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Occupation and renal cell cancer in Central and Eastern Europe

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Abstract

Objective—Central and Eastern Europe has among the highest rates of renal cell cancer worldwide. Few studies have been conducted in these areas to investigate the possible role of occupational exposures in renal cell cancer etiology. The purpose of this study was to examine the association of renal cell cancer with employment in specific occupations and industries.

Methods—From 1999–2003, we conducted a hospital-based case-control study in seven areas of the Czech Republic, Poland, Romania and Russia. A detailed occupational history was collected from renal cell cancer cases and controls, together with information on potential confounders. Odds ratios (OR) and 95% confidence intervals (CI) of cancer risk were calculated for having ever been employed in selected jobs and industries, with follow-up analyses examining duration of employment.

Results—A total of 992 histologically confirmed incident renal cell cancer cases and 1,465 controls were included in the analysis. An increased risk of renal cell cancer was observed for workers in agricultural labor and animal husbandry (OR=1.43, 95% CI 1.05, 1.93), particularly among women employed as general farm workers (OR=2.73, 95% CI 1.05, 7.13). Risk gradients for agricultural

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Competing Interests

None.

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work increased with longer employment. An overall increased risk of renal cell cancer was seen among architects and engineers (OR=1.89, 95% CI 1.35, 2.65), and mechanical engineers (OR=1.71, 95% CI 1.03, 2.84).

Conclusions—Our data suggest an association between renal cell cancer and agricultural work, particularly among female workers.

Keywords

Renal cell carcinoma; Agricultural work; Solvents; Painting; Firefighting

INTRODUCTION

The countries of Central and Eastern Europe have among the highest recorded incidence of kidney cancers worldwide, with the highest rates observed in the Czech Republic (20.1/100,000 among men and 10.2/100,000 among women).¹ The most common cancer occurring in the renal parenchyma is renal cell carcinoma (RCC), accounting for over 80% of kidney cancers.² Established risk factors for the development of RCC include obesity and hypertension.^{3, 4} There is suggestive evidence for an increased risk with tobacco smoking, the use of analgesics, and with low intakes of fruits and vegetables, and a possible reduced risk with moderate alcohol intake.^{2, 3, 5}

Although the evidence has been inconsistent, occupational studies have linked RCC to employment in certain industries, such as dry cleaning, oil refining, metal working, truck driving, printing, firefighting, pulp and paper work, and employment as a physician, journalist, painter, architect, and airline pilot.^{6–15} Similarly, several agents encountered in these occupational settings, notably asbestos, gasoline and solvents (particularly trichloroethylene) have been linked to RCC development.^{15–18}

Few studies have been conducted on etiological factors of RCC in Central and Eastern Europe, and in particular on the possible role of occupational factors in explaining the high incidence experienced in the region. Due to changing economic and political environments over the last several decades, varying occupational safety requirements and aging infrastructure, occupational exposure to carcinogens was likely higher in these countries than in many other industrial regions of the world.^{19, 20} There is additionally evidence that the metabolism of some occupational agents may be affected by alcohol intake, which may be of particular concern for the Central and Eastern European countries, where intakes of alcohol have been rising.^{21, 22} We have conducted a multicenter epidemiological study of RCC in four Central and Eastern European countries and report here the results of the analysis of job and industry titles. We had *a priori* hypothesized possible associations with occupational categories previously linked to RCC.

MATERIALS AND METHODS

We conducted a case-control study in seven cities in Central and Eastern Europe: Prague, Brno, Ceske Budejovice, and Olomouc (Czech Republic), Lodz (Poland), Bucharest (Romania), and Moscow (Russia). Each study centre followed an identical protocol and was responsible for recruitment of a consecutive group of newly diagnosed kidney cancer patients. Diagnostic procedures were comparable in all study areas, and the proportion of patients undergoing surgery was high in all study areas. To try to eliminate differences across centers, we conducted backward and forward translation of questionnaires and centralized training of interviewers.

Cases had histologically confirmed kidney cancer (ICD-0-2 code C64) and were admitted to one of the participating hospitals from 1999–2003; all histological diagnoses were

subsequently reviewed by one pathologist, and the current analysis is restricted to RCC cases only. RCC cases included clear cell carcinoma (N=897, 90.4%), papillary (N=71, 7.2%), chromophobe (N=22, 2.2%), and 2 cases (0.2%) of oncocyctic neoplasm. Controls were recruited in the same hospitals and were chosen from patients suffering from a predefined list of diseases that excluded malignant neoplasms, other conditions related to smoking, diseases of the respiratory system, some endocrine, metabolic and neurological diseases, as well as trauma. No single disease made up more than 25% of the control group (diseases of digestive system: 24%, musculoskeletal system/connective tissue: 12%, genitourinary system: 11%, skin and subcutaneous tissue: 10%, circulatory system: 9%, central nervous system: 9%, eye and ear: 8% and other smaller categories combined: 17%). Country-specific participation rates ranged from 90% to 99% among cases and from 90% to 96% among controls.

Cases and controls underwent a detailed personal interview in which they provided information on occupational history, personal medical history, family history of cancer, tobacco smoking, alcohol drinking, dietary and anthropometric factors, and other lifestyle habits. The occupational interview consisted of a general questionnaire for each job, and for 16 prespecified jobs a specific questionnaire was also used. The general questionnaire intended to ascertain complete occupational history and additional information relevant to exposure assessment, including job titles, tasks, industries, starting and stopping dates, full-time/part-time status, working environments, and specific exposures. The separate, more specific questionnaire was completed for employment in any of the following jobs or industries: toolmaker or machinist, motor vehicle mechanic, miner/quarryman, woodworker, painter, welder, insulation worker, meat worker or farmer, and the steel, coke manufacture, foundry, glass, tannery, chemical, and rubber industries.

The occupational exposure assessment was completed by localexperts, including chemists, industrial hygienists, and occupational physicians, who had practical experience in industrial hygiene and took into account regional differences in use of materials, production processes, and prevention measures and changes in exposure patterns within and across jobs and industries over time for the different exposures. We attempted to standardize exposure assessment through yearly workshops and coding exercises. All participating study centers applied the same occupational questionnaires and the same protocol for expert assessment. We assessed interrater agreement, finding reasonably good agreement between experts (κ between 0.53 and 0.64).²³ Coders, blinded to case-control status, classified positions using the International Standard Classification of Occupation 1968 version (ISCO-68),²⁴ while industries were coded according to the Statistical Classification of Economic Activities of the European Community, 1999 version (NACE-99).²⁵ The present study reports the results of job and industry titles, while the analysis of specific exposures will be reported elsewhere.

We retained in the analysis 2-digit job and industry titles in which more than 10 cases had ever been employed. Several occupational categories that were previously associated with renal cell cancer, including employment in dry cleaning or exposure to solvents,^{10–12, 17, 26–29} exposure to gasoline or its derivatives,^{17, 18} or employment as a firefighter,^{30, 31} had less than 10 cases per category. These results were reported in a supplemental table.

We conducted tests for heterogeneity by study center, which showed that a minority of occupational categories exhibited heterogeneity. Random effects models were used in analysis. To control for potential confounders, we included in the regression models terms for study centre, age (5-year categories), sex, tobacco smoking (person-years), body mass index (less than 25, 25–29.9, 30 or more), hypertension (self-reported, yes/no), educational attainment (low, medium, high), and alcohol use (never drinkers, <8 ml/day, 8–18 ml/day, 18+ ml/day). We examined a potential confounding effect from urban vs. rural residence, but due to collinearity between that variable and some occupational categories, it was taken out of the

final model. All statistical analyses were performed using SAS 9.1 (Cary, NC, USA). As some previous studies have reported gender-specific risks associated with occupational exposures,³² we also provided stratified effect estimates by gender.

When an increased risk (at $p < 0.10$) was identified for a job or an industry title, we conducted further analyses to assess the effect of duration of employment. We additionally conducted sensitivity analyses, stratifying the agricultural findings by urban or rural residence.

RESULTS

A total of 1097 cases and 1476 controls were recruited into the study. We excluded 93 cases (3.6%) from the current analysis that were not RCC. An additional 29 (1.1%) subjects were excluded due to missing information on smoking, body mass index, hypertension, educational attainment, or place of residence. The final sample size was 992 RCC cases and 1,459 controls (Table 1).

The ages of subjects ranged from 25 to 88; mean age did not differ between cases (mean, 59.5, standard deviation (SD) 10.2) and controls (59.4, SD 10.3); 59% of cases and 65% of controls were men. There were proportionally more cases than controls living in a rural area. More controls than cases reported smoking tobacco, a difference that was not significant after controlling for sex. Obesity and a history of hypertension were more prevalent among cases.

The mean number of different jobs was similar between controls (2.2, SD 1.3; range 0–10) and cases (2.1, SD 1.3, range 0–7) as was the mean duration of employment per job (cases: 13.3 years, SD 13.2; controls: 13.5 years, SD 12.9).

Table 2 reports the results of the analysis of ever employment in selected job titles. An increased risk of RCC was observed for architects and engineers (OR 1.89, 95% CI 1.35, 2.65), all engineers (OR=1.39, 95% CI 1.05, 1.86), and mechanical engineers and technicians (OR 1.71, 95% CI 1.03, 2.84). In several of these categories, point estimates were higher for women than for men. Elevated risks were also seen among working proprietors (OR=4.05, 95% CI 1.62, 10.14).

Increased risks were also seen among the broad class of workers in agriculture, animal husbandry, forestry, fishing, and hunting (OR 1.43, 95% CI 1.05, 1.93). Risks were seen among all agricultural and animal husbandry workers (OR=1.43, 95% CI 1.03, 2.00). This result appeared to be driven by trends towards an increased risk for general farm workers and field crop and vegetable workers, in particular among female general farm workers (OR=2.73, 95% CI 1.05, 7.13). In sensitivity analyses, these findings could be seen to have been mainly driven by an effect among rural residents (OR=1.61, with 25% of rural persons ever employed in agriculture) in comparison to urban residents (OR=1.16, with 3.8% ever employed in agriculture). Decreased risks were observed among metal processors and transport equipment operators.

When stratifying by gender, it was observed that many occupational categories had a small N for female participants. The effect estimates for agricultural work were slightly elevated among women in comparison to men. As a whole, however, although point estimates between men and women differed in several occupational groups, confidence intervals typically overlapped. The increased risk of disease among architects was observed in both men and women.

With regards to professions previously reported to be at elevated risk of kidney cancer, non-significantly elevated risks (OR>2.5), based on small numbers of employed persons, were observed for employment as launderer or dry cleaner, hairdresser, or firefighter (Supplemental table).

In the analysis of industry of employment (Table 3), we observed increased risks for those employed in agriculture, hunting, and related services (OR=1.35, 95% CI 1.03, 1.78), an association that was also higher among women (OR=1.66). Elevated risks were seen among employees in research and development, based on only 10 cases. Decreased risks of RCC were observed among individuals employed in the manufacture of radio, television, and communication equipment, and construction. In comparing men and women, some categories exhibited varying effect estimates, but confidence intervals frequently overlapped.

The analysis by duration of employment in jobs and industries with an overall increased risk was limited by the small number of exposed cases and controls in many of the detailed categories (Table 4). A trend was observed with longer duration of employment among architects and engineers, engineers and engineering technicians, and specifically among mechanical engineers. Trends for duration of employment were also observed in the larger job class of agriculture and animal husbandry, and more specifically among field crop and vegetable workers. Trends were observed with employment in metal processing, machinery fitting, and employment as a transport equipment operator, and in the industries of agriculture, and manufacture of radio and television equipment.

DISCUSSION

This is one of the first studies conducted to investigate the relationship between occupation and RCC risk in Central and Eastern Europe, a region characterized by a high incidence of this disease. The strengths of the study include the large number of cases included in the analysis, the very high participation rate among both cases and controls, the use of personal interviews, and the detailed information collected on the occupational history of study subjects, which was assessed by experts in industrial hygiene. While RCC is not generally considered to be a cancer driven by occupational exposures, elevated patterns of disease have been previously reported across several occupational groups.⁶⁻¹⁵ In this study we observed increased risks of cancer among those employed as architects and engineers, mechanical engineers in particular, and among those working in agriculture. The varying risks seen among working proprietors and metal processors were based on fewer than 20 exposed cases, suggesting that results be taken with caution. The findings observed in several occupational groups, including working proprietors, and those in the industries of research and development, manufacture of television and radio equipment, and construction, were not supported by the analysis by length of employment, suggesting they may have been due to chance. There is also the chance the multiple testing may have caused spurious results in some categories, including possibly the decreased risk seen for transport equipment operators.

We observed an increase in RCC risk among agricultural and animal husbandry workers, which was seen to increase with longer employment. Of the subtypes of agricultural laborers, elevated associations were seen among farm workers and field crop and vegetable workers, a group potentially exposed to a variety of pesticides. The effect was primarily driven by exposures among rural subjects, potentially indicating confounding by urbanicity of residence. At present, no relationship between pesticide exposure and RCC has been established. Two prior cohort studies found conflicting results. An Italian study of mortality among farmers observed an elevated risk of death from all kidney neoplasms (SMR=2.12)³³, while in a Swedish cohort, there was slightly reduced risk for renal cell cancer among persons employed as farmers, fishermen, hunters, or related workers (SIR=0.87).³⁴ Case-control studies have generally observed slightly elevated risk estimates among persons exposed to pesticides,^{12, 16, 17, 29} while case-control investigations that classified subjects by occupational category found varying results, both when specifically examining work in farming and horticulture^{10, 11, 18, 29, 35} and well as those that reported effects for the broader occupational group of farmers, hunters, fishermen, and workers in forestry or animal husbandry.^{6, 9} Another investigation

from the current study observed increased risk from pesticide exposure to be modified by alternations in glutathione S-transferase activity related to certain polymorphisms.³⁶ In interpreting the results of this study, it is necessary to consider the wide variety of substances contained within pesticides, which may include solvents, arsenic, and halogenated compounds. Although investigations into specific pesticides are rare, there have been associations seen between RCC and exposure to pentachlorophenol, based on only two studies.^{37, 38}

We observed slightly higher effect estimates for women working in agriculture than for men, as has been seen elsewhere.^{6, 17} Previous studies have reported 3 to 4-fold greater risk for RCC among women exposed to solvents, in comparison to men.^{11, 17, 32} Further research on RCC and pesticides with more specified exposure measures able to may help to determine whether the findings we observed were due to solvent, or other chemical, exposures.

Studies in the US and Sweden have reported increased risks for RCC among architects.^{13, 14} The occupational classifications of architect and engineer are broad and can include individuals employed in a variety of settings, such as in government, office work, construction, and in industrial sites. Similar to other studies, we did not simultaneously observe an increased risk among those involved in construction.^{10, 34, 39} While the possibility exists that these findings are due to chance, architects may potentially be exposed to several carcinogens, including solvents such as benzene, xylene, butane, heptane, or trichloroethylene, albeit at generally low levels.¹³ While cancer risks in mechanical engineers have only sporadically been reported to be elevated,⁴⁰ one other paper reported a weakly elevated increase in kidney cancer risk, which the authors attributed to gasoline exhaust exposure.⁴¹

Some occupational categories previously linked to RCC did not emerge as high risk in our study. For example, this study did not confirm previous reports of an increased risk among metal workers, printers, or textile workers.

A potential limitation of this study was the use of hospitalized controls, which may be a concern if the reason for hospitalization was associated with employment in specific jobs or industries. Further, hospitalized patients are thought to have differing smoking patterns than the general population, although the exclusion of controls hospitalized for smoking-related diseases, as used here, is a common strategy to reduce selection bias.⁴² Nonetheless, despite the demonstrated association between tobacco and RCC, the higher numbers of current smokers among controls may indicate a possible selection bias in our study. Although we attempted to control for confounding by adjusting for tobacco use, the possibility exists of unknown confounders, related to tobacco use, which may have affected results. As the study's design was retrospective, there is the possibility of recall bias, although this is likely to be non-differential with regards to lifetime occupational histories. In addition, a limitation is the concerns due to multiple testing.

In summary, we observed an elevated risk for RCC among agricultural workers, architects, and engineers, particularly among females. Further studies may continue to investigate pesticide or solvent exposures, particularly among female workers.

WHAT THIS PAPER ADDS

What is already known on this subject?

Central and Eastern Europe have among the highest rates of renal cell cancer worldwide, but few studies have been conducted in these areas to investigate the possible role of occupational exposures in renal cell cancer etiology. Occupational studies have linked renal cell cancer to employment in certain industries, such as dry cleaning, oil refining, metal

working, truck driving, printing, firefighting, pulp and paper work, and employment as a physician, journalist, painter, architect, and airline pilot.

What does this study add?

This study suggests a possible association of renal cell cancer with employment in agriculture, particularly among women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Selected characteristics of the study population

	Cases N=992 N (%)	Controls N=1,459 N (%)	P-value *
Study center			<0.001
Romania – Bucharest	75 (7.6)	155 (10.6)	
Poland – Lodz	88 (8.9)	197 (13.5)	
Russia – Moscow	287 (29.9)	462 (31.7)	
Czech Republic			
Brno	145 (14.6)	145 (9.9)	
Olomouc	137 (13.8)	192 (13.2)	
Prague	135 (13.6)	186 (12.8)	
Ceske Budejovice	125 (12.6)	122 (8.4)	
Sex			0.008
Male	590 (59.5)	945 (64.8)	
Female	402 (40.5)	514 (35.2)	
Age (years)			0.9
<50	165 (16.6)	252 (17.3)	
50–59	315 (31.8)	464 (31.8)	
60–69	312 (31.5)	456 (31.2)	
70+	200 (21.2)	287 (19.7)	
Educational attainment			<0.001
High	313 (31.6)	353 (24.2)	
Medium	572 (57.7)	984 (67.4)	
Low	107 (10.8)	122 (8.4)	
Current residence			<0.001
Rural (<10,000 inhabitants)	274 (27.6)	294 (20.2)	
Urban (10,000+ inhabitants)	718 (72.4)	1165 (79.8)	
Tobacco smoking			0.006
Never smoker	466 (47.0)	592 (40.6)	
< 20 pack-years	221 (22.3)	373 (25.6)	
20–39 pack-years	216 (21.8)	321 (22.0)	
40+ pack years	89 (9.0)	171 (11.7)	
Alcohol drinking (ethanol ml/day)			0.002
Never drinkers	92 (11.1)	148 (11.7)	
>0–8 ml/day	412 (50.0)	552 (43.7)	
>8–18 ml/day	177 (21.4)	259 (20.5)	
>18 ml/day	145 (17.6)	305 (24.1)	
Body mass index (kg/m ²)			<0.001
< 25.0	285 (28.7)	529 (36.3)	
25.0 – 29.9	434 (43.8)	615 (42.2)	
≥ 30	273 (27.5)	315 (21.6)	
Hypertension, self-reported (yes/no)			0.001

	Cases N=992 N (%)	Controls N=1,459 N (%)	P-value *
Yes	449 (45.3)	566 (38.8)	
No	543 (54.7)	893 (61.2)	

* p-value calculated using chi-square testing

Table 2

Odds ratios of renal cell cancer for ever having been employed in selected job categories

Jobs (ISCO-68 code)	Cases N=992		Controls N=1,459		All subjects		Men N=590 cases, 945 controls		Women N=402 cases, 514 controls	
	Men/Women	Men/Women	Men/Women	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	
Professional, technical and related workers (group 0/1)			241/169	1.13 (0.92, 1.40)	1.17 (0.87, 1.56)	1.07 (0.78, 1.48)				
Architects and engineers (0.2)	184/148			1.89 (1.35, 2.65)	1.59 (1.07, 2.35)	3.66 (1.75, 7.65)				
Technicians (0.3)	70/31		74/12	0.79 (0.56, 1.10)	0.73 (0.48, 1.10)	0.84 (0.46, 1.54)				
Engineers and engineering technicians (0.22, 0.23, 0.24, 0.25, 0.27, 0.28, 0.29, 0.33, 0.36, 0.38, 0.39)	40/20		76/29	1.39 (1.05, 1.86)	1.37 (0.97, 1.92)	1.49 (0.85, 2.61)				
Electrical, electronics engineers and related technicians (0.23, 0.34)	87/34		103/29	1.54 (0.94, 2.52)	1.30 (0.72, 2.35)	2.57 (0.93, 7.11)				
Mechanical engineers and related technicians (0.24, 0.35)	23/13		29/6	1.71 (1.03, 2.84)	1.59 (0.93, 2.71)	-----				
Chemists, chemical engineers and related technicians (0.25, 0.36)	31/5		31/1	0.98 (0.42, 2.29)	-----	-----				
Medical doctors and related workers (0.6)	5/5		7/6	0.87 (0.45, 1.70)	1.70 (0.62, 4.61)	-----				
Professional nurses and related workers (0.7)	10/7		7/14	0.78 (0.49, 1.25)	-----	0.80 (0.49, 1.32)				
Economists (0.9)	3/30		6/45	1.59 (0.82, 3.09)	-----	2.50 (0.93, 6.75)				
Teachers (1.3)	7/14		11/6	0.94 (0.65, 1.35)	0.75 (0.43, 1.31)	1.06 (0.65, 1.75)				
Sculptors, painters, photographers and related artists (1.6)	24/37		37/40	1.41 (0.70, 2.84)	1.67 (0.69, 4.05)	-----				
Administrative and managerial workers (group 2)	10/6		11/6	1.29 (0.97, 1.71)	1.38 (0.99, 1.91)	0.98 (0.53, 1.81)				
Clerical and related workers (group 3)	91/21		103/27	0.90 (0.73, 1.12)	0.72 (0.52, 0.99)	1.09 (0.81, 1.46)				
Bookkeepers, cashiers, and related workers (3.3)	71/126		138/158	0.94 (0.63, 1.39)	-----	1.02 (0.65, 1.62)				
Transport and communications supervisors (3.5)	8/38		17/53	1.53 (0.79, 2.99)	1.23 (0.56, 2.71)	-----				
Mail distribution clerks (3.7)	12/7		15/3	1.22 (0.54, 2.76)	-----	1.82 (0.66, 5.00)				
Telephone and telegraph operators (3.8)	2/10		6/7	2.42 (0.92, 6.37)	-----	-----				
Clerical and related workers not elsewhere classified (3.9)	6/5		2/5	0.86 (0.67, 1.12)	0.76 (0.52, 1.12)	0.97 (0.67, 1.39)				
Sales workers (group 4)	48/71		89/92	1.06 (0.78, 1.44)	1.63 (1.02, 2.61)	0.78 (0.51, 1.18)				
Managers (wholesale and retail trade) (4.0)	40/44		40/70	2.29 (0.99, 5.29)	3.83 (1.20, 12.2)	-----				
Working proprietors (wholesale and retail trade) (4.1)	12/4		4/5	4.05 (1.62, 10.14)	4.73 (1.60, 14.0)	-----				
Salesmen, shop assistants, and related workers (4.5)	12/4		5/2	0.93 (0.63, 1.39)	-----	0.96 (0.61, 1.51)				
Service workers (group 5)	9/39		17/53	0.88 (0.68, 1.15)	0.88 (0.62, 1.27)	0.90 (0.62, 1.32)				
Cooks, waiters, bartenders and related workers (5.3)	56/61		98/85	0.86 (0.55, 1.34)	0.65 (0.29, 1.45)	0.98 (0.57, 1.68)				

Jobs (ISCO-68 code)	Cases N=992		Controls N=1,459		All subjects		Men N=590 cases, 945 controls		Women N=402 cases, 514 controls	
	Men/Women	Men/Women	Men/Women	Men/Women	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	
Building caretakers, charworkers, cleaners, and related workers (5.5)	10/22	10/26	1.14 (0.69, 1.88)	1.14 (0.69, 1.88)	1.45 (0.58, 3.62)	1.05 (0.57, 1.92)				
Protective service workers (5.8)	26/3	55/11	0.68 (0.43, 1.08)	0.68 (0.43, 1.08)	0.77 (0.47, 1.26)	-----				
Agricultural, animal husbandry and forestry workers, fishermen and hunters (group 6)	62/45	75/33	1.43 (1.05, 1.93)	1.43 (1.05, 1.93)	1.23 (0.84, 1.80)	1.79 (1.07, 2.99)				
Agricultural and animal husbandry workers (6.2)	51/38	57/29	1.43 (1.03, 2.00)	1.43 (1.03, 2.00)	1.29 (0.85, 1.98)	1.62 (0.94, 2.79)				
General farm workers (6.21)	18/16	20/7	1.70 (0.99, 2.92)	1.70 (0.99, 2.92)	1.31 (0.66, 2.61)	2.73 (1.05, 7.13)				
Field crop and vegetable workers (6.22)	4/10	3/5	2.42 (0.98, 5.98)	2.42 (0.98, 5.98)	2.19 (0.46, 10.5)	2.53 (0.82, 7.76)				
Livestock workers (6.24)	9/6	13/6	1.00 (0.49, 2.03)	1.00 (0.49, 2.03)	-----	-----				
Dairy farm workers (6.25)	3/8	4/8	1.12 (0.48, 2.62)	1.12 (0.48, 2.62)	-----	-----				
Farm machinery operators (6.28)	22/2	21/0	1.55 (0.84, 2.87)	1.55 (0.84, 2.87)	1.36 (0.72, 2.57)	-----				
Production and related workers, transport equipment operators and labourers (groups 7, 8, 9)	393/162	694/224	0.92 (0.74, 1.14)	0.92 (0.74, 1.14)	0.83 (0.63, 1.08)	0.91 (0.68, 1.23)				
Production supervisors and general foremen (7.0)	47/8	65/5	1.27 (0.87, 1.85)	1.27 (0.87, 1.85)	1.17 (0.78, 1.76)	-----				
Miners, quarrymen, well drillers, and related workers (7.1)	24/1	27/0	1.37 (0.77, 2.43)	1.37 (0.77, 2.43)	1.28 (0.71, 2.31)	-----				
Metal processors (7.2)	12/3	42/9	0.43 (0.24, 0.78)	0.43 (0.24, 0.78)	0.41 (0.21, 0.80)	-----				
Wood preparation workers and paper makers (7.3)	9/2	8/1	1.70 (0.69, 4.22)	1.70 (0.69, 4.22)	-----	-----				
Spinners, weavers, knitters, dyers, and related workers (7.5)	8/30	20/45	0.90 (0.58, 1.39)	0.90 (0.58, 1.39)	-----	1.01 (0.60, 1.69)				
Food and beverage processors (7.7)	14/11	20/15	1.02 (0.60, 1.74)	1.02 (0.60, 1.74)	1.10 (0.54, 2.24)	0.92 (0.41, 2.09)				
Tailors, dressmakers, sewers, upholsterers, and related workers (7.9)	7/41	13/51	1.09 (0.73, 1.63)	1.09 (0.73, 1.63)	1.03 (0.40, 2.66)	1.14 (0.72, 1.81)				
Shoemakers and leather goods makers (8.0)	7/6	13/10	0.93 (0.46, 1.87)	0.93 (0.46, 1.87)	-----	-----				
Cabinetmakers and related woodworkers (8.1)	10/9	22/2	1.23 (0.66, 2.31)	1.23 (0.66, 2.31)	0.80 (0.36, 1.74)	-----				
Blacksmiths, toolmakers, and machine tool operators (8.3)	85/17	167/26	0.85 (0.65, 1.12)	0.85 (0.65, 1.12)	0.90 (0.67, 1.22)	0.71 (0.37, 1.35)				
Machine tool operators (8.34)	37/12	79/13	0.92 (0.64, 1.34)	0.92 (0.64, 1.34)	0.91 (0.60, 1.40)	1.07 (0.48, 2.43)				
Machinery fitters, machine assemblers, and precision-instrument workers (8.4)	98/8	181/15	0.90 (0.69, 1.18)	0.90 (0.69, 1.18)	0.94 (0.71, 1.25)	-----				
Machinery fitters and machine assemblers (8.41)	27/1	72/4	0.65 (0.41, 1.03)	0.65 (0.41, 1.03)	0.73 (0.46, 1.17)	-----				
Motor-vehicle mechanics (8.43)	25/0	49/1	0.83 (0.50, 1.37)	0.83 (0.50, 1.37)	0.83 (0.50, 1.38)	-----				
Machinery fitters, machine assemblers, and precision-instrument makers (except electrical) NEC (8.49)	47/4	72/8	0.97 (0.67, 1.41)	0.97 (0.67, 1.41)	1.06 (0.71, 1.58)	-----				
Electrical fitters and related electrical and electronics workers (8.5)	45/9	96/12	0.80 (0.56, 1.14)	0.80 (0.56, 1.14)	0.80 (0.55, 1.18)	-----				

Jobs (ISCO-68 code)	Cases N=992		Controls N=1,459		All subjects		Men N=590 cases, 945 controls		Women N=402 cases, 514 controls	
	Men/Women	Men/Women	Men/Women	Men/Women	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	
Plumbers, welders, sheet-metal and structural preparers and erectors (8.7)	43/5	76/1			1.11 (0.76, 1.64)			1.04 (0.69, 1.57)		
Painters (9.3)	9/3	19/9			0.74 (0.37, 1.48)					
Production and related workers not elsewhere classified (9.4)	10/14	13/26			0.87 (0.51, 1.47)			1.20 (0.51, 2.81)	0.69 (0.35, 1.36)	
Bricklayers, carpenters, and other construction workers (9.5)	51/2	93/8			0.81 (0.56, 1.16)			0.86 (0.59, 1.25)		
Stationary engine and related equipment operators (9.6)	10/4	20/3			0.79 (0.40, 1.56)			0.63 (0.29, 1.39)		
Material handling and related equipment operators, dockers, and freight handlers (9.7)	30/18	59/17			1.03 (0.70, 1.51)			0.90 (0.56, 1.44)	1.47 (0.73, 2.99)	
Transport equipment operators (9.8)	88/6	192/4			0.71 (0.54, 0.95)			0.66 (0.49, 0.89)		
Laborers not elsewhere classified (9.9)	32/30	49/45			1.00 (0.70, 1.41)			1.22 (0.76, 1.98)	0.74 (0.44, 1.24)	

* CI, confidence interval; OR, odds ratio; NEC, not otherwise classified. Adjusted for age, sex, educational attainment, center, tobacco pack-years, alcohol drinks/day, body mass index and hypertension. Referent, never employed in that job category. ORs and CIs given when N cases > 10.

Table 3

Odds ratios of renal cell cancer for ever employment in selected industries

Industries (NAACE-99 code)	Cases N=992		Controls N=1,459		All subjects		Men N=590 cases, 945 controls		Women N=402 cases, 514 controls	
	Men/Women	Men/Women	Men/Women	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*		
Agriculture, hunting and related services (01)	81/51	97/41		1.35 (1.03, 1.78)		1.17 (0.83, 1.65)		1.66 (1.04, 2.66)		
Forestry, logging and related services activities (02)	14/5	24/2		1.05 (0.56, 1.94)		0.88 (0.44, 1.78)		-----		
Mining of coal and lignite (10)	18/2	21/2		1.27 (0.68, 2.36)		1.30 (0.67, 2.50)		-----		
Food and beverage (15)	34/30	53/36		0.99 (0.70, 1.39)		0.93 (0.59, 1.48)		1.02 (0.61, 1.72)		
Manufacture of textiles (17)	22/42	53/65		0.90 (0.64, 1.27)		0.72 (0.42, 1.25)		1.04 (0.66, 1.63)		
Manufacture of wearing apparel, dressing and dyeing of fur (18)	11/42	15/54		1.12 (0.76, 1.65)		1.32 (0.59, 2.96)		1.10 (0.70, 1.72)		
Tanning and dressing of leather, manufacture of luggage, handbags (19)	10/8	18/15		0.83 (0.46, 1.50)		0.90 (0.40, 1.99)		-----		
Manufacture of wood and of products of wood and cork (20)	10/4	21/6		0.68 (0.35, 1.34)		0.69 (0.31, 1.52)		-----		
Manufacture of paper and paper products (21)	5/5	5/7		1.07 (0.45, 2.52)		-----		-----		
Manufacture of chemicals and chemical products (24)	6/1	5/0		1.09 (0.61, 1.95)		-----		-----		
Manufacture of rubber and plastics products (25)	14/7	22/9		1.29 (0.67, 2.46)		1.70 (0.69, 4.24)		-----		
Manufacture of other non-metallic mineral products (26)	9/9	11/11		0.99 (0.63, 1.56)		1.20 (0.72, 1.99)		-----		
Manufacture of basic metals (27)	30/6	38/13		0.88 (0.53, 1.48)		0.97 (0.53, 1.77)		-----		
Manufacture of fabricated metal products, except machinery and equipment (28)	20/6	30/11		0.95 (0.65, 1.39)		1.05 (0.69, 1.60)		-----		
Manufacture of machinery and equipment not elsewhere classified (29)	40/9	66/15		0.84 (0.65, 1.09)		0.71 (0.52, 0.96)		-----		
Manufacture of office, accounting and computing machinery (31)	77/35	172/34		1.05 (0.64, 1.71)		0.83 (0.45, 1.53)		1.74 (0.72, 4.21)		
Manufacture of radio, television and communication equipment and apparatus (32)	17/13	34/9		0.39 (0.20, 0.75)		0.34 (0.14, 0.84)		0.46 (0.17, 1.22)		
Manufacture of medical, precision and optical instruments (33)	6/6	30/15		0.66 (0.36, 1.20)		-----		-----		
Manufacture of motor vehicles, trailers and semi-trailers (34)	10/7	24/13		0.80 (0.49, 1.30)		0.76 (0.42, 1.38)		-----		
Manufacture of other transport equipment (35)	17/9	42/12		1.35 (0.89, 2.04)		1.34 (0.84, 2.14)		1.52 (0.59, 3.95)		
Manufacture of furniture, manufacturing not elsewhere classified (36)	34/11	48/8		1.17 (0.69, 1.98)		0.78 (0.38, 1.59)		2.14 (0.91, 5.04)		
Electricity, gas, steam and hot water supply (40)	12/14	25/10		0.70 (0.39, 1.24)		0.57 (0.29, 1.13)		1.56 (0.46, 5.35)		
Construction (45)	12/6	33/5		0.79 (0.63, 0.99)		0.85 (0.66, 1.09)		-----		
Motor vehicle repair (50)	131/22	252/45		0.93 (0.60, 1.43)		0.94 (0.58, 1.51)		0.83 (0.25, 2.73)		

Industries (NAACE-99 code)	Cases N=992		Controls N=1,459		All subjects		Men N=590 cases, 945 controls		Women N=402 cases, 514 controls	
	Men/Women	Men/Women	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*		
Wholesale and retail trade (51,52)	30/5	54/7	0.98 (0.76, 1.25)	0.98 (0.76, 1.25)	1.10 (0.78, 1.57)	-----	-----			
Hotels and restaurants (55)	61/65	93/93	0.68 (0.44, 1.04)	0.68 (0.44, 1.04)	0.54 (0.28, 1.05)	0.78 (0.43, 1.39)	0.78 (0.43, 1.39)			
Land transport, transport via pipelines (60)	13/21	34/33	0.87 (0.65, 1.16)	0.87 (0.65, 1.16)	0.82 (0.60, 1.13)	1.24 (0.54, 2.83)	1.24 (0.54, 2.83)			
Post and telecommunications (64)	72/12	145/13	1.17 (0.69, 2.01)	1.17 (0.69, 2.01)	0.82 (0.35, 1.91)	1.59 (0.76, 3.32)	1.59 (0.76, 3.32)			
Finance, insurance and real estate activities (65-67,70)	9/18	17/14	1.58 (0.93, 2.67)	1.58 (0.93, 2.67)	1.57 (0.77, 3.18)	1.49 (0.67, 3.31)	1.49 (0.67, 3.31)			
Computer and related activities (72)	16/14	18/12	1.79 (0.66, 4.83)	1.79 (0.66, 4.83)	1.14 (0.32, 4.10)	3.79 (0.70, 20.6)	3.79 (0.70, 20.6)			
Research and development (73)	5/5	5/2	1.37 (1.01, 1.85)	1.37 (1.01, 1.85)	-----	-----	-----			
Other business activities (74)	62/40	73/42	0.72 (0.50, 1.04)	0.72 (0.50, 1.04)	0.63 (0.40, 0.98)	1.01 (0.52, 1.96)	1.01 (0.52, 1.96)			
Public administration and defense, compulsory social security (excluding military period) (75)	34/19	74/21	0.98 (0.81, 1.20)	0.98 (0.81, 1.20)	0.89 (0.71, 1.11)	1.51 (0.97, 2.36)	1.51 (0.97, 2.36)			
Education (excluding periods as student) (80)	310/52	496/42	0.96 (0.77, 1.20)	0.96 (0.77, 1.20)	0.99 (0.74, 1.32)	0.90 (0.64, 1.28)	0.90 (0.64, 1.28)			
Health and social work (85)	144/89	193/110	0.74 (0.54, 1.02)	0.74 (0.54, 1.02)	0.76 (0.42, 1.40)	0.74 (0.50, 1.09)	0.74 (0.50, 1.09)			
Activities of membership organizations not elsewhere classified (91)	18/54	34/88	0.84 (0.44, 1.63)	0.84 (0.44, 1.63)	0.68 (0.29, 1.61)	1.24 (0.43, 3.62)	1.24 (0.43, 3.62)			
Recreational, cultural and sporting activities (92)	8/7	19/8	1.08 (0.74, 1.58)	1.08 (0.74, 1.58)	-----	-----	-----			
Other services activities (93)	32/17	52/20	1.30 (0.66, 2.55)	1.30 (0.66, 2.55)	1.55 (0.59, 4.09)	1.03 (0.40, 2.66)	1.03 (0.40, 2.66)			

* CI, confidence interval; OR, odds ratio. Adjusted for age, sex, educational attainment, center, tobacco pack-years, alcohol drinks/day, body mass index and hypertension. Referent: never employed in this job category. ORs and CIs given when N cases > 10.

Table 4
Odds ratios of renal cell cancer for duration of employment in selected jobs and industries

Job titles (ILO-68 code)	Employed < 10 years		Employed 10+ years		Wald chi-square for linear trend
	Cases/Controls	OR [95% CI]*	Cases/Controls	OR [95% CI]*	
Architects and engineers (0.2)	54/48	1.75 (1.14, 2.68)	47/38	2.21 (1.38, 3.54)	0.0002
Engineers and engineering technicians (0.22, 0.23, 0.24, 0.25, 0.27, 0.28, 0.29, 0.33, 0.36, 0.38, 0.39)	60/69	1.31 (0.90, 1.92)	52/47	1.93 (1.25, 2.98)	0.004
Electrical, electronics engineers and related technicians (0.23, 0.34)	18/21	1.29 (0.67, 2.48)	18/14	1.96 (0.95, 4.05)	0.06
Mechanical engineers and related technicians (0.24, 0.35)	21/21	1.50 (0.80, 2.82)	15/11	2.16 (0.97, 4.85)	0.03
Accountants (1.1)	7/6	1.82 (0.60, 5.53)	4/2	3.54 (0.64, 19.67)	0.1
Administrative and managerial workers (group 2)	66/75	1.31 (0.92, 1.87)	46/55	1.31 (0.86, 1.99)	0.1
Telephone and telegraph operators (3.8)	10/5	2.94 (0.99, 8.77)	1/2	0.96 (0.09, 10.89)	0.1
Managers (wholesale and retail trade) (4.0)	14/5	3.71 (1.31, 10.58)	2/4	0.59 (0.10, 3.33)	0.2
Working proprietors (wholesale and retail trade) (4.1)	13/7	3.28 (1.27, 8.50)	3/0		
Agricultural, animal husbandry and forestry workers, fishermen and hunters (group 6)	60/68	1.22 (0.84, 1.78)	47/40	1.78 (1.13, 2.82)	0.01
Agricultural and animal husbandry workers (6.2)	55/57	1.30 (0.87, 1.93)	34/29	1.74 (1.02, 2.96)	0.02
General farm workers (6.21)	21/16	1.80 (0.90, 3.57)	13/11	1.54 (0.66, 3.57)	0.09
Field crop and vegetable workers (6.22)	8/5	1.80 (0.57, 5.68)	6/3	3.71 (0.88, 15.75)	0.04
Metal processors (7.2)	13/39	0.48 (0.25, 0.91)	2/12	0.26 (0.06, 1.19)	0.005
Machinery fitters and machine assemblers (8.41)	26/54	0.85 (0.52, 1.40)	2/22	0.16 (0.04, 0.70)	0.02
Transport equipment operators (9.8)	69/130	0.77 (0.56, 1.07)	25/66	0.61 (0.37, 0.99)	0.01
Industries (NAACE-99 code)					
Agriculture, hunting and related services (01)	73/90	1.10 (0.78, 1.54)	59/48	1.91 (1.26, 2.89)	0.006
Manufacture of radio, television and communication equipment and apparatus (32)	10/33	0.46 (0.22, 0.94)	2/12	0.23 (0.05, 1.05)	0.005
Construction (45)	97/199	0.74 (0.57, 0.97)	56/98	0.90 (0.63, 1.28)	0.1
Hotels and restaurants (55)	25/44	0.74 (0.45, 1.24)	9/23	0.55 (0.25, 1.21)	0.1
Finance, insurance and real estate activities (65–67, 70)	21/18	1.78 (0.93, 3.43)	9/12	1.26 (0.52, 3.07)	0.2
Research and development (73)	66/70	1.46 (1.01, 2.10)	36/45	1.30 (0.81, 2.09)	0.1
Other business activities (74)	43/70	0.80 (0.53, 1.20)	10/25	0.51 (0.24, 1.09)	0.06

	Employed < 10 years		Employed 10+ years		Wald chi-square for linear trend
	Cases/Controls	OR [95% CI]*	Cases/Controls	OR [95% CI]*	
Health and social work (85)	34/67	0.60 (0.41, 0.99)	38/55	0.86 (0.55, 1.34)	0.2

* CI, confidence interval; OR, odds ratio. Adjusted for age, sex, educational attainment, center, tobacco pack-years, alcohol drinks/day, body mass index and hypertension. Referent: never employed in this job category.