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Incidence of cancer among Nordic police officers

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Abstract

Police work may expose officers to various circumstances that have potential for increasing their risk of cancer, including traffic-related air pollution, night shift work and radiation from radars. In this study, we examined the incidence of cancer among Nordic male and female police officers. We utilize data from the Nordic Occupational Cancer (NOCCA) project, which linked census data on occupations from Finland, Iceland, Norway and Sweden to national cancer registries for the period 1961 to 2005. We report standardized incidence ratios (SIR) and 95% confidence intervals (CI) of selected cancers for each country by sex, age and calendar period. The cohort included 38 523 male and 1998 female police officers. As compared with the general population, male police officers had a 7% (95% CI: 4-9%) excess cancer risk, with elevated SIRs for various cancer sites, including prostate (SIR 1.19, 1.14-1.25), breast (SIR 1.77, 1.05-2.80), colon (SIR 1.22, 1.12-1.32) and skin melanoma (SIR 1.44, 1.28-1.60). Conversely, male police officers had a lower risk of lung cancer than the general population (SIR 0.72, 0.66-0.77). In female police officers, the SIR for cancer overall was 1.15 (0.98-1.34), and there was a slight excess of cancers of the breast (SIR 1.25, 0.97-1.59) and colon (SIR 1.21, 0.55-2.30). In conclusion, cancer incidence among the police officers was slightly higher than in the general population. Notably, SIRs were elevated for cancer sites potentially related to night shift work, namely colon, breast and prostate cancer.

KEYWORDS
cancer risk, exposure, occupation, police officers

What's new?

Police work may expose officers to various cancer risk factors, including traffic-related air pollution, night shift work and radiation from radars. On the other hand, the good physical condition expected of police officers may reduce their cancer risk. This study provides estimates on cancer incidence among Nordic male and female police officers, utilizing extensive, population-based datasets for the 1961 to 2005 period. The results suggest that police officers, especially males, have been at increased risk of several cancers, and strengthens the evidence on the elevated risk of cancers potentially related to night shift work, namely colon, breast and prostate cancer.

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; IARC, The International Agency for Research on Cancer; NOCCA, Nordic Occupational Cancer Study; PSA, prostate-specific antigen; SIR, standardized incidence ratio; SMR, standardized mortality ratio; UV radiation, ultraviolet radiation.

1 | INTRODUCTION

Police work may expose officers to various cancer risk factors. The job often includes working in night shifts, which involves disruption of circadian rhythms, suggested to be associated with breast, prostate and colorectal cancers.[1] Traffic-related air pollution may pose health risks. Police officers are also potentially exposed to microwave radiation from police radars, psychological stress and excessive alcohol consumption as a coping mechanism. Ultraviolet (UV) radiation, when patrolling on foot and directing traffic, may also be a relevant exposure. Air pollution,[2] shift work,[1] nonionizing radiation, including UV-radiation,[3-6] alcohol consumption[7] and psychological stress and related indirect effects[7-9] are all known or suspected carcinogens. Some of these factors, namely stress, shiftwork and certain ambient exposures, such as traffic-related air pollution, may be of concern also among Nordic police officers.[10,11] It has also been shown that police work today is largely sedentary by nature,[11,12] which may be an additional risk factor for certain cancers, such as cancers of the colorectum and endometrium.[13,14]

Police officers in the Nordic countries are a selected group with respect to physical health and fitness, considering the strict admittance and recruitment criteria applied to police education and employment. In Finland and Iceland, for example, applicants for police education are required to pass vigorous physical tests and once in post, fitness tests are carried out every 2 to 3 years. These include tests for endurance, agility, and muscle fitness. Students applying to police education must also pass a health inspection. In Norway and Sweden, there are health requirements for admittance to police education, whereas regular and required health check-ups are carried out only for certain specialized personnel, such as bomb and anti-terrorism groups. Good physical condition has been associated with reduced risk of several cancers.[13]

Previous studies on cancer among police officers have shown mixed results, except for prostate cancer, where an excess has been observed in several studies.[15-19] Increased incidence or mortality has been reported for cancers overall,[15,20-22] Hodgkin lymphoma,[23] skin melanoma,[15,24] and cancers of the testis,[15,25] male breast,[15,26] colon,[20-22] thyroid,[27] kidney,[20] esophagus[20-22] and bladder.[28] Only a few studies were published on cancer risk among female police officers. Finkelstein reported lower than expected incidence of lung cancer and higher than expected incidence of bone cancer from a Canadian cohort of 1596 female police officers.[24] Vena et al[21] observed a nonsignificant elevated overall cancer mortality from a cohort of 259 female police officers in New York.

Overall, previous research on the cancer risk of police officers still shows conflicting results and large-scale studies are needed to shed more light on the matter. In this article, we aim to present the incidence of cancer among Nordic male and female police officers. We utilize data from the Nordic Occupational Cancer (NOCCA) project (http://astra.cancer.fi/NOCCA), which linked the census data on occupations from the five Nordic countries: Finland, Iceland, Norway, Sweden and Denmark to national cancer registries for the period 1961 to 2005.

2 | MATERIALS AND METHODS

Data collection and analysis methods have been described in detail earlier.[29] Data from Denmark were not included in the present study due to lack of access to individual-level information on police employees. The study cohort includes approximately 12.9 million persons participating in any of the computerized national censuses: Finland (1970, 1980 and 1990 censuses), Iceland (1981 census), Norway (1960, 1970 and 1980 censuses) and Sweden (1960, 1970, 1980 and 1990 censuses). The cohort included police officers aged 30 to 64 years residing in the country on January first of the year following the census.

Census questionnaires surveyed persons' economic activity, occupation and industry. A person was classified as a police officer if he/she had been working in that occupation for more than half of the regular working hours during the census year. Professional police officers had a specific occupational category. The follow-up ended on the date of emigration, death, or 31 December of the following years: in Norway 2003, in Iceland 2004 and in Finland and Sweden 2005. Information on the dates of death and emigration was retrieved from the national population registries. Data on cancers were obtained from the cancer registry of each country. The cancer registries receive clinical and pathological cancer notifications from hospitals and laboratories in the public and private sectors.[30] Cancers have been registered nationwide since 1953 in Finland and Norway, since 1955 in Iceland and since 1958 in Sweden.

The cancers were classified into 54 main categories and 21 diagnostic subgroups based on the national topography and morphology coding systems (Supplementary Tables 5-6 at http://astra.cancer.fi/NOCCA). All invasive cancers and benign brain tumors are included in the study.

Standardized incidence ratios (SIRs) were calculated as the ratio of the observed and expected numbers of cancers. For each country and sex, the observed numbers of cancers and person-years were stratified into 5-year age categories (follow-up age, 30-34, 35-39, ..., 85+ years) and into 5-year calendar periods (1961-1965, 1966-1970, ..., 2001-2005). The expected numbers of cancer cases were based on the number of person-years in each stratum (country, sex, age and calendar period) and the corresponding national reference rate. Aggregate risk measures for all Nordic countries combined were calculated as the ratio of the total number of observed cases to the total number of expected cases of the four countries. For each SIR, a 95% confidence interval (CI) was defined assuming a Poisson distribution of the observed numbers of cases.

3 | RESULTS

The study cohort included 38 523 male and 1998 female police officers, accumulating a total of 1 028 449 person-years. There were 20 804 males and 1644 females from Sweden, 10 220 males and 230 females from Finland, 6956 males and 106 females from Norway, and 543 males and 18 females from Iceland. In total, 7181 cancers in

TABLE 1 Standardized incidence ratios (SIR) among 38 523 male (A) and 1998 female (B) police officers, follow-up 1961 to 2005, for cancer sites with at least 10 (males) or five (females) observed cases, Finland, Iceland, Norway and Sweden combined

Cancer site	Observed	Expected	SIR (95% CI)
A. Males			
Lip	36	59.3	**0.61 (0.43-0.84)**
Tongue	19	26.7	0.71 (0.43-1.11)
Salivary glands	12	15.8	0.76 (0.39-1.33)
Oral cavity	25	34.6	0.72 (0.47-1.07)
Pharynx	28	47.7	**0.59 (0.39-0.85)**
Oropharynx	9	20.2	0.45 (0.20-0.85)
Esophagus	48	83.6	**0.57 (0.42-0.76)**
Adenocarcinoma	21	23.3	0.90 (0.56-1.38)
Stomach	276	334.5	**0.83 (0.73-0.93)**
Cardia	48	56.5	0.85 (0.63-1.13)
Small intestine	34	31.2	1.09 (0.75-1.52)
Colon	566	465.7	**1.22 (1.12-1.32)**
Rectum, rectosigmoid	360	321.6	**1.12 (1.01-1.24)**
Primary liver	85	77.7	1.09 (0.87-1.35)
Gallbladder	38	34.6	1.10 (0.78-1.51)
Pancreas	225	203.4	1.11 (0.97-1.26)
Nose	10	14.9	0.67 (0.32-1.23)
Larynx	67	74.9	0.89 (0.69-1.14)
Lung	609	851.4	**0.72 (0.66-0.77)**
Adenocarcinoma	118	156.2	**0.76 (0.63-0.91)**
Small cell	96	121.1	**0.79 (0.64-0.97)**
Squamous cell	186	278.0	**0.67 (0.58-0.77)**
Other	199	281.0	**0.71 (0.61-0.81)**
Mesothelioma	21	28.3	0.74 (0.46-1.14)
Breast	18	10.2	**1.77 (1.05-2.80)**
Prostate	2020	1695.5	**1.19 (1.14-1.25)**
Testis	49	38.2	1.28 (0.95-1.70)
Seminoma	38	27.1	1.40 (0.99-1.93)
Nonseminoma	11	10.3	1.06 (0.53-1.90)
Penis	13	20.2	0.64 (0.34-1.10)
Kidney	297	244.2	**1.22 (1.08-1.36)**
Renal pelvis	24	23.1	1.04 (0.66-1.54)
Bladder	495	461.7	1.07 (0.98-1.17)
Skin melanoma	320	223.0	**1.44 (1.28-1.60)**
Eye	14	18.7	0.75 (0.41-1.25)
Eye melanoma	10	15.5	0.65 (0.31-1.19)
Brain	218	187.4	**1.16 (1.01-1.33)**
Glioma	110	94.2	1.17 (0.96-1.41)
Meningeoma	41	37.0	1.11 (0.80-1.50)
Thyroid	45	34.3	1.31 (0.96-1.76)
Follicular	10	3.6	**2.75 (1.32-5.05)**
Papillary	17	13.5	1.26 (0.73-2.02)
Bone	14	10.5	1.33 (0.73-2.23)
Soft tissue	62	42.0	**1.48 (1.13-1.90)**
Liposarcoma	20	7.7	**2.59 (1.58-4.00)**
Non-Hodgkin lymphoma	218	210.7	1.03 (0.90-1.18)
Hodgkin lymphoma	33	32.2	1.03 (0.71-1.44)
Multiple myeloma	117	99.4	1.18 (0.97-1.41)
Leukemia	183	157.7	**1.16 (1.00-1.34)**
Chronic lymphatic	78	69.1	1.13 (0.89-1.41)
Acute myeloid	43	42.5	1.01 (0.73-1.36)
Mycosis fungoides	10	8.9	1.13 (0.54-2.08)
Nonmelanoma skin	360	271.6	**1.33 (1.19-1.47)**
Other/unknown site	170	195.2	0.87 (0.74-1.01)
All sites	7181	6721.8	**1.07 (1.04-1.09)**
B. Females			
Colon	9	7.4	1.21 (0.55-2.30)
Breast	66	52.9	1.25 (0.97-1.59)
Ductal	30	28.8	1.04 (0.70-1.49)
Lobular	10	5.2	1.92 (0.92-3.52)
Cervix uteri	11	6.2	1.78 (0.89-3.19)
Corpus uteri	7	6.8	1.04 (0.42-2.13)
Ovary	8	9.3	0.86 (0.37-1.69)
Kidney	6	2.4	2.47 (0.91-5.37)
Skin melanoma	11	7.5	1.47 (0.73-2.62)
Brain	8	6.2	1.30 (0.56-2.56)
All sites	166	144.3	1.15 (0.98-1.34)

Note: Statistically significant SIRs at 95% confidence level are denoted with bold.

males and 166 in females were observed in the cohort during the follow-up. More than half, 57% (N = 4168) of the cases were from Sweden, 23% (N = 1656) from Finland, 20% (N = 1462) from Norway and 1% (N = 61) from Iceland.

Table 1, A and B present the observed and expected numbers of cancers and SIRs for male and female police officers. The SIR for all cancer sites combined among male police officers was 1.07 (95% CI: 1.04-1.09) and among female police officers 1.15 (95% CI: 0.98-1.34) (Table 1, A and B). The highest site-specific SIR among male police officers was observed for follicular thyroid cancer (SIR 2.75, 95% CI: 1.32-5.05). Elevated cancer risks were also seen for male breast cancer (SIR 1.77, 95% CI: 1.05-2.80), cancer of the soft tissue (SIR 1.48, 95% CI: 1.13-1.90 overall, SIR 2.59, 95% CI: 1.58-4.00 for liposarcoma), skin melanoma (SIR 1.44, 95% CI: 1.28-1.60), nonmelanoma skin cancer (SIR 1.33, 95% CI: 1.19-1.47) and cancers of the colon (SIR 1.22, 95% CI: 1.12-1.32), kidney (SIR 1.22, 95% CI: 1.08-1.36), prostate (SIR 1.19, 95% CI: 1.14-1.25) and brain (SIR 1.16, 95% CI: 1.01-1.33), as well as for leukemia (SIR 1.16, 95% CI: 1.00-1.34) and cancer of the rectum (SIR 1.12, 95% CI: 1.01-1.24). Lower incidence than expected was observed for cancers of the esophagus (SIR 0.57, 95 CI: 0.42-0.76), pharynx (SIR 0.59, 95% CI: 0.39-0.85 overall, SIR

TABLE 2 Standardized incidence ratios (SIR) among male (A) and female (B) police officers by country, follow-up 1961 to 2005, for cancer sites with at least 10 (males) or five (females) cases in total

	Finland			Iceland			Norway			Sweden		
Cancer site	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)
A. Males												
Lip	8	19.0	**0.42 (0.18-0.83)**	0	0.4	0 (0-10.33)	11	13.6	0.81 (0.40-1.45)	17	26.3	0.65 (0.38-1.03)
Tongue	2	6.6	0.31 (0.04-1.10)	0	0.2	0 (0-18.35)	3	5.9	0.51 (0.11-1.50)	14	14.1	1.00 (0.54-1.67)
Salivary glands	1	3.8	0.27 (0.01-1.48)	0	0.2	0 (0-24.05)	2	2.7	0.76 (0.09-2.73)	9	9.2	0.98 (0.45-1.86)
Oral cavity	2	6.6	0.30 (0.04-1.09)	0	0.3	0 (0-12.78)	6	8.3	0.72 (0.27-1,58)	17	19.4	0.87 (0.51-1.40)
Pharynx	2	8.2	**0.25 (0.03-0.89)**	0	0.3	0 (0-11.17)	2	9.5	**0.21 (0.03-0.76)**	24	29.7	0.81 (0.52-1.20)
Esophagus	7	19.1	**0.37 (0.15-0.76)**	0	1.2	0 (0-3.12)	11	16.0	0.69 (0.34-1.23)	30	47.3	**0.63 (0.43-0.90)**
Adenocarcinoma	5	4.6	1.09 (0.35-2.53)	0	0.5	0 (0-7.87)	4	3.6	1.10 (0.30-2.82)	12	14.6	0.82 (0.42-1.44)
Stomach	72	86.1	0.84 (0.65-1.05)	3	3.5	0.86 (0.18-2.50)	62	84.6	**0.73 (0.56-0.94)**	139	160.3	0.87 (0.73-1.02)
Cardia	12	15.3	0.78 (0.40-1.37)	1	0.7	1.49 (0.04-8.30)	10	15.2	0.66 (0.32-1.21)	25	25.3	0.99 (0.64-1.46)
Small intestine	6	5.6	1.06 (0.39-2.31)	0	0.4	0 (0-9.21)	6	4.8	1.24 (0.45-2.70)	22	20.3	1.08 (0.68-1.64)
Colon	93	77.3	1.20 (0.97-1.47)	7	5.0	1.41 (0.56-2.90)	115	126.1	0.91 (0.75-1.09)	351	257.3	**1.36 (1.23-1.52)**
Rectum, rectosigma	71	62.5	1.14 (0.89-1.43)	2	1.8	1.13 (0.14-4.07)	90	76.1	1.18 (0.95-1.45)	197	181.3	1.09 (0.94-1.25)
Primary liver	23	22.6	1.02 (0.64-1.52)	0	0.6	0 (0-6.66)	8	9.4	0.86 (0.37–1.69)	54	45.1	1.20 (0.90-1.56)
Gallbladder	9	11.9	0.75 (0.34-1.43)	0	0.3	0 (0-12.21)	7	6.8	1.03 (0.41-2.12)	22	15.6	1.41 (0.89-2.14)
Pancreas	62	55.5	1.12 (0.86-1.43)	3	1.9	1.62 (0.33-4.75)	46	45.1	1.02 (0.75-1.36)	114	101.0	1.13 (0.93-1.36)
Nose	3	3.33	0.90 (0.19-2.63)	0	0.2	0 (0-20.66)	4	3.6	1.10 (0.30–2.82)	3	7.8	0.39 (0.08-1.13)
Larynx	15	21.3	0.71 (0.39-1.16)	0	0.8	0 (0-4.92)	17	17.3	0.98 (0.57-1.57)	35	35.6	0.98 (0.68-1.37)
Lung	196	314.2	**0.62 (0.54-0.72)**	5	8.3	0.60 (0.19-1.40)	143	185.8	**0.77 (0.65-0.91)**	265	343.0	**0.77 (0.68-0.87)**
Adenocarcinoma	29	43.5	**0.67 (0.45-0.96)**	1	2.4	0.42 (0.01-2.31)	32	35.7	0.90 (0.61-1.26)	56	74.5	**0.75 (0.57-0.98)**
Small cell	37	49.6	0.75 (0.53-1.03)	2	1.7	1.21 (0.15-4.37)	23	32.2	0.71 (0.45-1.07)	34	37.6	0.90 (0.63-1.26)
Squamous cell	60	99.6	**0.60 (0.46-0.78)**	1	2.0	0.51 (0.01-2.86)	44	58.1	0.76 (0.55-1.02)	81	118.4	**0.68 (0.54-0.85)**
Other	70	121.6	**0.58 (0.45-0.73)**	1	2.1	0.47 (0.01-2.62)	34	44.7	0.76 (0.53-1.06)	94	112.6	0.84 (0.67-1.02)
Mesothelioma	4	6.9	0.58 (0.16-1.48)	0	0.2	0 (0-18.37)	2	5.5	0.36 (0.04-1.31)	15	15.6	0.96 (0.54-1.58)
Breast	2	1.9	1.08 (0.13-3.90)	1	0.2	4.27 (0.11-23.78)	7	2.0	**3.56 (1.43-7.33)**	8	6.1	1.31 (0.57-2.58)
Prostate	469	370.0	**1.27 (1.16–1.39)**	16	17.0	0.94 (0.54–1.53)	356	307.9	**1.16 (1.04-1.28)**	1179	1000.7	**1.18 (1.11–1.25)**
Testis	5	5.3	0.94 (0.31-2.20)	2	0.7	2.80 (0.34-10.12)	11	9.7	1.14 (0.57-2.03)	31	22.5	1.38 (0.93-1.95)
Seminoma	5	3.6	1.37 (0.45-3.21)	2	0.5	3.81 (0.46-13.75)	6	6.7	0.89 (0.33-1.94)	25	16.2	**1.55 (1.00-2.29)**
Nonseminoma	0	1.6	0 (0-2.31)	0	0.2	0 (0-19.57)	5	2.2	2.30 (0.75-5.36)	6	6.4	0.94 (0.35-2.05)
Penis	1	2.8	0.36 (0.01-2.02)	0	0.2	0 (0-15.76)	4	4.5	0.88 (0.24-2.26)	8	12.7	0.63 (0.27-1.24)
Kidney	79	61.8	**1.28 (1.01-1.59)**	3	3.3	0.92 (0.19-2.69)	54	46.8	1.15 (0.87-1.50)	161	132.3	**1.22 (1.04-1.42)**

(Continues)

TABLE 2 (Continued)

	Finland			Iceland			Norway			Sweden		
Cancer site	**Obs**	**Exp**	**SIR (95% CI)**	**Obs**	**Exp**	**SIR (95% CI)**	**Obs**	**Exp**	**SIR (95% CI)**	**Obs**	**Exp**	**SIR (95% CI)**
Renal pelvis	4	3.8	1.06 (0.29-2.71)	0	0.2	0 (0-20.87)	3	5.5	0.55 (0.11-1.59)	17	13.7	1.24 (0.72-1.99)
Bladder	107	85.7	**1.25 (1.02–1.51)**	3	4.8	0.63 (0.13-1.83)	103	109.8	0.94 (0.77-1.14)	282	261.5	1.08 (0.96-1.21)
Skin melanoma	52	43.5	1.20 (0.89-1.57)	1	1.4	0.70 (0.02-3.90)	73	49.2	**1.48 (1.16-1.87)**	194	128.9	**1.51 (1.30-1.73)**
Eye	7	4.0	1.75 (0.70-3.60)	0	0.1	0 (0-26.55)	2	3.9	0.51 (0.06-1.84)	5	10.7	0.47 (0.15-1.09)
Eye melanoma	6	3.6	1.67 (0.61-3.63)	0	0.1	0 (0-33.90)	1	3.4	0.29 (0.01-1.62)	3	8.3	0.36 (0.07-1.05)
Brain	53	42.3	1.25 (0.94-1.64)	1	2.1	0.48 (0.01-2.69)	42	35.2	1.19 (0.86-1.61)	122	107.8	1.13 (0.94-1.35)
Glioma	22	19.4	1.13 (0.71-1.71)	0	1.3	0 (0-2.95)	26	18.0	1.44 (0.94-2.11)	62	55.5	1.12 (0.86–1.43)
Meningeoma	8	8.7	0.92 (0.40-1.80)	1	0.5	1.98 (0.05-11.02)	6	5.9	1.01 (0.37-2.21)	26	21.8	1.19 (0.78-1.75)
Thyroid	13	9.9	1.32 (0.70-2.25)	3	1.2	2.60 (0.54-7.61)	5	6.3	0.79 (0.26-1.85)	24	17.0	1.41 (0.91-2.10)
Follicular	6	1.6	**3.66 (1.34-7.96)**	1	0.2	6.05 (0.15-33.72)	0	0.8	0 (0-4.72)	3	1.1	2.85 (0.59-8.32)
Papillary	5	6.1	0.83 (0.27-1.93)	2	0.9	2.32 (0.28-8.39)	5	3.4	1.46 (0.47-3.41)	5	3.2	1.59 (0.51-3.70)
Bone	1	2.7	0.37 (0.01-2.07)	1	0.2	5.71 (0.14-31.82)	4	1.9	2.16 (0.59-5.54)	8	5.8	1.38 (0,60-2.72)
Soft tissue	15	9.6	1.56 (0.87-2.57)	1	0.4	2.74 (0.07-15.27)	8	5.6	1.44 (0.62-2.84)	38	26.4	**1.44 (1.02-1.98)**
Liposarcoma	5	2.1	2.36 (0.77-5.52)	1	0.1	7.77 (0.20-43.32)	4	0.9	**4.28 (1.17-10.95)**	10	4.5	**2.20 (1.06-4.05)**
Non-Hodgkin lymphoma	54	55.4	0.98 (0.73-1.27)	2	2.2	0.90 (0.11-3.25)	38	33.2	1.14 (0.81-1.57)	124	119.9	1.03 (0.86-1.23)
Hodgkin lymphoma	9	8.1	1.11 (0.51-2.11)	0	0.3	0 (0-13.05)	6	5.8	1.03 (0.38-2.25)	18	18.0	1.00 (0.59-1.58)
Multiple myeloma	23	19.6	1.17 (0.74-1.76)	1	0.9	1.09 (0.03-6.06)	30	23.8	1.26 (0.85-1.80)	63	55.0	1.14 (0.88-1.46)
Leukemia	50	34.8	**1.43 (1.07–1.89)**	0	1.6	0 (0–2.25)	33	33.1	1.00 (0.69-1.40)	100	88.2	1.13 (0.92-1.38)
Chronic lymphatic	18	15.0	1.20 (0.71-1.90)	0	0.5	0 (0-6.80)	17	12.2	1.39 (0.81-2.23)	43	41.4	1.04 (0.75-1.40)
Acute myeloid	12	9.7	1.24 (0.64-2.17)	0	0.5	0 (0-6.84)	7	11.9	0.59 (0.24-1.22)	24	20.5	1.17 (0.75-1.74)
Mycosis fungoides	1	1.4	0.69 (0.02-3.86)	0	0.1	0 (0-38.41)	1	0.9	1.06 (0.03-5.88)	8	6.4	1.26 (0.54-2.47)
Nonmelanoma skin	59	45.1	**1.31 (0.99-1.69)**	4	1.8	2.18 (0.59-5.59)	77	62.8	1.23 (0.97-1.53)	220	161.8	**1.36 (1.19-1.55)**
Other/unknown site	29	31.3	0.93 (0.62-1.33)	2	1.3	1.60 (0.19-5.77)	35	49.5	**0.71 (0.49-0.98)**	104	113.2	0.92 (0.75-1.11)
All sites	1563	1532.3	1.03 (0.98-1.08)	57	63.8	0.93 (0.71-1.19)	1359	1362.1	1.01 (0.96-1.06)	3807	3464.9	**1.11 (1.08-1.15)**
B. Females												
Colon	2	0.7	2.72 (0.33-9.81)	0	0.1	0 (0-52.85)	0	1.8	0 (0-2.11)	7	4.9	1.44 (0.58-2.96)
Breast	14	6.6	**2.11 (1.15–3.54)**	0	0.5	0 (0-8.28)	7	4.5	1.57 (0.63-3.23)	45	41.3	1.09 (0.79-1.46)
Ductal	10	5.1	1.98 (0.95-3.64)	0	0.4	0 (0-10.46)	4	3.0	1.34 (0.37-3.43)	16	20.4	0.79 (0.45-1.28)
Lobular	1	0.9	1.08 (0.03-6.02)	0	0.0	0 (0-106.80)	2	0.3	7.05 (0.85-25.47)	7	4.0	1.76 (0.71-3.63)
Cervix uteri	1	0.3	3.02 (0.08-16.83)	0	0.1	0 (0-63.39)	3	0.8	3.76 (0.78-11.00)	7	5.0	1.40 (0.56-2.89)
Corpus uteri	1	0.9	1.17 (0.03-6.51)	0	0.1	0 (0-62.97)	0	1.0	0 (0-3.85)	6	4.9	1.23 (0.45-2.67)
Ovary	1	0.8	1.34 (0.03-7.45)	0	0.1	0 (0-69.79)	0	1.0	0 (0-3.72)	7	7.6	0.93 (0.37-1.91)

TABLE 2 (Continued)

Cancer site	Finland			Iceland			Norway			Sweden		
	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)	Obs	Exp	SIR (95% CI)
Kidney	1	0.4	2.80 (0.07-15.59)	0	0.0	0 (0-102.53)	2	0.4	5.29 (0.64-19.10)	3	1.7	1.81 (0.37-5.28)
Skin melanoma	0	0.5	0 (0-6.82)	0	0.1	0 (0-71.82)	3	0.8	3.96 (0.82-11.57)	8	6.2	1.30 (0.56–2.56)
Brain	2	0.8	2.56 (0.31-9.25)	0	0.1	0 (0-69.98)	0	0.5	0 (0-6.93)	6	4.8	1.25 (0.46-2.73)
All sites	31	16.0	**1.89 (1.29–2.69)**	0	1.4	0 (0.67-2.72)	19	17.2	1.07 (0.64-1.67)	115	106.6	1.07 (0.88-1.28)

Note: Statistically significant SIRs at 95% confidence level are denoted with bold.

0.45, 95% CI: 0.20-0.85 for oropharynx), lip (SIR 0.61, 95% CI: 0.43-0.84), lung (SIR 0.72, 95% CI: 0.66-0.77) and stomach (SIR 0.83, 95% CI: 0.73-0.93).

In female police officers, none of the site-specific SIRs reached statistical significance, when considering all four countries together, but as in the male police officers, there were more cases than expected for skin melanoma and cancers of the breast, kidney, brain and colon (Table 1B).

When inspecting the results by country, excess of prostate cancer was observed in Finland (SIR 1.27, 95% CI: 1.16-1.39), Sweden (SIR 1.18, 95% CI: 1.11-1.25) and Norway (1.16, 95% CI: 1.04-1.28), but not in Iceland (SIR 0.94, 95% CI: 0.54-1.53, Table 2A). Number of observed cases were consistently higher than expected in all countries for liposarcoma (SIRs ranging between 2.20 and 7.77), male breast cancer (SIRs ranging between 1.08 and 4.27) and nonmelanoma skin cancer (SIRs ranging between 1.23 and 2.18). SIRs for colon cancer and follicular thyroid cancer were elevated in all countries except Norway.

SIR for leukemia in Finland was 1.43 (95% CI: 1.07-1.89), and in other countries between zero and SIR 1.13 (95% CI: 0.92-1.38). SIR for bladder cancer was also highest in Finland (SIR 1.25, 95% CI: 1.02-1.51), SIRs in other countries ranging between 0.63 and 1.08. The observed overall lower than expected number of lip cancer in male police officers (SIR 0.61, 95% CI: 0.43-0.84) was mainly driven by the deficit of cases in Finland, while the overall lower than expected risk of stomach cancer (SIR 0.83, 95% CI: 0.73-0.93) was due to significantly decreased number of stomach cancer cases in Norway. In males, the risk of lung cancer was decreased in all countries, with SIRs ranging between 0.60 and 0.77. In females (Table 2B), the overall cancer risk was increased only in Finland (SIR 1.89, 95% CI: 1.29-2.69). Cancer-specifically, the only statistically significant excess was observed for breast cancer in Finland (SIR 2.11, 95% CI: 1.15-3.54).

In male police officers, the overall cancer risk was 1.03 (95% CI: 0.94-1.11) for the period 1961 to 1975, 1.05 (95% CI: 1.01-1.09) for 1976 to 1990 and 1.08 (95% CI: 1.05-1.12) for 1991-2005 (Figure 1 and Supplementary Table 1). The SIR for kidney cancer was highest during the period 1961 to 1975 (SIR 1.46, 95% CI: 1.05-1.97) and the excess diminished over time. SIRs for colon cancer, skin melanoma, and nonmelanoma skin cancer were higher in the later periods. Excess risk of prostate cancer ranged between 13% and 21% over the periods, being the highest in 1991 to 2005 (SIR 1.21, 95% CI: 1.15-1.28). Excess of cancers of the pancreas, testis, brain, follicular thyroid and liposarcoma of the soft tissue was only observed during the latest period, 1991 to 2005. Lower than expected incidence was seen for cancers of the lip and esophagus in 1976 to 2005 and of penile cancer in 1991 to 2005. SIRs for lung cancer in males remained below 1.0 throughout the study periods.

Overall cancer risk increased with time also in female police officers, with SIR 0.60 (95% CI: 0.16-1.56) observed for 1961 to 1975, SIR 1.03 (95% CI: 0.68-1.49) for 1976 to 1990 and SIR 1.21 (95% CI: 1.02-1.44) for 1991 to 2005 (Figure 2 and Supplementary Table 2). In period-stratified analysis, the only statistically significant site-specific excess was observed for cervical cancer in 1991 to 2005 (SIR 2.51, 95% CI: 1.20-4.61).

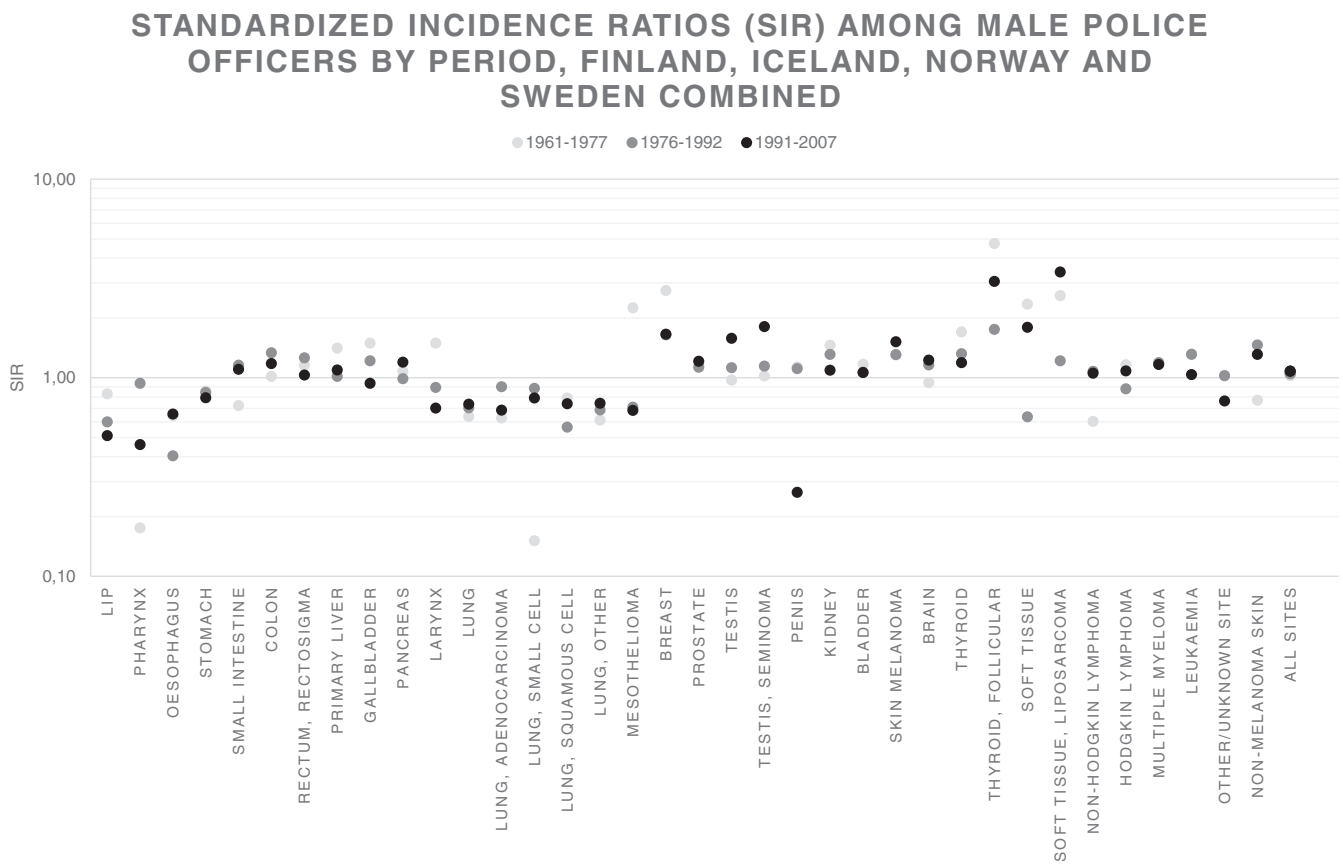


FIGURE 1 Standardized incidence ratios (SIR) among male police officers by period, Finland, Iceland, Norway and Sweden combined. SIRs are presented on a log scale

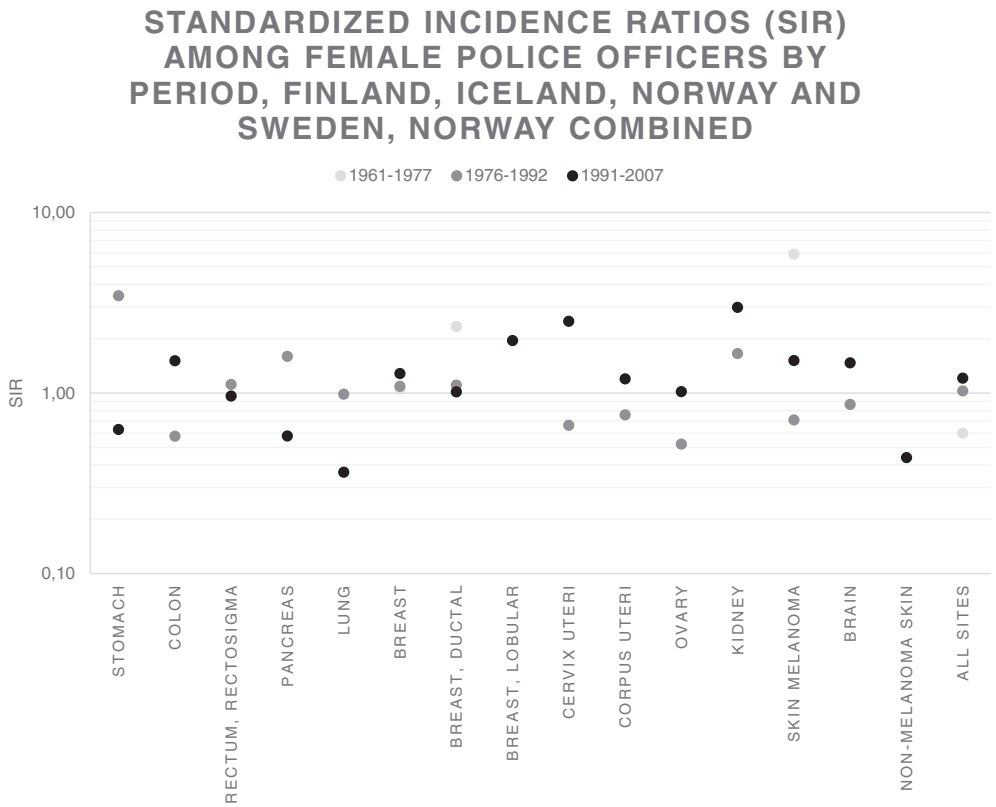


FIGURE 2 Standardized incidence ratios (SIR) among female police officers by period, Finland, Iceland, Norway and Sweden combined. SIRs are presented on a log scale. Zero-values are omitted

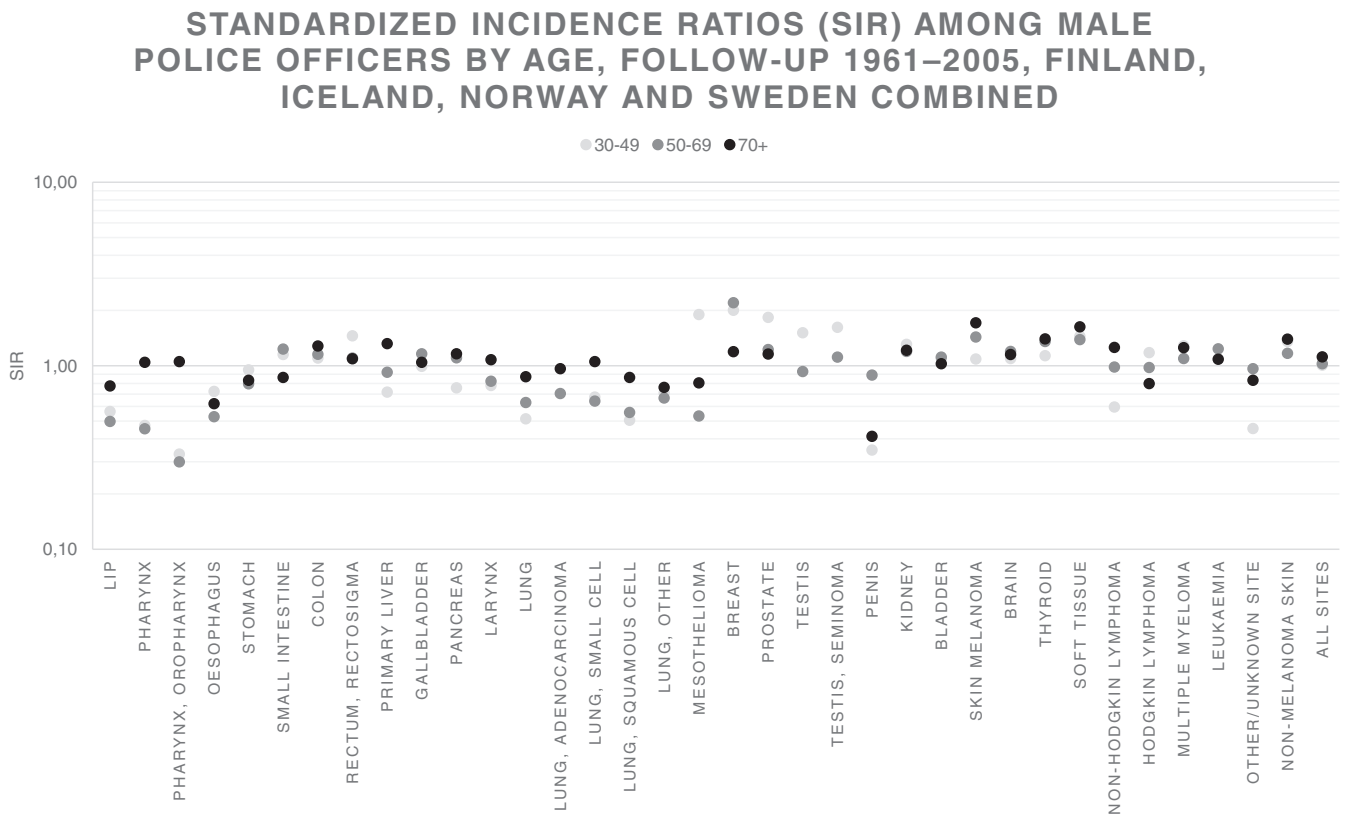
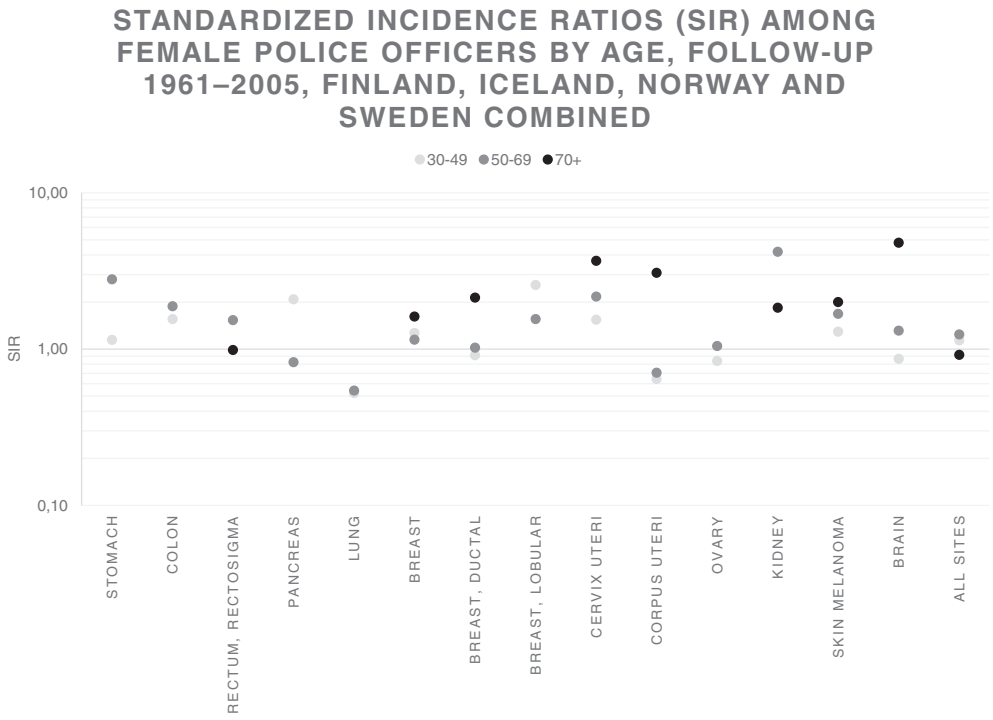


FIGURE 3 Standardized incidence ratios (SIR) among male police officers by age, follow-up 1961 to 2005, Finland, Iceland, Norway and Sweden combined. SIRs are presented on a log scale. Zero-values are omitted

FIGURE 4 Standardized incidence ratios (SIR) among female police officers by age, follow-up 1961 to 2005, Finland, Iceland, Norway and Sweden combined. SIRs are presented on a log scale. Zero-values are omitted



In male police officers, there were more prostate cancers than expected in all three age groups, the SIR being highest in the youngest ages (30-49 years, SIR 1.84, 95% CI: 1.07-2.94) and lowest in the oldest ages (70+ years, SIR 1.16, 95% CI: 1.09-1.23) (Figure 3 and Supplementary Table 3). In the youngest age group (30-49 years), the SIR for testicular cancer was also increased (SIR 1.52, 95% CI:

1.08-2.07). The SIRs for colon cancer and skin melanoma were most elevated in the oldest age group (70+ years), being 1.28 (95% CI: 1.14-1.44) for colon cancer and 1.72 (95% CI: 1.40-2.08) for skin melanoma. Also, elevated SIRs for non-Hodgkin lymphoma, cancer of the soft tissue and nonmelanoma skin cancer were observed only in the oldest age group (70+ years).

There were fewer cases of lung cancer than expected in all age groups in males, with SIR 0.51 (95% CI: 0.32-0.78) for police officers aged 30 to 49 years, 0.63 (95% CI: 0.56-0.71) for age group 50 to 69 years and 0.87 (95% CI: 0.77-0.98) for age 70+ years. There was a deficit of non-Hodgkin lymphoma in males aged 30 to 49 years, SIR 0.60 (95% CI: 0.35-0.96). In female police officers, the only statistically significant increased age-specific SIR was observed in kidney cancer, 4.21 (95% CI: 1.37-9.82) in the age group 50 to 69 years (Figure 4 and Supplementary Table 4).

4 | DISCUSSION

Overall, we observed a 7% excess cancer risk in male police officers, compared with the general population. SIRs were elevated for various cancer sites, with most of the excess cases observed in prostate cancer. Increased risks in male police officers were also seen for cancers of the colon, rectum, breast, kidney, brain, thyroid and soft tissue, as well as for leukemia, skin melanoma and nonmelanoma skin cancer. Risk of lung cancer was significantly decreased across all studied calendar periods and age groups in males. In female police officers we observed small, not statistically significant, excesses of breast and colon cancer.

Increased incidence of prostate cancer among male police officers was the most consistent observation in this study, being elevated across countries, periods, and age groups. The highest relative excess in prostate cancer was noted in males under 50 years of age, though the number of excess cases was larger in the older age groups. The excess of prostate cancer cases among 30 to 49-year-old males was 84% (8 excess cases), 23% (163 excess cases) in age group 50 to 69 years and 16% (154 excess cases) in males aged 70 or over. Overall, our finding agrees with previous studies on prostate cancer among police officers.[15,16,18,19] Our SIR 1.19 (95% CI: 1.14-1.25) is of the same order of magnitude as the relative risk observed in a systematic review of 12 police studies by Sritharan et al (1.14, 95% CI: 1.02-1.28) and in a large Canadian census cohort study by Harris et al (1.28, 95% CI: 1.14-1.42).[15,18] Sauve et al found an odds ratio of 1.8 (95% CI: 1.1-2.9) for prostate cancer in police officers and detectives.[19] Zeegers et al reported a relative risk of 1.62 (99% CI: 0.62-4.27) for those who had ever worked as a police officer and as high as 3.91 (99% CI: 1.14-13.42) for those who reported working as a policeman for most of their occupational life.[16] Studies of firefighters have also consistently found an increased risk of prostate cancer.[17,18,31] Police officers and firefighters have certain similarities in their work, including working in shifts and at times in stressful situations, and a requirement of a good physical fitness. Potential occupational causes of prostate cancer are poorly understood, but The International Agency for Research on Cancer (IARC) has classified night shift work as one possible cause.[1] Traffic-related air pollution has also been speculated to play a role in the etiology of prostate cancer.[32,33] The level of exposure to traffic-related air pollution among Nordic police officers is, however, unclear. The introduction of the prostate-specific antigen (PSA) test in the 1990s led to major increases in the incidence of prostate cancer, including younger age groups, through easier diagnosis of low-grade tumors.[34] However, the observed excess of prostate cancer in this study was relatively consistent across the three time periods, suggesting that temporal trends in PSA testing do not fully explain the findings. Police officers in many Nordic countries are subject to regular health check-ups and are likely to have good access to occupational health care. This probably leads to more frequent PSA testing compared with men in the general population and, subsequently, somewhat higher likelihood of diagnosis of nonsymptomatic prostate cancer. According to partly unpublished data from Norway, police officers were less often diagnosed with prostate cancers with distant metastases and also at a slightly younger age than the general population in 1960 to 2017 (mean age at diagnosis 70.2 vs 71.0 years), the difference being largest in the earliest inspection period 1960 to 1993 (mean age 71.0 vs 72.5 years).[35] These observations suggest that police officers are indeed subject to more frequent health check-ups.

We observed an elevated risk of male breast cancer in police officers in ages 30 to 49 years (SIR 2.01, 95% CI: 0.24-7.25) and 50 to 69 years (2.21, 95% CI: 1.10-3.95) and there was also an excess of breast cancer among female police officers (in Finland as high as SIR 2.11, 95% CI: 1.15-3.54). Forastiere et al reported a statistically significant 14-fold breast cancer mortality among Italian male police officers, however, based only on two cases.[26] Harris et al reported a hazard ratio (HR) of 2.96 (95% CI: 1.21-7.21) of breast cancer among male police officers in Canada, based on five observed cases.[15] To the best of our knowledge, there is no research on the association between police occupation and breast cancer in females. The IARC has classified night shift work as a possible cause of breast cancer, although the human evidence was only based on studies of women.[1] Female breast cancer is also known to be associated with reproduction and other hormone-related factors, for example, older age at first birth and lower number of children increasing the risk.[36,37] It is possible that Nordic female police officers differ from the general population in terms of reproduction patterns, but unfortunately, we did not have such information available in this study. Alcohol consumption and higher body mass index (BMI) are also known to be associated with breast cancer.[7,38] We know some of the characteristics of Finnish police officers from surveys on the health habits of the Finnish adult population during 1995 to 2003 collected for the Finnish Job Exposure Matrix.[39] Proportion of male police officers who drank at least eight drinks weekly was 42% and of female police officers who drank at least five drinks weekly was 29%.[39] The corresponding proportion in the general population was 39% among males and 27% among females.[40] The patterns of alcohol consumption among police officers appear relatively similar to the general population and are thus not likely to majorly impact cancer incidence. Regarding BMI, 69% of Finnish male police officers and 37% of Finnish female police

officers had a BMI 25 kg/m^2 or higher.[39] The respective population rates were 52% in males and 36% in females.[40] However, the somewhat higher BMI among police officers than in the general population, are possibly at least partly due to muscular build, instead of body fat.

Our observation of SIR 1.22 (95% CI: 1.12-1.32) for colon cancer in male and 1.21 (95% CI: 0.55-2.30) in female police officers are in line with the HR of 1.18 (95% CI: 0.96-1.45) observed by Harris et al for colon cancer in police workers.[15] Violanti and Vena reported nearly a doubled risk of dying of colon cancer among police officers,[20-22] but there are also studies, which have found no relationship between police work and risk of colon cancer.[41] Earlier evidence of an association between working as a police officer and an increased risk of rectal cancer is even weaker. A systematic review by Wirth et al reported several increased, but not statistically significant risk estimates for rectal cancer among police officers.[41] Our observed SIR 1.12 (95% CI: 1.01-1.24) for rectal cancer in male police officers is concordant with many of the estimates presented in the review. Many lifestyle factors are related to increased risk of colon and rectal cancer, including alcohol consumption, processed meat consumption, low fiber intake, tobacco smoking and high BMI.[42] While the Finnish male police officers consumed slightly more alcohol than the Finnish general population and had on average higher BMIs, they smoked a little less (prevalence of daily smoking 26% among police officers vs 28% in the population).[39] Differences in alcohol consumption and tobacco smoking are small and considering that the higher BMIs are possibly resulting from muscular build, these factors are not likely to explain the observed increase in the risk of colon and rectal cancers in Finland (SIR for colon cancer 1.20, and for rectal cancer 1.14). An association between colon and rectal cancer and night shift work has been observed in several studies and the potential relationship has also been acknowledged in an IARC evaluation, the evidence, however, still judged as limited.[1] Continuous disruption of the circadian rhythm is nevertheless among the probable risk factors for cancers of the colon and rectum among Nordic police officers.[11] Also, it has been shown that shift work is associated with certain adverse lifestyle behaviors, such as poor nutritional habits.[43,44] This may in part contribute to the potential negative impact of shift work on cancer outcomes. Information on nutritional factors were unfortunately not available for this study. Furthermore, sedentary behavior has been linked to risks of colon and rectal cancers.[45] However, even if the police work itself is for the large part sedentary, it was shown in a Finnish report that police officers are more active during their leisure time than the general population.[11]

Our observation of a 44% to 47% excess risk of skin melanoma (in both sexes) is in line with the estimates reported by Harris et al (HR 1.69, 95% CI: 1.32-2.16)[15] and Finkelstein (SIR 1.45, 90% CI: 1.1-1.9).[24] The most common exposure associated with skin melanoma is intermittent solar UV radiation.[46] The observed excess risk of skin melanoma may be attributed to past intermittent exposure to UV radiation during sunny holidays abroad common among higher socioeconomic groups.[47] Due to the nature of shift work, police officers may also have more opportunities for travel and for spending time outdoors during sunlight hours. Some previous studies have also suggested an association between radar emissions and skin melanoma.[24,48] Risk of nonmelanoma skin cancer was also elevated among male police officers in this study (SIR 1.33, 95% CI 1.19-1.47) and its main risk factor is cumulative dose of UV radiation.[46]

We observed an SIR of 1.28 (95% CI: 0.95-1.70) for testicular cancer, which is in line with previous findings. Harris et al reported an elevated HR of 1.63 (95% CI: 0.99-2.69) for testicular cancer among policemen from a Canadian census cohort[15] and Finkelstein observed SIR of 1.3 (90% CI: 0.9-1.8) in a Canadian retrospective cohort study.[24] In our analyses, the risk was most elevated for seminoma-type testicular cancer (SIR 1.40, 95% CI: 0.99-1.93). The excess was stronger in the latest period (1991-2005, SIR 1.81, 95% CI: 1.12-2.77) and in the youngest age group (30-49 years, SIR 1.62, 95% CI: 1.09-2.33). Risk factors for testicular cancer include family history of testicular cancer and undescended testis[49] which are not related to police work. Exposure to radar emissions has been associated with potential impacts on the risk of testicular cancer.[3] However, exposure to radar emissions among police officers has been found to be very small and likely not to pose a threat to their health.[4,50]

Previous studies have been inconsistent regarding evidence on the relationship between the police occupation and tumors of the brain. Harris et al reported a decreased risk of brain cancer among Canadian police officers (HR 0.49, 95% CI: 0.26-0.95).[15] None of the studies reviewed by Wirth et al, however, showed statistically significant effects for brain cancer among police officers, in either direction.[41] Vena et al reported an elevated risk of dying from brain cancer among police officers during the 1960s (standardized mortality ratio, SMR 4.75, 95% CI: 1.53-11.09), but not in the later inspection periods stretching to 2005.[21] We observed a slightly increased incidence of brain cancer in male police officers (overall SIR 1.16, 95% CI: 1.01-1.33). The excess was highest in the latest period and in the age group 50 to 69 years, contrary to the finding of Vena et al.[21] Known risk factors for brain cancer are very few, namely X- and gamma radiation, certain hereditary syndromes and obesity.[51,52] Other possible lifestyle or occupational factors remain unknown.

As for soft tissue cancer, previous research has reported null associations with police occupation.[28,41] Our findings of a positive association between soft tissue cancer, especially liposarcoma and police occupation were rather consistent over several countries, periods, and age groups and hence may not be due to chance alone. In addition to some hereditary syndromes (eg, neurofibromatosis and Li-Fraumeni syndrome), known etiological factors underlying the risk of soft tissue cancers include exposures unrelated to occupation of a police officer, such as exposure to ionizing radiation and some chemicals, including dioxin and chlorophenols.[53-55] There is no evidence of lifestyle factors impacting the risk.

We also observed an increased SIR for follicular thyroid cancer, most notably in the latest time period. This is likely due to higher diagnostic intensity with more frequent health check-ups among police officers, compared with the general population. In Finland, occupational health care must be offered, by law, for all employees, regardless of the type or duration of the employment. In Norway certain industries, including police work, are required to have occupational health service.

The risk of kidney cancer was elevated in male police officers in the first two periods but not any more in 1991 to 2005 (SIR 1.09, 95% CI: 0.92-1.29). Excess was observed most notably in the age group 50 to 69 years, in both males (SIR 1.20, 95% CI: 1.02-1.40) and females (SIR 4.21, 95% CI: 1.37-9.82). Violanti et al observed an elevated mortality from kidney cancer among policemen (SMR 2.08, 95% CI: 1.00-3.82).[20] Apart from that, there is no previous evidence of the relationship between police occupation and kidney cancer. Known risk factors for kidney cancer include obesity and smoking, and hypertension has also been shown to increase the risk.[56] As we believe that the higher average BMIs among the police officers is more due to muscular build than fat, it is possible that hypertension contributes to the observed excess of kidney cancer cases. Hypertension has been shown to be relatively common among police officers.[57,58] However, due to regular health check-ups of the police officers, hypertension would likely to be diagnosed at early stages, hence not probably being the main cause of subsequent cancer.

In some earlier studies, cases of esophageal cancer have been found to be overrepresented among police officers.[20,21] In our analyses of male police officers, the number of esophageal cancers was lower than expected. Esophageal cancer is related to tobacco smoking, which is probably less common among the Nordic police officers compared with the general population as was shown to be the case for the Finnish police.[39] Same can be concluded from the decreased SIRs of lung cancer in all Nordic countries, there was a deficit of lung cancers among both female and male police officers in our data.

This study was based on a large cohort with nationwide data and a long follow-up period, thus enabling the identification of excesses even for relatively rare cancers. The study had access to high quality population-based cancer registry data from across the Nordic countries, which rank very high in international comparison, in terms of completeness and accuracy.[30] The cancer registry data allowed identification of nonfatal cancers and enabled examination of histologic subtypes of cancer. Owing to the high coverage and validity of the data sets utilized in the study, we consider the cancer risk estimates reliable. Also, as we examine incident cancer cases and not cancer deaths, there is no bias due to occupational variation in cancer patient survival nor due to mortality from competing causes of death.

This study also has several limitations. The occupational affiliation at one point in time may not always correspond to the lifelong occupational history of a person. However, comparison of results from studies with a single cross-sectional information on occupation and from studies with complete occupational histories, suggests that the diluting effect due to misclassification of occupations is small.[29] It is also known from a study comparing censuses 1980 and 1985 in Finland that the occupational stability among policemen was exceptionally high (96-97%).[59] We were also not able to adjust for general lifestyle or directly occupation-related factors. Police officers are likely to be a selected group of people with respect to general health conditions. Comparing a generally healthier group of individuals to the general population may lead to underestimation of cancer risks.[60] Also, police officers are often subject to regular health checks, which may in turn bias the observed incidence upwards in certain cancers. In particular, we cannot rule out the fact that the findings on prostate cancer may mostly be due to surveillance bias, resulting from frequent PSA testing.

5 | CONCLUSION

In conclusion, this study suggests that especially male police officers have been at increased risk of several cancers, and it strengthens the evidence on the elevated risk of cancers potentially related to night shift work, namely colon, breast, and prostate cancer. Considering the assumed, and in part evidenced better physical health of police officers,[11] it would have been expected that the overall risk of some cancer types, such as cancers of the colon and breast would have been lower than in the general population, but the opposite was observed. It is possible that more active diagnostics explain part of the observed excess, but night shift work and related disruption of circadian rhythm and possible adverse dietary habits may as well play a role in it. Further studies with more individual-level information on other potential risk factors for colon, breast and prostate cancer are needed to better untangle the etiology of these cancers among police officers.

AUTHOR CONTRIBUTIONS

Eero Pukkala, Kristina Kjaerheim, Johnni Hansen, Elisabete Weiderpass and Elsebeth Lynge contributed to material preparation and data acquisition. Data analysis was performed by Jan Ivar Martinsen. Sanna Heikkinen and Eero Pukkala prepared the first draft of the manuscript. All authors interpreted the data, critically revised the manuscript, and approved of the final version to be published. The work reported in the paper has been performed by the authors, unless clearly specified in the text.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

This study was based on population-based register data from the Nordic Occupational Cancer Study (NOCCA, http://astra.cancer.fi/NOCCA) database. All data relevant to the study are included in the article or uploaded as supplementary information. The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The investigation did not involve any human contact, but only record linkage analysis. The NOCCA Study was approved according to the rules and regulations of each participating country.[29]

DISCLAIMER

Where authors are identified as personnel of the International Agency for Research on Cancer/World Health Organization, the authors alone

are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy, or views of the International Agency for Research on Cancer/World Health Organization.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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