Occupation and bladder cancer in a hospital-based case–control study in Spain

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ABSTRACT

Objectives: We investigated the association between occupation and bladder cancer in a hospital-based case–control study conducted in Spain.

Methods: 1219 patients with transitional cell carcinoma of the urinary bladder and 1271 controls selected from 18 hospitals in Spain between June 1998 and September 2000 provided detailed information on life-time occupational history, smoking habits, medical history, and other factors. We used unconditional logistic regression to calculate odds ratios (OR) and 95% confidence intervals (CI) for each occupation and industry, adjusting for age, hospital region, smoking duration, and employment in a high-risk occupation for bladder cancer.

Results: Statistically significant increased risks were observed among men employed as machine operators in the printing industry (OR 5.4; 95% CI 1.6 to 17.7), among men employed in the transportation equipment industry (OR 1.6; 95% CI 1.1 to 2.6) and among those who had worked for ⩾10 years in the electrical/gas/sanitary services (OR 3.9; 95% CI 1.5 to 10.4) and in hotels and other lodgings (OR 3.1; 95% CI 1.3 to 7.3). Men who worked as miscellaneous mechanics and repairers (OR 2.0; 95% CI 1.1 to 3.6) and as supervisors in production occupations (OR 2.1; 95% CI 1.2 to 3.6) also had excess risks for bladder cancer. Male farmers and those who worked in crop and livestock production had decreased risks for bladder cancer. We found no significant associations between occupation or industry and bladder cancer risk among women.

Conclusions: We did not observe excess bladder cancer risk for many of the occupations identified as being a priori at high risk. Examination of more detailed job exposure information should help clarify these associations.

Although more than 40 different occupations have been associated with an elevated risk of bladder cancer, the evidence for most occupations is unclear.[1] Findings for many occupations have been inconsistent and based on small numbers of exposed subjects, with observed relative risks of less than two. Strong evidence of increased risk is apparent for very few occupational groups, including painters, machinists, mechanics, aluminium workers, workers in the textile industry, rubber workers, hairdressers, drycleaners and transport workers.[1–4] These occupational relationships may reflect past exposure to chemicals that are no longer used, such as benzidine, as well as more recent exposures. The excess risks that have been observed for white-collar occupations have been linked to changes in the socioeconomic pattern of bladder cancer, and may be more indicative of lifestyle factors than occupational exposures.[4]

A few occupational bladder carcinogens have been identified to date, namely aromatic amines such as β-naphthylamine and benzidine,[3 5] while there is weaker evidence for polycyclic aromatic hydrocarbons[4 6 7] and diesel engine exhaust.[8–10] Other occupational exposures considered by IARC to be associated with bladder cancer include 4-aminobiphenyl, tetrachloroethylene and benzo-a-pyrene.[5] It is unclear whether occupations and industries identified in the past can still be linked with excess risks for bladder cancer. Using data from a hospital-based case–control study of bladder cancer in Spain, we examined the relationships between occupation, industry and bladder cancer risk.

METHODS

Details of our study have been described previously.[11 12] Briefly, cases and controls were selected from 18 hospitals in the following regions of Spain: Barcelona, Valles, Asturias, Alicante and Tenerife. Cases were all male and female patients with newly diagnosed, urothelial cell carcinoma of the bladder (ICD-9: 1880–1889) or carcinoma in situ (ICD-9: 2337) of the bladder, including uretric orafice and urachus, who were 21–80 years of age at the time of diagnosis and resided in the catchment areas of the 18 participating hospitals. Patients who had a previous diagnosis of cancer of the lower urinary tract (ie, bladder, renal pelvis, ureters or urethra) were not eligible for the study, as were patients with bladder tumours that were secondary to other malignancies. This study was approved by the Institutional Review Board of the National Cancer Institute, as well as the ethics committees of all participating hospitals. The study began in June 1998 and concluded in September 2000.

We identified 1462 cases and interviewed 1219 (84%) of them (1067 men, 152 women). For each bladder cancer case, one control was selected. Controls were individually matched to cases by age (within 5 years) at diagnosis/interview, gender, race/ethnicity and hospital. Controls were selected from patients admitted to the same hospital around the same time as the cases for diseases/conditions unrelated to the exposures under study (36% hernias, 12% other abdominal surgery, 12% hydrocele, 23% fractures, 6% other orthopaedics, 4% circulatory diseases, 1% ophthalmological diseases, 2% dermatological diseases and 4% other diagnosis). We identified 1465 eligible controls and interviewed 1271 (88%) of them (1105 men, 166 women).

Since there were only six non-white participants, these subjects were excluded; our analyses therefore are based exclusively on white subjects. In addition, we excluded 16 non-urothelial cell carcinoma cases, 20 participants who provided unsatisfactory information on occupation, 56 participants with missing values for smoking duration, and two participants who did not report an employment history. A total of 1159 cases (1013 male, 146 female) and 1231 controls (1066 male, 165 female) were retained in the analysis, including 34 females cases and 43 female controls who indicated they worked as housewives.

All participants were interviewed in the hospital using a computer-assisted personal interview (CAPI). Prior to the interview, written informed consent to participate in the study was obtained from each subject. The questionnaire was designed to elicit detailed information on occupational and residential histories, smoking habits, dietary factors, medical conditions, family history of cancer, and history of medication use. For each job held for at least 6 months or longer, we obtained information on the name of the workplace, job title at the workplace, beginning and ending year of the job, industry name, production type, main activities or duties, chemicals and materials used, number of months worked per year, and number of days per week and number of hours worked per day.

Occupations and industries were coded using the 1977 Standard Occupational Classification (SOC)[13] and the 1972 Standard Industrial Classification (SIC) schemes.[14] Based on a review of the literature, an occupational physician (AT) assigned one or more SIC/SOC codes to each occupation. Due to the relatively small numbers of jobs for many codes, occupations and industries were often grouped in terms of potential for similar exposures by an experienced industrial hygienist (MD).

We used unconditional logistic regression to calculate odds ratios (OR) and 95% confidence intervals (CI) for each occupation and industry, for men and women separately. We examined bladder cancer risk for every four-digit SIC and SOC code. For each occupation and industry, those never employed in the occupation or industry being evaluated comprised the referent group. We also examined risk by duration of employment (>0 to <10 years, ⩾10 years). We used 10 years as the cut-off point for duration because of the small numbers of subjects for most jobs. ORs were adjusted for age at diagnosis/interview, hospital region and smoking duration. ORs were also adjusted for employment in high-risk occupations, which included a priori high-risk jobs identified in the literature, and jobs within our study that were either statistically significantly associated with bladder cancer or had an OR of 1.5 or higher.

Tests for trend were computed using the Wald statistic, entering the median value for each level of the categorical variable for exposure among control subjects. In the tables, we present results for all the SIC and SOC groups examined, for which there were at least 10 exposed subjects (cases and controls). Since we collapsed many SIC/SOC codes into broader groupings due to small numbers, we did not order results in the tables according to the actual SIC/SOC codes. Instead, we present ORs and 95% CIs for industries and occupations in descending order of magnitude. In addition, we were unable to adequately examine duration of employment by industry and occupation among women due to small numbers.

RESULTS

Risk by industry

Men who worked in the printing and publishing (OR 2.8; 95% CI 1.3 to 6.2) and transportation equipment industries (OR 1.6; 95% CI 1.1 to 2.6) had statistically significant risks of bladder cancer (table 1). We observed a positive trend of increasing risk with increasing duration of employment in printing and publishing ($p_{trend} = 0.03$) but not for transportation equipment ($p_{trend} = 0.66$). Men who ever worked in electrical, gas or sanitary service industries had a non-significantly increased risk for bladder cancer (OR 1.7; 95% CI 0.9 to 3.2). Although there was a positive trend of increasing risk for increasing duration of employment ($p_{trend} = 0.007$), only men who worked in these industries for 10 years or more had a significantly increased risk (OR 3.9; 95% CI 1.5 to 10.4). We also observed a positive trend of increasing risk for men who worked in hotels and other lodgings ($p_{trend} = 0.008$), with significantly increased risk confined to those who had worked in this industry for 10 years or longer (OR 3.1; 95% CI 1.3 to 7.3). Men who worked in wholesale trade/durable goods had an elevated risk for bladder cancer (OR 1.7; 95% CI 0.8 to 3.4), but this trend was inconsistent.

We observed significant decreases in bladder cancer risk among men, but not among women, who worked in crop and livestock production. Although bladder cancer risk was elevated for women who worked in legal and educational services, groceries and related goods, and yarn and thread mills, numbers were sparse (table 2).

Risk by occupation

Men who worked as miscellaneous mechanics and repairers had a two-fold, statistically significant risk of bladder cancer (OR 2.0; 95% CI 1.1 to 3.6) (table 3). We also observed a significant trend of increasing risk with increasing duration of employment in this occupational group ($p_{trend} = 0.04$). Male production supervisors also had a two-fold, significant risk (OR 2.1; 95% CI 1.2 to 3.6), and longer duration of employment was associated with excess risk ($p_{trend} = 0.01$). We observed a significant excess risk for men who had worked in cleaning or building service occupations for 10 years or longer (OR 2.9; 95% CI 1.3 to 6.7; $p_{trend} = 0.02$). Men who had worked as electrical repairers for 10 years or longer had an excess risk for bladder cancer (OR 3.9; 95% CI 1.0 to 15.0), although the trend for duration of employment in this occupation was marginally significant ($p_{trend} = 0.07$). Work as a painter, paperhanger or plasterer was not significantly associated with bladder cancer overall, or by duration. However, the point estimate for work up to 10 years was significantly elevated (OR 2.5; 95% CI 1.1 to 5.6). Although risks for male health professionals and sales supervisors were elevated, numbers were sparse.

As seen with the crop and livestock production industries, male farmers experienced a significant decrease in risk for bladder cancer (OR 0.8; 95% CI 0.6 to 1.0). This decreased risk persisted among men who had worked as farmers for 10 years or longer. Male kitchen workers also seemed to have a decreased risk, which was statistically significant among those who had worked for 10 years or longer (OR 0.2; 95% CI 0.1 to 0.9; $p_{trend} = 0.04$). None of the occupations we examined for women showed a statistically significantly increased risk for bladder cancer. The majority of women in the study reported employment as farmers, technical sales workers, and in cleaning/building service occupations. However, ORs were elevated for machine operators and tenders, officials/administrators, and female farm workers.

Table 1 Risk of bladder cancer for industry (SIC) among men, overall and by duration of employment†

	Overall			>0 to <10 years			≥10 years		
Industry	**Cases**	**Controls**	**OR (95% CI)**	**Cases**	**Controls**	**OR (95% CI)**	**Cases**	**Controls**	**OR (95% CI)**
Printing and publishing*	20	12	2.81 (1.28 to 6.17)	10	6	2.54 (0.85 to 7.58)	10	6	3.11 (1.02 to 9.47)
Electrical/gas/sanitary services*	28	19	1.71 (0.91 to 3.22)	8	13	0.71 (0.27 to 1.82)	20	6	3.94 (1.49 to 10.44)
Wholesale trade - durable goods	22	15	1.66 (0.82 to 3.37)	14	6	2.88 (1.03 to 8.01)	8	9	0.93 (0.34 to 2.55)
Hotels and other lodgings*	40	29	1.65 (0.98 to 2.80)	19	20	1.05 (0.54 to 2.08)	21	9	3.14 (1.34 to 7.32)
Transportation equipment	59	39	1.63 (1.05 to 2.55)	41	20	2.20 (1.23 to 3.92)	18	19	1.03 (0.52 to 2.07)
Health services	23	18	1.47 (0.76 to 2.88)	7	5	1.51 (0.43 to 5.26)	16	13	1.46 (0.66 to 3.21)
Miscellaneous retail	31	24	1.37 (0.77 to 2.42)	19	15	1.34 (0.65 to 2.75)	12	9	1.42 (0.56 to 3.58)
Painting/paper hanging	22	14	1.37 (0.67 to 2.78)	11	6	1.66 (0.59 to 4.67)	11	8	1.15 (0.44 to 3.03)
Beer/wine/ales/spirits	16	14	1.37 (0.63 to 2.96)	13	9	1.85 (0.74 to 4.64)	3	5	0.61 (0.14 to 2.73)
Automotive dealers/services	14	14	1.34 (0.61 to 2.95)	7	7	1.69 (0.56 to 5.12)	7	7	1.07 (0.36 to 3.19)
Lumber/wood products	42	37	1.32 (0.81 to 2.15)	28	21	1.44 (0.78 to 2.66)	14	16	1.14 (0.52 to 2.51)
Automobile/automotive equipment	22	22	1.31 (0.69 to 2.47)	10	13	0.98 (0.41 to 2.34)	12	9	1.81 (0.72 to 4.55)
Electrical work	17	15	1.31 (0.62 to 2.77)	14	10	1.76 (0.73 to 4.25)	3	5	0.59 (0.14 to 2.57)
Civil/religious/political associations	15	13	1.30 (0.58 to 2.90)	8	8	1.06 (0.37 to 3.02)	7	5	1.73 (0.49 to 6.08)
Electrical and electronic equipment	32	32	1.30 (0.76 to 2.23)	16	15	1.40 (0.65 to 2.97)	16	17	1.22 (0.58 to 2.55)
Food products/preparation	31	26	1.28 (0.73 to 2.24)	17	14	1.45 (0.68 to 3.13)	14	12	1.10 (0.49 to 2.48)
Plastics/synthetics	29	26	1.25 (0.70 to 2.22)	14	14	1.12 (0.50 to 2.45)	15	12	1.39 (0.62 to 3.14)
Grain mill products	62	57	1.23 (0.83 to 1.82)	38	34	1.29 (0.78 to 2.15)	24	23	1.14 (0.62 to 2.09)
Auto repair services/garages	55	64	1.21 (0.81 to 1.81)	29	29	1.32 (0.75 to 2.35)	26	35	1.11 (0.64 to 1.94)
Water transportation	34	22	1.21 (0.67 to 2.18)	16	10	1.08 (0.47 to 2.49)	18	12	1.34 (0.60 to 3.02)
Yarn/thread mills	28	23	1.20 (0.65 to 2.21)	16	13	1.14 (0.52 to 2.50)	12	10	1.29 (0.50 to 3.28)
General construction	270	235	1.16 (0.93 to 1.44)	139	118	1.23 (0.93 to 1.63)	131	117	1.09 (0.82 to 1.46)
Amusement/recreation services	16	18	1.15 (0.55 to 2.40)	11	13	1.31 (0.55 to 3.15)	5	5	0.85 (0.23 to 3.16)
Fabricated metal products	100	93	1.13 (0.82 to 1.56)	52	48	1.17 (0.76 to 1.81)	48	45	1.09 (0.70 to 1.70)
Textile mill products	37	34	1.13 (0.67 to 1.92)	14	20	0.83 (0.40 to 1.75)	23	14	1.53 (0.73 to 3.21)
Machinery, except electrical	63	63	1.12 (0.75 to 1.66)	38	31	1.38 (0.82 to 2.33)	25	32	0.87 (0.49 to 1.54)
Banking	42	41	1.12 (0.70 to 1.78)	6	14	0.39 (0.14 to 1.08)	36	27	1.53 (0.89 to 2.63)
Transportation services	78	78	1.10 (0.78 to 1.57)	35	31	1.15 (0.68 to 1.93)	43	47	1.07 (0.68 to 1.69)
Glass	28	26	1.10 (0.62 to 1.98)	15	17	0.84 (0.40 to 1.78)	13	9	1.67 (0.66 to 4.23)
Food stores	44	45	1.08 (0.68 to 1.70)	21	26	1.11 (0.59 to 2.08)	23	19	1.04 (0.55 to 2.00)
Metal mining	13	10	1.06 (0.44 to 2.53)	8	6	1.05 (0.35 to 3.20)	5	4	1.07 (0.26 to 4.32)
Non-metal/mineral mining	43	33	1.05 (0.64 to 1.71)	28	23	1.02 (0.57 to 1.85)	15	10	1.10 0.47 to 2.59)
National security	433	441	1.01 (0.83 to 1.24)	430	432	1.03 (0.84 to 1.26)	3	9	0.37 (0.09 to 1.49)
Primary metal industries	112	113	1.01 (0.74 to 1.36)	30	31	0.86 (0.50 to 1.49)	82	82	1.07 (0.75 to 1.52)
Special trade contractors	18	20	1.00 (0.50 to 1.99)	12	16	0.78 (0.35 to 1.73)	6	4	2.09 (0.52 to 8.31)
Coal mining	94	97	0.96 (0.69 to 1.34)	36	36	0.93 (0.56 to 1.54)	58	61	0.98 (0.65 to 1.48)
Heavy construction	88	89	0.96 (0.69 to 1.34)	65	68	0.93 (0.64 to 1.36)	23	21	1.04 (0.55 to 1.98)
Hardware	15	17	0.95 (0.45 to 2.01)	7	11	0.61 (0.22 to 1.70)	8	6	1.66 (0.53 to 5.24)
Miscellaneous business services	63	77	0.94 (0.65 to 1.36)	22	39	0.78 (0.44 to 1.37)	41	38	1.07 (0.66 to 1.74)
Carpentry/floorwork	23	30	0.93 (0.51 to 1.68)	14	19	0.94 (0.44 to 1.99)	9	11	0.91 (0.36 to 2.35)
Clothing/suits, coats, trousers	22	21	0.90 (0.52 to 1.88)	10	11	0.74 (0.30 to 1.79)	12	10	1.35 (0.53 to 3.39)
Wholesale trade - non-durable goods	25	27	0.88 (0.50 to 1.57)	14	8	0.74 (0.36 to 1.54)	11	9	1.17 (0.46 to 2.95)
Other furniture	18	21	0.88 (0.45 to 1.74)	11	9	1.56 (0.59 to 4.13)	7	12	0.51 (0.19 to 1.33)
Agricultural production/crops*	251	276	0.86 (0.69 to 1.07)	110	87	1.10 (0.80 to 1.51)	141	189	0.74 (0.57 to 0.96)
Clay and porcelain	28	31	0.85 (0.49 to 1.48)	15	19	0.70 (0.34 to 1.42)	13	12	1.14 (0.48 to 2.69)
Restaurants/kitchens, etc	57	74	0.84 (0.58 to 1.23)	26	37	0.82 (0.48 to 1.41)	31	37	0.86 (0.51 to 1.44)
Railroads	35	29	0.84 (0.49 to 1.42)	17	12	0.99 (0.45 to 2.20)	18	17	0.74 (0.37 to 1.47)
Concrete/gypsum/lime	15	14	0.83 (0.39 to 1.80)	12	9	1.00 (0.40 to 2.50)	3	5	0.53 (0.12 to 2.30)
Groceries and related goods	22	26	0.79 (0.43 to 1.44)	12	11	1.06 (0.45 to 2.53)	10	15	0.59 (0.25 to 1.38)
Beverages	10	14	0.78 (0.33 to 1.86)	5	11	0.40 (0.13 to 1.22)	5	3	2.89 (0.63 to 13.33)
Industrial inorganic chemicals	10	15	0.77 (0.33 to 1.80)	7	5	1.74 (0.52 to 5.75)	3	10	0.31 (0.08 to 1.21)
Leather, tanning and finishing	28	38	0.76 (0.43 to 1.34)	10	11	0.89 (0.35 to 2.22)	18	27	0.69 (0.34 to 1.39)
Other wholesale trade	20	30	0.76 (0.41 to 1.39)	11	18	0.69 (0.31 to 1.52)	9	12	0.86 (0.34 to 2.19)
Fishing	27	31	0.74 (0.43 to 1.30)	9	10	0.85 (0.33 to 2.20)	18	21	0.70 (0.36 to 1.37)
Weaving mills	31	34	0.73 (0.42 to 1.26)	10	14	0.57 (0.24 to 1.37)	21	20	0.84 (0.43 to 1.65)
Local urban transportation	33	49	0.67 (0.42 to 1.10)	15	19	0.72 (0.35 to 1.48)	18	30	0.64 (0.34 to 1.22)
Masonry/stone work	10	14	0.66 (0.28 to 1.56)	6	11	0.45 (0.16 to 1.28)	4	3	1.63 (0.33 to 8.12)
Legal/educational services	22	41	0.63 (0.36 to 1.10)	12	26	0.53 0.26 to 1.11)	10	15	0.79 (0.34 to 1.85)
Agricultural services	13	21	0.61 (0.29 to 1.29)	5	14	0.39 (0.13 to 1.14)	8	7	1.02 (0.34 to 3.11)
Forestry	16	26	0.60 (0.31 to 1.16)	15	18	0.77 (0.37 to 1.59)	1	8	0.15 (0.02 to 1.23)
Agricultural production/livestock*	50	93	0.57 (0.39 to 0.83)	17	34	0.49 (0.26 to 0.91)	33	59	0.62 (0.39 to 1.00)

†Adjusted for age, hospital region, smoking duration (missing, never, 0 to <10 years, 10 to <20 years, 20 to <30 years, 30 to <40 years, and ≥40 years), and ever being employed in a high-risk occupation for bladder cancer. For each SIC category, the reference group does not include subjects who ever held a job in that SIC category.

*p Value for trend <0.05; for all other trends p>0.05.

SIC, Standard Industrial Classification.

Table 2 Risk of bladder cancer for industry (SIC) and occupation (SOC) among women*

	Overall		
	Cases	Controls	OR (95% CI)
Industry			
Legal/educational services	8	3	3.41 (0.81 to 14.3)
Groceries and related goods	7	4	2.08 (0.56 to 7.72)
Yarn and thread mills	8	4	1.94 (0.45 to 8.44)
Textile mill products	7	6	1.23 (0.35 to 4.41)
Agricultural production - crops	32	34	1.16 (0.63 to 2.15)
Miscellaneous retail	4	6	0.94 (0.24 to 3.59)
Clothing/suits, coats, trousers	7	9	0.91 (0.31 to 2.68)
Miscellaneous business services	34	40	0.89 (0.49 to 1.62)
Agricultural production - livestock	6	10	0.74 (0.24 to 2.26)
Food products/preparation	4	6	0.65 (0.17 to 2.53)
Food stores	3	7	0.53 (0.13 to 2.14)
Restaurants/kitchens, etc	4	8	0.23 (0.05 to 1.07)
Occupation			
Machine operators and tenders	14	11	1.83 (0.71 to 4.71)
Officials and administrators	7	4	1.79 (0.47 to 6.79)
Farm workers	8	7	1.66 (0.57 to 4.84)
Technical sales workers	17	16	1.14 (0.53 to 2.46)
Cleaning/building service occupations	29	31	1.01 (0.55 to 1.87)
Farmers	31	37	0.99 (0.55 to 1.79)
Other precision workers	5	5	0.95 (0.23 to 3.94)
Hand working occupations	8	14	0.72 (0.28 to 1.82)
Manual occupations	9	11	0.49 (0.16 to 1.48)

*Adjusted for age, hospital region, smoking duration (missing, never, 0 to <10 years, 10 to <20 years, 20 to <30 years, 30 to <40 years and ≥40 years) and ever being employed in a high-risk occupation for bladder cancer. For each SIC category, the reference group does not include subjects who ever held a job in that SIC category. SIC, Standard Industrial Classification; SOC, Standard Occupational Classification.

Industry and occupation

To better understand the associations we observed between certain industries/occupations and bladder cancer, we next examined risk for occupation within industry, and risk for industries within occupation, for which there were at least 10 exposed subjects (table 4). Within the printing and publishing industries, printing machine operators and tenders experienced excess risk for bladder cancer (OR 5.3; 95% CI 1.6 to 17.7). None of jobs within the other industry groups presented in table 4 had significantly elevated risk. Jobs which seem to contribute to the elevated risk observed for these industry groups include the following: mechanics and repairers in transportation equipment industries; electricians within electrical, gas or sanitary service industries; and managers in hotels and other lodgings. We were unable to clearly distinguish which type of job, if any, contributed most to the reduced risk observed for the agricultural production industry. However, farm managers seemed to have the lowest risk.

We also could not clearly identify particular industries that contributed most to the elevated bladder cancer risks we observed for certain occupations (table 5). Men who worked as production supervisors in the textile industry had a non-significantly elevated risk for bladder cancer; however, there were a relatively small number of workers in this industry. Within the crop and livestock production industries, livestock and dairy farmers had significantly reduced risks for bladder cancer.

DISCUSSION

We found a significantly elevated bladder cancer risk among men who worked as machine operators in the printing industry, men who worked in transportation equipment industries, men who worked as miscellaneous mechanics and repairers, and men who worked as production supervisors. We also observed a significant excess risk for long-term (eg, ≥10 years) work in the electrical, gas or sanitary industries, and in cleaning/building and electrical repair occupations. Our findings suggested an excess risk for men who worked as electrical repairers, and suggested an elevated risk for women who worked as administrators or were engaged in farm work. Men who worked in agriculture, however, seemed to have a lower risk for bladder cancer, as did long-term kitchen workers.

Bladder cancer has been associated with employment as a printer, and in the printing industry, in previous studies.[8 15–22] In a case–control study conducted in Spain, which included Barcelona, Gonzalez and colleagues[20] reported an association between bladder cancer and occupations with probable exposure to printing inks (OR 2.1; 95% CI 1.0 to 4.3). We also observed a significant trend of increasing risk with duration of employment for male production supervisors, with the highest point estimate for those in the textile industry. Exposures occurring in the textile industry have been identified as one of the main occupational risk factors for bladder cancer in Spain, probably because of exposure to dyes derived from aromatic amines, a known class of bladder carcinogens.[20 23] In the study by Gonzalez *et al*,[20] male supervisors in the textile industry had a non-significant, two-fold excess risk for bladder cancer (RR 2.5; 95% CI 0.9 to 6.4).

In our study, within the transportation equipment industry, bladder cancer was non-significantly elevated for mechanics and repairers, and for miscellaneous mechanics and repairers as an occupational group. Increased risk of bladder cancer has been reported for these occupations, especially automobile mechanics, in previous studies.[1 24–28] Mechanics may be exposed to mists from oils or solvents, and solvent additives such as polycyclic aromatic hydrocarbons, formaldehyde, *N*-phenyl-2-naphthylamine, and exposure to diesel exhaust may also play a role.[1 7 29] It is unclear which exposures may have contributed to the excess risk we observed for men who worked as miscellaneous mechanics and repairers, since most jobs in this occupational group could not be classified with respect to industry. In addition, we could not determine which occupation may have contributed most to the risk observed for working 10 years or longer in the electrical/gas/sanitary service industries. Although we did observe a marginally significant increased risk among men who had worked for ≥10 years as electrical repairers, the overall trend in risk was inconsistent.

Despite the elevated risk for men who worked in the transportation equipment industry, we did not observe excess risk for bladder cancer among truck drivers in our study, a group which has previously been found to be at increased risk for bladder cancer.[8 10 18 20] However, we do not believe that we were able to fully examine risk among truck drivers due to errors with the translation of job titles into Spanish during our interview, as tractor-trailer and other heavy trucks were not clearly distinguished from delivery and other light trucks. In addition, we did not observe a strong association between bladder cancer risk and sales occupations, a relationship which has been reported in previous studies.[2 30]

In our study, men who had worked ≥10 years in hotels or other lodgings had an increased risk for bladder cancer. Within this industry, those who worked as managers seemed to have the highest risk, although this risk was not statistically significant. Gonzalez *et al*[20] reported a significant, two-fold excess risk for managers in Spain, which could not be fully explained by smoking or other occupational exposures. Findings

Table 3 Risk of bladder cancer for occupation (SOC) among men, overall and by duration of employment†

Occupation	Overall			>0 to <10 years			≥10 years		
	Cases	Controls	OR (95% CI)	Cases	Controls	OR (95% CI)	Cases	Controls	OR (95% CI)
Production inspectors, testers and weighers	11	5	2.41 (0.78 to 7.48)	3	3	1.47 (0.24 to 8.85)	8	2	3.42 (0.71 to 16.54)
Supervisors - sales	14	7	2.35 (0.91 to 6.06)	3	4	1.29 (0.27 to 6.09)	11	3	3.46 (0.94 to 12.68)
Health professionals	7	4	2.16 (0.58 to 8.01)	2	3	0.71 (0.10 to 5.00)	5	1	6.24 (0.70 to 55.42)
Supervisors - production occupations*	37	22	2.05 (1.16 to 3.62)	11	8	1.57 (0.60 to 4.07)	26	14	2.35 (1.16 to 4.73)
Miscellaneous mechanics and repairers*	38	22	2.00 (1.12 to 3.55)	2	11	1.77 (0.81 to 3.87)	18	11	2.28 (1.00 to 5.19)
Cooks	15	7	1.93 (0.75 to 4.99)	11	4	2.52 (0.74 to 8.53)	4	3	1.22 (0.26 to 5.67)
Brick, stone and tile setters	29	17	1.82 (0.95 to 3.47)	15	8	2.48 (0.99 to 6.26)	14	9	1.33 (0.55 to 3.23)
Architects/engineers	20	14	1.71 (0.82 to 3.59)	6	8	0.98 (0.30 to 3.17)	14	6	2.53 (0.92 to 6.91)
Painters, paperhangers and plasterers	37	25	1.60 (0.93 to 2.78)	20	10	2.47 (1.08 to 5.64)	17	15	1.11 (0.53 to 2.32)
Art professionals	21	17	1.58 (0.79 to 3.17)	9	11	1.42 (0.55 to 3.67)	12	6	1.79 (0.63 to 5.06)
Supervisors - service occupations	15	10	1.51 (0.65 to 3.53)	8	4	2.27 (0.65 to 7.95)	7	6	1.04 (0.33 to 3.31)
Precision food production occupations	35	26	1.41 (0.82 to 2.43)	21	15	1.51 (0.74 to 3.06)	14	11	1.28 (0.55 to 2.98)
Supervisors - construction	34	28	1.38 (0.79 to 2.42)	14	12	1.51 (0.64 to 3.55)	20	16	1.30 (0.63 to 2.68)
Electrical repairers	12	15	1.35 (0.59 to 3.11)	4	11	0.59 (0.18 to 1.98)	8	4	3.94 (1.04 to 14.98)
Hand working occupations	23	16	1.33 (0.67 to 2.63)	14	9	1.75 (0.70 to 4.35)	9	7	0.92 (0.33 to 2.54)
Animal caretakers	11	7	1.32 (0.49 to 3.56)	8	7	0.96 (0.33 to 2.78)	3	0	–
Cleaning/building service occupations*	38	27	1.28 (0.75 to 2.17)	12	19	0.58 (0.27 to 1.25)	26	8	2.92 (1.26 to 6.75)
Health service workers	14	16	1.28 (0.58 to 2.83)	7	11	0.86 (0.30 to 2.33)	7	5	2.44 (0.69 to 8.62)
Barbers/hairdressers	12	10	1.24 (0.51 to 3.01)	3	4	0.93 (0.19 to 4.52)	9	6	1.42 (0.48 to 4.18)
Supervisors – administrative	11	10	1.24 (0.49 to 3.10)	6	6	1.13 (0.34 to 3.83)	5	4	1.39 (0.34 to 5.58)
Officials/administrators	137	133	1.22 (0.92 to 1.60)	49	42	1.33 0.85 to 2.08)	88	91	1.16 (0.84 to 1.61)
Water transportation	29	20	1.22 (0.67 to 2.21)	22	14	1.32 (0.66 to 2.64)	7	6	0.99 (0.32 to 3.06)
Butchers/meat cutters	10	9	1.20 (0.46 to 3.14)	8	5	1.80 (0.53 to 6.10)	2	4	0.54 (0.09 to 3.06)
Waiters	69	68	1.19 (0.82 to 1.73)	39	38	1.30 (0.80 to 2.13)	30	30	1.07 (0.62 to 1.85)
Plumbers, pipefitters and steamfitters	17	20	1.15 (0.57 to 2.31)	7	10	0.78 (0.28 to 2.19)	10	10	1.60 (0.63 to 4.08)
Technical sales workers	130	133	1.14 (0.86 to 1.51)	60	52	1.42 (0.94 to 2.14)	70	81	0.97 (0.68 to 1.39)
Taxi drivers/chauffeurs	37	35	1.14 (0.69 to 1.90)	14	18	0.74 (0.35 to 1.54)	23	17	1.68 (0.83 to 3.37)
Precision metal workers	33	32	1.13 (0.67 to 1.90)	16	15	1.22 (0.58 to 2.57)	17	17	1.05 (0.51 to 2.16)
Extractive occupations/mining	116	04	1.11 (0.82 to 1.52)	60	44	1.35 (0.88 to 2.07)	56	60	0.93 (0.62 to 1.41)
Metal/plastic workers	104	97	1.11 (0.81 to 1.53)	46	37	1.27 (0.79 to 2.03)	58	60	1.02 (0.68 to 1.52)
Military occupations	283	275	1.10 (0.88 to 1.37)	279	272	1.10 (0.88 to 1.37)	4	3	1.02 (0.22 to 4.73)
Assemblers	42	41	1.09 (0.68 to 1.75)	27	23	1.37 (0.75 to 2.52)	15	18	0.78 (0.37 to 1.61)
Miscellaneous food and beverage workers	9	8	1.06 (0.39 to 2.92)	4	5	0.85 (0.21 to 3.45)	5	3	1.36 (0.31 to 3.08)
Welders	42	53	1.05 (0.67 to 1.64)	16	26	0.77 (0.40 to 1.52)	26	27	1.32 (0.74 to 2.36)
Rail transportation	11	8	1.04 (0.40 to 2.69)	4	4	0.62 (0.15 to 2.55)	7	4	1.56 (0.43 to 5.70)
Protective service occupation	36	36	1.03 (0.62 to 1.70)	17	17	1.08 (0.52 to 2.21)	19	19	0.98 (0.49 to 1.95)
Mechanics and repairers	92	111	1.01 (0.74 to 1.38)	43	57	0.91 (0.58 to 1.41)	49	54	1.11 (0.73 to 1.71)
Machine operators and tenders	175	178	1.00 (0.78 to 1.29)	91	94	0.95 (0.69 to 1.32)	84	84	1.07 (0.76 to 1.50)
Manual occupations	211	202	0.98 (0.78 to 1.23)	148	136	1.03 (0.78 to 1.34)	63	66	0.88 (0.60 to 1.29)
Farm workers	75	80	0.97 (0.68 to 1.39)	40	43	0.94 (0.59 to 1.51)	35	37	1.01 (0.61 to 1.68)
Carpenters	59	63	0.96 (0.65 to 1.41)	29	40	0.80 (0.48 to 1.35)	30	23	1.19 (0.67 to 2.14)
Other construction trades	25	25	0.96 (0.52 to 1.77)	16	16	1.02 (0.47 to 2.21)	9	9	0.87 (0.33 to 2.31)
Truck drivers	89	110	0.91 (0.67 to 1.25)	33	41	0.83 (0.50 to 1.36)	56	69	0.97 (0.66 to 1.43)
Supervisors - transportation	19	21	0.91 (0.46 to 1.78)	10	10	1.14 (0.43 to 3.03)	9	11	0.74 (0.30 to 1.86)
Technicians	16	21	0.88 (0.43 to 1.79)	7	13	0.77 (0.29 to 2.08)	9	8	1.02 (0.37 to 2.85)
Construction labourers	159	148	0.87 (0.67 to 1.13)	126	117	0.91 (0.68 to 1.22)	33	31	0.73 (0.43 to 1.25)
Precision woodworkers	20	24	0.86 (0.45 to 1.64)	10	13	0.81 (0.33 to 1.97)	10	11	0.92 (0.36 to 2.33)
Other precision workers	32	37	0.83 (0.50 to 1.38)	16	15	1.06 (0.50 to 2.25)	16	22	0.68 (0.34 to 1.35)
Administrative support occupations	75	94	0.80 (0.57 to 1.12)	46	55	0.89 (0.58 to 1.36)	29	39	0.69 (0.42 to 1.16)
Farmers*	244	298	0.78 (0.63 to 0.97)	96	88	0.93 (0.67 to 1.29)	148	210	0.71 (0.55 to 0.91)
Bus drivers	11	16	0.75 (0.32 to 1.73)	8	7	1.42 (0.47 to 4.34)	3	9	0.31 (0.08 to 1.24)
Kitchen workers*	21	27	0.73 (0.39 to 1.36)	18	16	1.12 (0.54 to 2.34)	3	11	0.23 (0.06 to 0.88)
Electricians	35	55	0.69 (0.44 to 1.09)	17	18	0.95 (0.47 to 1.93)	18	37	0.55 (0.30 to 1.01)
Material movers/equipment operators	11	15	0.63 (0.27 to 1.47)	5	7	0.77 (0.22 to 2.73)	6	8	0.55 (0.18 to 1.66)
Teachers	10	22	0.62 (0.28 to 1.38)	5	13	0.45 (0.15 to 1.35)	5	9	0.92 (0.29 to 2.94)
Fishers	24	29	0.60 (0.37 to 1.17)	10	11	0.72 (0.29 to 1.77)	14	18	0.62 (0.29 to 1.30)
Forestry workers	13	23	0.58 (0.28 to 1.20)	12	18	0.64 (0.30 to 1.39)	1	5	0.29 (0.03 to 2.74)

†Adjusted for age, hospital region, smoking duration (missing, never, 0 to <10 years, 10 to <20 years, 20 to <30 years, 30 to <40 years, and ≥40 years) and ever being employed in a high-risk occupation for bladder cancer. For each SOC category, the reference group does not include subjects who ever held a job in that SOC category.
*p value for trend <0.05; all other trends p>0.05.
SOC, Standard Occupational Classification.

Table 4 Bladder cancer risk for occupation within industry, men only*

	Cases	Controls	OR (95% CI
Agricultural production			
Other agricultural worker	7	5	0.98 (0.30 to 3.18)
Farmer	201	225	0.86 (0.68 to 1.08)
Farm worker	9	16	0.55 (0.23 to 1.32)
Manager	8	12	0.47 (0.19 to 1.21)
Printing and publishing			
Printing machine operator/tender	13	4	5.35 (1.62 to 17.72)
Transportation equipment			
Mechanic/repairer	9	3	3.26 (0.81 to 13.03)
Other labourer	10	7	1.16 (0.43 to 3.13)
Machine operator/tender	7	8	0.98 (0.33 to 2.93)
Welder	7	12	0.67 (0.25 to 1.82)
Electrical/gas/sanitary services			
Electrician	9	7	1.73 (0.59 to 5.01)
Wholesale trade/durable goods			
Sales worker	13	7	2.43 (0.91 to 6.50)
Hotels/other lodgings			
Manager	6	4	2.56 (0.65 to 10.06)
Waiting staff	18	11	1.71 (0.76 to 3.85)
Food preparation	8	6	1.59 (0.50 to 5.05)

*Adjusted for age, hospital region, smoking duration (missing, never, 0 to <10 years, 10 to <20 years, 20 to <30 years, 30 to <40 years, and ≥40 years), and ever being employed in a high-risk occupation for bladder cancer.

from a case–control study of occupational bladder cancer in British Columbia[31] also suggest an excess risk for occupations related to management and administration, and for hotel clerks and work in hotels and motels. The pattern of risk we observed for work as a painter, paperhanger or plasterer is unclear, although painting has been associated with bladder cancer in previous studies.[32]

Our finding of a reduced risk for bladder cancer among male farmers, and those who worked in agricultural industries, has been shown in previous studies.[31 33 34] It has long been thought that lower overall cancer rates, including bladder cancer, among farmers is due to lower smoking prevalence, healthy diet and more physically active lifestyles.[35] Since all of our risk estimates were adjusted for cigarette smoking, this cannot fully explain the significantly reduced risks we observed for bladder cancer among agricultural workers and farmers.

Table 5 Bladder cancer risk for industry within occupation, men only*

	Cases	Controls	OR (95% CI)
Farmers			
Crops	192	201	0.96 (0.76 to 1.22)
Livestock	31	63	0.58 (0.36 to 0.92)
Ornamental plants	10	16	0.52 (0.23 to 1.20)
Field crops	8	15	0.45 (0.18 to 1.11)
Dairy	4	9	0.36 (0.11 to 1.26)
Fruit/vegetables	8	8	0.22 (0.06 to 0.86)
Painters, paperhangers, plasterers			
Manufacturing	5	5	1.62 (0.42 to 6.33)
Retail stores	6	4	1.61 (0.41 to 6.35)
Painting/paperhanging	17	14	1.07 (0.50 to 2.27)
Miscellaneous mechanics/repairers			
Other manufacturing	16	10	1.59 (0.69 to 3.65)
Supervisors, production occupations			
Textiles	7	5	1.73 (0.50 to 6.01)
Other manufacturing	15	11	1.55 (0.68 to 3.55)
Metal industries	9	7	1.41 (0.49 to 4.04)

*Adjusted for age, hospital region, smoking duration (missing, never, 0 to <10 years, 10 to <20 years, 20 to <30 years, 30 to <40 years, and ≥40 years) and ever being employed in a high-risk occupation for bladder cancer.

The specific occupations contributing to occupational bladder cancer in our study include work in the printing, textile, transportation, and hotel/lodging industries, and for most occupational groups, bladder cancer risks were more pronounced among men who had worked ≥10 years. Our findings are similar to those from a pooled study of occupation and bladder cancer in western Europe, in that we did not observe excess bladder cancer risk for many of the occupations identified as being a priori at high risk (eg, textile workers, rubber workers, leather workers and aluminium workers).[8] Kogevinas *et al*[8] suggest that this is due to improved working conditions in western Europe over the past few decades and prevention of exposure to occupational carcinogens. Changes in worker exposures and the development of new chemicals highlight the need to identify risks which may have diminished over time, such as risk among rubber and leather workers, and to identify new high-risk occupations which may emerge, such as truck driving.[1]

Our null findings for many of these a priori high-risk jobs may also be due to the fact that our analyses by occupation and industry codes lack a true exposure orientation. Although the case–control study design provides an efficient means of testing hypotheses about a broad range of exposures in the workplace and the general environment, the occupational data collected in interviews are usually limited to responses to general questions asked of all study subjects.[36] To overcome this limitation, we incorporated 63 job- and industry-specific questionnaire modules into the CAPI interview, in order to target jobs with specific exposures that may be related to bladder cancer risk. We first collected the full work histories, and then the CAPI system triggered job modules based on the keywords screened in the fields of job titles, activities, products and services provided, and materials and tools used. These job modules contained additional questions about specific exposures of interest for each job or industry. This procedure should improve disease risk estimates over those derived from more traditional approaches to exposure assessment, and has been described previously in detail.[37]

The potential differences between risk estimates based on traditional occupation and industry coding and risk estimates derived from job-specific exposure information are exemplified by our findings for bladder cancer risk and work in the textile industry. As noted previously, exposures related to work in the textile industry have historically been considered some of the main occupational risk factors for bladder cancer in Spain.[23] In the present study, we did not find excess bladder cancer risks associated with work in the textile industry for either men (OR 1.1; 95% CI 0.7 to 1.9) or women (OR 1.2; 95% CI 0.4 to 4.4). Using more detailed exposure information collected through the textile exposure module incorporated into our CAPI interview, Serra *et al*[38] identified excess bladder cancer risks for loom weavers (OR 1.8; 95% CI 0.8 to 3.8), those working in winding, warping and sizing (OR 4.1; 95% CI 1.6 to 10.7), those exposed to synthetic fibres (OR 1.9; 95% CI 1.0 to 3.6) and those exposed to cotton materials (OR 1.5; 95% CI 0.9 to 2.4). These risks increased with employment duration, tended to be higher in women, and were similar after restricting the analysis to participants who never smoked.

Examination of the more detailed exposure information reported by participants who worked in the textile industry helped to elucidate more specific associations than we observed with occupation and industry based solely on job title. Although we evaluated a large number of occupational groups and industries in our analysis, and some of the observed associations maybe due to chance, our results should direct future exposure-specific analyses. The series of detailed examinations of

Main messages

- The specific occupations contributing to bladder cancer risk in our study include work in the printing, textile, transportation and hotel/lodging industries.
- Knowledge of specific carcinogenic exposures within occupations and industries is needed to clarify occupational cancer risks and identify protective changes that may be applied within specific occupational settings.

Policy implication

Changes in workplace exposures over time indicate the need to periodically evaluate a priori high-risk occupations and identify potentially new high-risk occupations and exposures.

occupational exposures and bladder cancer incidence in this study should help clarify the associations with occupational groups, for both the positive and null associations we observed. Although analysis of occupational groups can identify general patterns and trends in risk, more specific knowledge of carcinogenic exposures within occupations and industries can clarify these risks and therefore identify protective changes that may be applied within specific occupational settings.

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