This is the accepted manuscript of the article, which has been published in *Acta Oncologica*. 2020, 59(5), 582-587.
https://doi.org/10.1080/0284186X.2020.1714722

Title: Smoking-Adjusted Risk of Kidney Cancer by Occupation: a Population-Based Cohort Study of Nordic Men

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Sources of funding: This research was supported by a Nordic Cancer Union grant for the project "Work and cancer: in-depth studies initiated by the NOCCA project".

Disclosure of interest: The authors report no conflict of interest

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Smoking-Adjusted Risk of Kidney Cancer by Occupation: a Population-Based Cohort Study of Nordic Men

Abstract

Background

Evidence suggests that among some occupational groups, there is an elevated risk of kidney cancer. This might, however, derive from a difference in smoking habits across occupational groups. The objective of this study was to determine smoking-adjusted occupational variation in the incidence of kidney cancer in Nordic males.

Materials and Methods

The source population for this study consisted of 7.4 million men from Denmark, Iceland, Finland, Norway, and Sweden. Data on occupation were obtained from national censuses conducted in the years 1960-1990. Data on cancer cases came from national cancer registries. A proxy for the occupation-specific smoking prevalence among all Nordic men was calculated based on the occupation-specific smoking prevalence and lung cancer incidence data for Finnish men. Smoking-adjusted standardized incidence ratio (SIR_{adj}) with 95% confidence intervals (95%CI) were calculated for each occupational group.

Results

The highest SIR_{adj} estimates were observed in dentists (1.32, 95%CI 1.06-1.62), journalists (1.20, 95%CI 1.00-1.42), physicians (1.19, 95%CI 1.03-1.36), public safety workers (1.18, 95%CI 1.10-1.26), administrators (1.17, 95%CI 1.13-1.22), military personnel (1.16, 95%CI 1.05-1.28), and religious workers (1.17, 95%CI 1.09-1.26). The lowest SIR_{adj} was observed among forestry workers (0.82, 95%CI 0.76-0.88).

Conclusions

Tobacco smoking plays an important role in the occupational variation in the risk of kidney cancer. The smoking-adjusted incidence of kidney cancer was increased in dentists, physicians, journalists, administrators, and public safety workers.

Keywords: Kidney neoplasms; Nordic countries epidemiology; occupation; occupational groups; risk; tobacco smoking

Introduction

Kidney cancer is a common condition that has a considerable impact on global cancer mortality rates [1]. Its most widely recognized risk factors include obesity, hypertension, and end-stage renal disease [2-4]. Furthermore, there is evidence that tobacco smoking is one of the most important risk factors for the disease [5]. A much-debated question is whether any occupational exposures can contribute to the risk of kidney cancer [6-14].

In the field of occupational exposures, most studies have focused on occupational groups or specific agents. Oftentimes, they have failed to address the potential confounding connected with tobacco smoking. Notably, studies based on big datasets, like whole national populations, tend to be limited by lack of data on smoking habits.

The impact of the occupation-specific prevalence of tobacco smoking on the risk of kidney cancer in particular occupational groups remains unknown. This study aimed to examine the smoking-adjusted occupational variation in the incidence of kidney cancer in Nordic males.

Material and methods

Study population

The population of the Nordic Occupational Cancer Study (NOCCA) (described in detail elsewhere [15]) served as a source population for the presented study. The NOCCA population included all individuals aged 30-64, living in the Nordic countries (Denmark, Iceland, Finland, Norway, and Sweden), who participated in at least one of the national censuses conducted between 1960 and 1990. In total, the NOCCA population included 14.9 million individuals (7.4 million men, and 7.5 million women).

In this study, we used data on men only. We did not analyze data for women since smoking among them was less prevalent, and the smoking pattern across occupations changed over time from the most frequent in women with high socioeconomic status to the most frequent among those with low socioeconomic status [16]. Therefore, it would be hard to estimate the sum effect of smoking in the female population.

Data on exposure and outcome

Data on exposure (occupation) were obtained from national censuses. The censuses were held in the following years: 1960, 1970, and 1990 in Sweden; 1960, 1970, and 1980 in Norway; 1970, 1980, and 1990 in Finland; 1970 in Denmark; and 1981 in Iceland. All men aged 30-64 during at least one of the censuses were included in the study. For participants of more than one census, the first registered occupation was used. The data were initially coded using national coding schemes. For the NOCCA study, they were uniformly categorized in 53 occupational categories and an additional category of economically inactive men.

The data on the outcome, namely kidney cancer (International Classification of Diseases, 7th Revision 180), were obtained from national cancer registries in the respective countries. The follow-up took place until the day of emigration, death, or December 31st of the following year: 2003 in Denmark and Norway, 2004 in Iceland, and 2005 in Finland and Sweden; whichever came first.

Data on occupation-specific standardized incidence ratios (SIRs) of male lung cancer were obtained from the publication by Pukkala et al. [15]. The SIR was defined as a ratio of the observed to the expected number of cases, with national incidence rates as a reference.

Since no individual-level data on smoking were available, we used occupational-group-level data. Such data were available from Finnish men only. They came from the

Finnish Information System on Occupational Exposures (FINJEM) survey of 1978-1995 [17]. No comparable data from other Nordic countries were available.

Statistical analysis

Based on the occupation-specific smoking prevalence [17] and lung cancer incidence data for Finnish men [15], we calculated a proxy for the occupation-specific smoking prevalence among all Nordic men.

First, we fitted a regression line Y=0.05+2.48X (r^2=0.57; Figure 1), where X denoted the occupation-specific smoking prevalence, Y the occupation-specific SIR of lung cancer, and where the intercept of 0.05 represented the risk of lung cancer in non-smokers [18] (Model A). Due to missing data on smoking prevalence, domestic assistants, economically inactive persons, hairdressers, and tobacco workers did not contribute to the model. The model was validated using a jackknife resampling [19].

In the second model, we excluded occupations likely to be exposed to lung cancer risk factors other than smoking, e.g., drivers to diesel engine exhaust [20, 21]; painters to polycyclic aromatic hydrocarbons [22]; and plumbers to asbestos [23]. We excluded beverage workers, chemical process workers, drivers, electrical workers, painters, plumbers, smelting workers, tobacco workers, and waiters. In the analysis by Haldorsen et al. [24], all of these groups had a smoking adjusted SIR for lung cancer >1.15. The fitted regression line was Y=0.05+2.46X (r^2=0.58; Figure 1) (Model B). The model was validated using a jackknife resampling [19].

Subsequently, Model B and occupation-specific SIRs of lung cancer for men in the other Nordic countries [15] were used to predict their occupation-specific smoking prevalence, assuming that the association between the occupation-specific smoking prevalence and the occupation-specific risk of lung cancer was similar across the Nordic countries. Using person counts in all occupational groups as weights, we calculated a proxy of national smoking prevalence for all Nordic countries.

The calculation of the occupation-specific smoking-adjusted SIR (SIR_{adj}) of kidney cancer included several steps. First, the national smoking prevalence was subtracted from the smoking prevalence in a given occupational group. Second, the difference was multiplied by the expected number of kidney cancer cases in the given occupation. Third, to calculate the smoking-adjusted expected number of cases, the obtained product was added to/subtracted from the expected number of kidney cancer cases in the given occupation. Finally, SIR_{adj} was calculated as a ratio between the observed number of cases and the smoking-adjusted expected number of cases. The 95% confidence intervals (CI) were calculated assuming a Poisson distribution.

Statistical analysis was performed with Stata/IC 15.0 for Mac (StataCorp LP, College Station, TX, USA).

Results

During the follow-up of 185 million person-years, altogether 50,330 cases of kidney cancer were identified among Nordic men. The highest unadjusted SIRs (>1.15) were observed among waiters (SIR 1.26, 95%CI 1.02-1.53), welders (SIR 1.25, 95%CI 1.14-1.36), cooks and stewards (SIR 1.23, 95%CI 1.05-1.44), public safety workers (SIR 1.16, 95%CI 1.08-1.25), and seamen (SIR 1.16, 95%CI 1.07-1.26) (Table 1).

The highest adjusted SIRs (>1.15) were observed among dentists (SIR_{adj} 1.32, 95%CI 1.06-1.62), journalists (SIR_{adj} 1.20, 95%CI 1.00-1.42), physicians (SIR_{adj} 1.19, 95%CI 1.03-1.36), public safety workers (SIR_{adj} 1.18, 95%CI 1.10-1.26), administrators (SIR_{adj} 1.17, 95%CI 1.13-1.22), military personnel (SIR_{adj} 1.16, 95%CI 1.05-1.28), and religious workers (SIR_{adj} 1.17, 95%CI 1.09-1.26) (Table 1). The lowest SIR_{adj} (<0.85) was observed among forestry workers (SIR_{adj} 0.82, 95%CI 0.76-0.88).

In most occupational groups (34 out of 54), the adjusted SIR was closer to 1.0 than the unadjusted SIR (Table 1). In the case of 18 occupational groups, SIR changed from above 1.0 to below 1.0, or vice versa.

Discussion

Main research findings

Several studies have indicated that the risk of kidney cancer may be elevated in certain occupations [6-14]. However, until now, no population-level study controlling for the possible confounding from tobacco smoking has been published. The present study was designed to determine the smoking-adjusted risk of kidney cancer across occupations in Nordic men.

An unexpected finding of this study was the significantly elevated SIR_{adj} among dentists and physicians. To our knowledge, this is the first study reporting such results. Previously, some studies indicated an elevated risk of oral cancer [23] and cutaneous squamous cell carcinoma [24] among dentists, and breast cancer [25] and seminoma [26] among physicians. In contrast to some of these diseases, in the case of kidney cancer, we do not expect that surveillance bias may play an important role. A possible explanation for our findings could be occupational exposure to X-radiation and gamma radiation, classified by the International Agency for Research on Cancer (IARC) as carcinogenic to the human kidney [27]. Further research should be undertaken to obtain a full understanding of these findings.

Another unexpected finding was the elevated SIR_{adj} among journalists, administrators, and religious workers. According to our knowledge, this is the first study reporting such observations. Previously, an increased risk of mouth and pharynx cancer was reported among journalists [23, 28, 29]. Among administrators and religious workers, elevated risks of ovarian cancer [30], testicular cancer [26,31], skin cancers [24,32], hematological tumors [32-33], and thyroid cancer [32] have been reported. One of the explanations of our findings can be higher body mass index (BMI) observed in these occupational groups, possibly associated with the sedentary nature of their work.

Consistently with previous literature [34-41], we observed an increased risk of kidney cancer among public safety workers. This occupational category included firefighters, police officers, detectives, guards with civil duties, and customs officers. Some of these subgroups are occupationally exposed to diesel fumes, asbestos, and polycyclic aromatic hydrocarbons, previously associated with an increased risk of kidney cancer [42-46].

Another group in which we observed an elevated SIR_{adj} was military workers. In previous literature, an increased risk of certain neoplasms, including prostate cancer, were reported in this occupation [24, 47, 48]. However, these findings could possibly be attributed to overdiagnosis due to regular screening. In the case of kidney cancer, such a surveillance bias is less likely. The reasons for the observed elevated risk among military workers remain to be investigated.

A possible explanation for some of our findings may be different overweight and obesity prevalence across occupational groups. Extensive research has shown that increased BMI is an independent risk factor for kidney cancer [27]. In a meta-analysis, the estimated pooled risk ratio associated with every 5kg/m^2 increase in BMI was 1.24 (95%CI 1.15-1.34) in men [49].

It is noteworthy that, in Finland, among journalists, military personnel, religious workers, and some of the public safety workers (police officers, guards, customs officers), the fraction of individuals with BMI ≥25 was one of the highest among all occupational groups (fourth quarter). However, among dentists, physicians, and firefighters, the fraction of individuals with BMI ≥25 was one of the lowest (first quarter) [50]. No similar data from other Nordic countries were available.

This study showed how adjustment for a proxy of smoking influenced the SIR of kidney cancer. We noticed changes among tobacco workers, waiters, dentists, nurses, teachers, physicians, seamen, and cooks and stewards. In the case of waiters, seamen, and cooks and stewards, the elevated risk of kidney cancer ceased to be statistically significant. Contrarily, in the case of dentists and physicians the risks became statistically significantly elevated. The largest change was observed for teachers, who, before adjustment for smoking had a risk of kidney cancer below that of other men, but after adjustment had an excess risk.

Strengths and limitations of the study

This is the first study examining smoking-adjusted occupational variation in kidney cancer at the national level. A major advantage of this study was the high completeness and accuracy of cancer registration in Nordic countries [51]. Another strength was the large source population and precise coding of occupations.

A limitation of this study was the fact that the occupational categories were based on the first available census only. This could lead to exposure misclassification, which would bias the observed effects towards the null. However, such a dilution is probably rather small because, at the time of the study, occupational stability was high in the Nordic countries [51, 52]. In Finland, for example, overall 85-86% of men had the same occupational branch in 1980-85 as they had in 1975-80, varying from 91% in transport to 82% in administration and manufacture [52].

The study was also limited by the lack of individual-level information on smoking. Residual confounding from smoking is therefore possible.

Conclusions

This study showed that the risk of kidney cancer varies across occupations. Differences in tobacco smoking play an important role in this variation. Smoking-adjusted risk of kidney cancer was increased among dentists, physicians, journalists, administrators, and public safety workers.

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Table legends

Table 1. The observed number of cases (Obs), crude and smoking-adjusted standardized incidence ratios (SIR) of kidney cancer in Nordic males by occupation.

Figure legends

Figure 1. Association between smoking prevalence and standardized incidence ratio (SIR) of lung cancer in Finnish males.

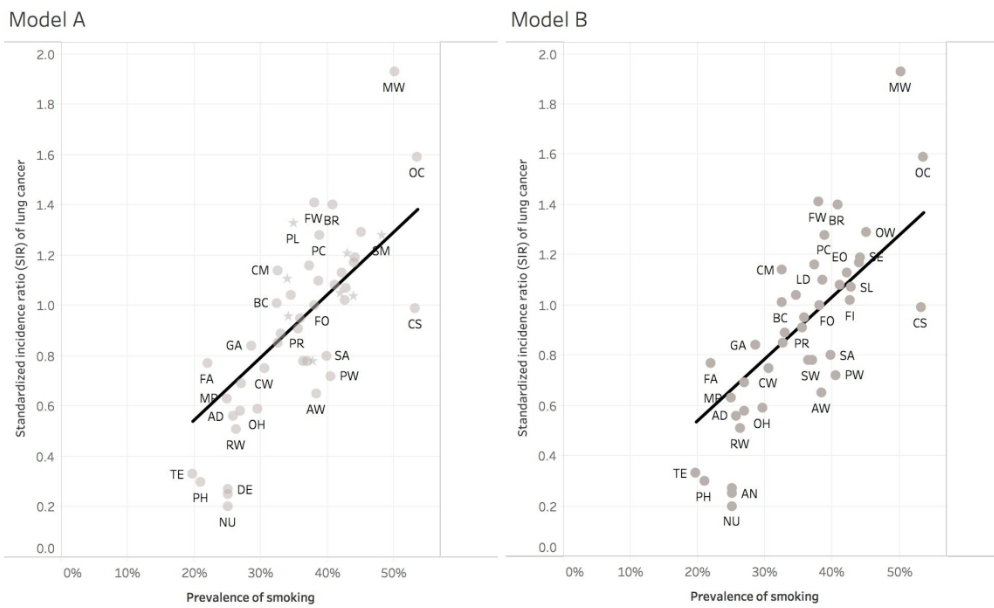
Table 1. The observed number of cases (Obs), crude and smoking-adjusted standardized incidence ratios (SIR) of kidney cancer in Nordic males by occupation

Occupational group	Obs	Unadjusted		Adjusted*	
		SIR	**95% CI**	**SIR**	**95% CI**
Administrators	2,300	1.08	1.04-1.13	1.17	1.13-1.22
Artistic workers	256	1.06	0.93-1.20	1.10	0.97-1.24
Assistant nurses	59	1.10	0.84-1.42	1.18	0.89-1.52
Beverage workers	52	1.13	0.84-1.48	0.97	0.72-1.27
Bricklayers	385	1.00	0.90-1.10	0.91	0.83-1.01
Building caretakers	531	1.02	0.93-1.11	0.95	0.87-1.04
Chemical process workers	570	0.93	0.85-1.01	0.88	0.81-0.96
Chimney sweeps	42	1.18	0.85-1.59	0.99	0.71-1.34
Clerical workers	1,810	1.06	1.01-1.11	1.12	1.07-1.17
Cooks and stewards	155	1.23	1.05-1.44	1.01	0.86-1.19
Dentists	89	1.04	0.83-1.28	1.32	1.06-1.62
Domestic assistants	4	0.72	0.20-1.84	0.84	0.23-2.14
Drivers	2,747	1.13	1.09-1.17	1.02	0.99-1.06
Economically inactive	2,575	1.03	0.99-1.07	0.92	0.88-0.95
Electrical workers	1,289	1.02	0.96-1.08	1.02	0.96-1.07
Engine operators	1,142	1.08	1.02-1.14	1.01	0.95-1.07
Farmers	4,458	0.78	0.75-0.80	0.96	0.93-0.98
Fishermen	572	1.08	1.00-1.18	1.03	0.94-1.11
Food workers	812	1.10	1.02-1.17	1.03	0.96-1.10
Forestry workers	849	0.77	0.72-0.83	0.82	0.76-0.88

Gardeners	1,233	0.84	0.80-0.89	0.98	0.93-1.04
Glassmakers	596	0.94	0.87-1.02	0.89	0.82-0.96
Hairdressers	119	1.11	0.92-1.33	1.03	0.86-1.24
Journalists	132	1.17	0.98-1.38	1.21	1.01-1.44
Laboratory assistants	42	0.80	0.58-1.09	0.86	0.62-1.16
Launderers	62	0.89	0.68-1.14	0.81	0.62-1.03
Mechanics	3,669	1.06	1.02-1.09	0.97	0.94-1.00
Military personnel	417	1.12	1.02-1.24	1.17	1.06-1.29
Miners and quarry workers	278	1.07	0.95-1.21	0.88	0.78-0.99
Nurses	7	0.72	0.29-1.49	0.97	0.39-1.99
Other construction workers	1,488	0.96	0.92-1.01	0.86	0.82-0.91
Other health workers	159	0.98	0.83-1.15	1.06	0.91-1.24
Other workers	1,671	0.97	0.93-1.02	0.92	0.87-0.96
Packers	1,264	1.06	1.01-1.13	0.96	0.90-1.01
Painters	671	0.96	0.89-1.04	0.89	0.82-0.96
Physicians	202	0.95	0.82-1.09	1.19	1.03-1.36
Plumbers	470	1.11	1.01-1.21	0.95	0.87-1.04
Postal workers	460	0.99	0.90-1.08	1.02	0.93-1.11
Printers	395	1.01	0.91-1.12	0.94	0.85-1.04
Public safety workers	768	1.16	1.08-1.25	1.19	1.10-1.27
Religious workers	751	0.98	0.91-1.05	1.17	1.09-1.26
Sales agents	2,398	1.11	1.07-1.16	1.12	1.07-1.16
Seamen	628	1.16	1.07-1.26	0.94	0.87-1.01
Shoe and leather workers	186	1.03	0.89-1.19	1.01	0.87-1.17

Shop workers	1,347	1.13	1.07-1.19	1.15	1.09-1.21
Smelting workers	813	1.07	0.99-1.14	0.94	0.88-1.01
Teachers	1,088	0.88	0.83-0.93	1.12	1.05-1.19
Technical workers	3,646	1.04	1.01-1.08	1.14	1.10-1.17
Textile workers	475	1.01	0.92-1.11	1.03	0.94-1.13
Tobacco workers	12	1.47	0.76-2.56	1.12	0.58-1.96
Transport workers	956	1.09	1.02-1.16	1.12	1.05-1.19
Waiters	95	1.26	1.02-1.53	0.93	0.75-1.13
Welders	533	1.25	1.14-1.36	1.11	1.02-1.21
Woodworkers	2,602	0.93	0.89-0.97	0.95	0.92-0.99

* - results from Model B



Standardized incidence ratio (SIR) of lung cancer dependence of smoking in Finnish males.
Model A. SIR L = 2.4878 S - 0.05; **Model B.** SIR L = 2.4612 S - 0.05; where: SIR L - standardized incidence ratio of lung cancer; S - prevalence of smoking.

The data is filtered on smoking prevalence in NOCCA occupational groups, which keeps non-null values only. Variables appearing only in model A are marked with a star symbol. The marks are labeled by the following NOCCA occupational groups: AD - administrators; AN - assistant nurses; AW - artistic workers; BC - building caretakers; BE - beverage workers; BR - bricklayers; CH - chemical process workers; CM - chimney sweeps; CS - cooks and stewards; CW - clerical workers; DE - dentists; DR - drivers; EO - engine operators; EW - electrical workers; FA - farmers; FI - fishermen; FO - food workers; FW - forestry workers; GA - gardeners; GM - glass makers etc.; JO - journalists; LA - laboratory assistants; LD - launderers; ME - mechanics; MP - military personnel; MW - miners and quarry workers; NU - nurses; OC - other construction workers; OH - other health workers; OW - other workers; PA - painters; PC - packers; PH - physicians; PL - plumbers; PR - printers; PS - public safety workers; PW - postal workers; RW - religious workers etc.; SA - sales agents; SE - seamen; SL - shoe and leather workers; SM - smelting workers; SW - shop workers; TE - teachers; TR - transport workers; TW - technical workers, etc.; TX - textile workers; WA - waiters; WE - welders; WW - woodworkers.

520x414mm (96 x 96 DPI)