87	Machine and motor maintenance	248	1.11	872	Crane operators	29	0.96
				875	Fork-lift operators	86	1.19
88	Packaging and warehouse work	442	1.08	882	Dock workers	89	1.12
				883	Warehouse supply workers	315	1.07

^a Adjusted for age and region.

^b *P* < 0.01.

^c *P* < 0.05.

technician may be associated with increased bladder cancer risk. Hazards in rope and twine making are usually respiratory and are similar to those found in the cotton industry (15), which was reported to be associated with an increased risk for bladder cancer in England (16). Exposure to a number of potential bladder carcinogens such as dyes, pitch, and tar may be common among rope makers (17). Both pulp grinding and fiberboard making were associated with elevated risk. There are a number of exposures to chemicals and to toxins from fungi and mold in these processes (18). Earlier investigations of the paper industry, however, have not reported elevated risks for bladder cancer (18). The 2½-fold increased risk among dental technicians is also new. These workers are involved in making bridge-work, dentures, and other prosthetic devices used by dentists, with potential exposure to solvents, acrylics, and dyes (19). The SIR for dentists was also elevated (SIR = 1.43; 28 cases), although not statistically significant. Smoking does not appear to account for the excess observed for dental technicians, since as a group they smoked less than the general male population of Sweden in 1963 (40 versus 46%).

Several results from our record linkage analysis provide further support for findings reported by others. The significantly elevated risk for men employed in butcher shops and meat processing is consistent with an earlier cancer mortality survey in Massachusetts (20) and a case-control study in Italy (21), raising the possibility of an unknown carcinogenic exposure in this industry. Our finding of a significant risk in the apparel industry is consistent with a number of studies indicating an increased bladder cancer risk for various types of clothing and textile workers (21-26), where exposure to dyestuffs and other

chemical compounds may be responsible. The significantly elevated risks for men in the industrial chemical industry and for chemical engineers and the elevated risk among chemical workers provide further support for previous studies documenting an increased risk for bladder cancer in this industry (20, 27-31). The statistically significant 20% increase in risks for men employed as toolmakers and machinists is consistent with a number of earlier findings for this employment group (21, 27, 32-36) and may reflect in part their exposure to cutting oils (37). As a group, toolmakers and machinists in Sweden had higher smoking rates (59%) in 1963 than the general male population (46%), so smoking may account for some of the increase in risk. The significant excess risk for men employed in the plumbing industry supports findings in the United States (23, 32) and England (38). Excess bladder cancer risk for mechanics has been reported in a number of earlier occupational mortality surveys (36, 39) and case-control studies (22, 27). Our finding for mechanical engineers may be new, although engineers as a group have been previously reported to be at increased risk (20, 24). In Sweden, smoking rates for both mechanics (55%) and mechanical engineers (60%) were higher than for males in general; thus smoking may account for much of the 20% increase in risk for these two employment groups.

The elevated risk for Swedish physicians supports the significant excess of bladder cancer reported recently in Massachusetts (20). The 40% excess is unlikely to be due to smoking, since physicians in Sweden smoked less (34%) than the male population as a whole (46%). It is not clear what occupational exposure if any this increase may reflect. Our finding of an excess in risk for bladder cancer among artistic painters lends

support to the recent report by Miller *et al.* (40). Exposure to pigments, solvents, and thinners is common in this activity (40). The smoking rate among male artists (55%) is higher than that in the general male population (46%), although this difference is unlikely to account for the 70% excess bladder cancer risk. In addition, the increased risk for artistic painters found by Miller *et al.* (40) was adjusted for smoking habits. In Sweden, male barbers and beauticians are at increased risk for bladder cancer, as they are in other countries (20, 23–24, 32, 38, 41). Barbers and beauticians are exposed to a number of agents, including hair dyes (17). Smoking among male barbers and beauticians, however, is considerably higher (74%) than among males in general in Sweden. Thus, smoking may be responsible for a large part of the excess risk in Sweden.

Although this survey of bladder cancer incidence and employment may provide further clues to the occupational determinants of this cancer, the Cancer-Environment Registry has several limitations that prevent drawing causal inferences (4, 9). (a) The employment data were for 1960 only; hence there is no information on duration of employment, and we were also unable to adjust for employment in other high-risk industries or occupations. (b) The SIRs were not adjusted for smoking, although the 1963 smoking habits survey permitted some consideration of the possible effect of smoking on the increased SIRs. (c) The number of multiple comparisons made in this analysis may limit the interpretation of our results. At the 3-digit level, over 450 occupations and industries were examined, thus some statistically significant associations may be expected on the basis of chance alone. It does increase confidence, however, that a large number of results were consistent with bladder cancer findings in other countries. Moreover, in our previous studies (5–7), the CER has detected well-established occupational associations such as mesothelioma with shipyard work and nasal adenocarcinoma with furniture making. If our new findings are confirmed in future studies, analytic investigations to evaluate specific exposures in these occupational settings should be initiated.

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