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Original Article

The Cancer Risk among Physicians in Taiwan, a Population-Based Propensity Score Matched Cohort Study

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Abstract

Background: The field of physician health is gaining increasing attention; however, most research and interventions have concentrated on factors such as job stress, mental health, and substance abuse. The risks of major cancers in physicians remain unclear. We used a propensity score-matched analysis to investigate the risk of cancer in physicians relative to the general population who had no healthcare-related professional background.

Methods: Data were obtained from the National Health Insurance system in Taiwan. The physician cohort contained 29,713 physicians, and each physician was propensity score-matched with a person from the general population.

Results: The physicians demonstrated a 0.90-fold lower risk of all-cancers (95% confidence interval [CI] = 0.83 – 0.96) when compared with the general population. Female physicians had a higher risk of cancer than male physicians (adjusted hazard ratio [HR] = 1.59; 95% CI = 1.28 – 1.96). Physicians had higher risks of prostate (HR = 1.26; 95% CI = 1.00 – 1.59) and thyroid cancers (HR = 3.16; 95% CI = 1.69 – 5.90) when compared with the general population.

Conclusion: Physicians have lower rates of overall cancer risk than the general population. Female physicians have higher cancer risks than male physicians. Male physicians have higher risks of thyroid and prostate cancer relative to the general population.

Keywords: Cancer risk; Cohort study; Gender; Physicians; Propensity score matching

Introduction

The risk of cancer in physicians is an undetermined topic. Physicians experience higher levels of occupational stress and more radiation exposure than the general population, which might contribute to a higher risk of cancer (1). Physicians, despite their medical training, tend to neglect their own health (2). When sick, they prefer self-care without pursuing formal medical help (2, 3). However, physicians have a better socioeconomic status than the general population in most countries, including Taiwan. They have better access to health services and superior medical knowledge, which might aid them in practicing a healthy lifestyle, thereby reducing the risks of some major diseases, including cancer.

Physicians had a lower overall cancer risk, except for prostate and breast cancer, than the general population (4, 5). Lee et al reported significantly higher risks for prostate and breast cancer (out of seven specific cancer types) in male and female doctors, respectively, when compared with non-medical staff (4). Of the 17 specific cancer types included in another study, male physicians were reported to have higher risks of prostate and thyroid cancer, whereas female physicians had higher risks of breast and uterine cancers when compared with non-physicians (5). Nevertheless, the risks of cancer in physicians remain unclear.
Herein, we conducted a population-based cohort analysis using propensity score matching analysis to investigate cancer risk in physicians relative to the general population, who did not have professional backgrounds in fields related to health care.

Materials and Methods

Data Sources

This retrospective population-based cohort study used the Longitudinal Health Insurance Database 2000 (LHID 2000) released by the Taiwan National Health Research Institutes (NHRI) for research purposes (6). We also used the Registry for Catastrophic Illness Patient Database (RCIPD), which was used in this study to select patients with confirmed cancer diagnoses. This study was reviewed and approved by the Institutional Review Board of the Ditmanson Medical Foundation Chia-Yi Christian Hospital, Taiwan (CYCH-IRB 101042).

Study participants

Figure 1 presents a flow chart of the process used to select the study population. All practicing doctors in 2000 above 25 yr of age were included in this study. The exclusion criteria were as follows: comorbidities with very high cancer risk, including AIDS or organ transplants; previous cancer history; and age greater than100 yr. The comparison group comprised people selected from LHID2000, who were registered in the NHI in 2000 and had no professional health care backgrounds. The comparison group was selected at a 1:1 ratio matched by the propensity scores estimated for age, sex, urbanization of residence area, and severity of comorbidity using the Charlson Comorbidity Index (CCI).

Definition of characteristics

The residential areas of the patients were classified into seven levels of urbanization, according to the method developed by Liu et al (7) .Modified CCI was used to classify the severity of the comorbidity, and the scores were sub-grouped as follows: 0, 1–3, 4–6, 7–9, and ≥10, wherein higher scores denoted greater comorbidity (8).

Outcome measures

The confirmation of malignant cancer (ICD-9-CM code 140–195 and 200–208) events was based on the RCIPD. The physicians and the general population were followed up until the development of the first malignancy, death, or the end of the year in 2010, whichever came first. We excluded patients who had any type of cancer before the index date. The cancers were divided into the following 16 groups: colorectal, hepatoma, lung, prostate, breast, oral and hypopharyngeal, stomach, cervical, uterus, skin, esophageal, bladder, nasopharyngeal, thyro-glandular, ovarian, and other cancers.

Statistical analysis

Chi-square and independent *t*-tests were used to evaluate the distributions of categorical and continuous variables, respectively, between the physician group and the general population. The propensity score for the likelihood of the physician group was calculated by multivariate logistic regression analysis, conditional on the baseline covariates. The incidence rates of all cancers and subdivisions of cancer between the two groups were calculated by Poisson's distribution. The risks of all cancers or subdivisions of cancer in the physician group, when compared with the general population, were calculated using the hazard ratio (HR) in a multivariate Cox regression model adjusted for clinical or significant confounders. A subgroup analysis of gender was also performed using a Cox regression model to examine its impact on the risk of cancer. All statistical analyses were performed using SPSS for Windows, version 21.0 (IBM Corp., Armonk, NY, USA), and a *P*value ≤0.05 was considered statistically significant.

Results

Table 1 shows the baseline characteristics of the general population and the physician group. The average age, sex distribution, and proportions of participants with residence and CCI were similar in both cohorts. Most physicians were males (89.22%). The mean age of the physicians was 45.25 ± 14.39 yr.

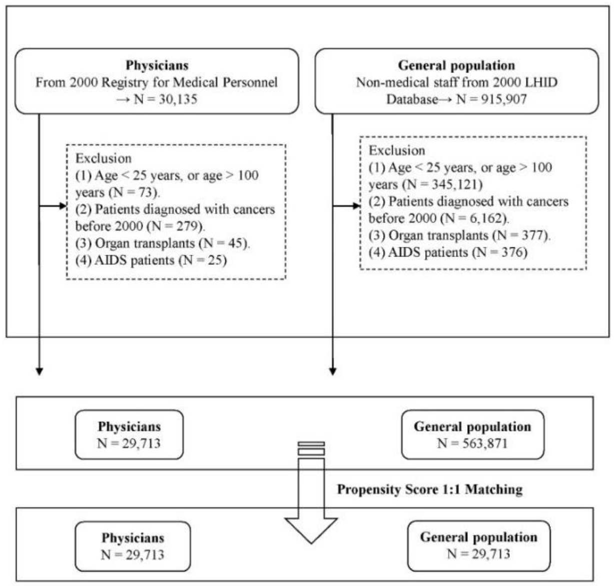

Fig. 1: Flow diagram of the present study

Table 1: Baseline characteristics of general population and physician

Variable	*Propensity score-matched*	
	General population N = 29,713	*Physician N = 29,713*
Sex		
Female	3203 (10.78)	3203 (10.78)
Male	26510 (89.22)	26510 (89.22)
Age (Mean ± SD)	45.14 ± 14.63	45.25 ± 14.39
≦ 34	7772 (26.16)	7772 (26.16)
35 - 44	10110 (34.03)	10110 (34.03)
45 - 54	5815 (19.57)	5815 (19.57)
55 - 64	2133 (7.18)	2133 (7.18)
65 - 74	2085 (7.02)	2085 (7.02)
≧ 75	1798 (6.05)	1798 (6.05)
Residence, level of urbanization		
Level 1	11936 (40.17)	11936 (40.17)
Level 2 & 3	13578 (45.7)	13578 (45.7)
Level 4 & 5	3187 (10.73)	3187 (10.73)
Level 6 & 7	1012 (3.41)	1012 (3.41)
CCI*		
0	10265 (34.55)	10265 (34.55)
1 - 3	10992 (36.99)	10992 (36.99)
4 - 6	5494 (18.49)	5494 (18.49)
7 - 9	2091 (7.04)	2091 (7.04)
≧ 10	871 (2.93)	871 (2.93)

*CCI = Charlson comorbidity index

After adjustment for the matching variables, the physician group had a 0.90-fold lower all-cancer risk (95% CI = 0.83 – 0.96) when compared with the general population (Table 2).
Female physicians had a higher risk of cancer than the male physicians had (adj. HR = 1.59; 95% CI = 1.28 – 1.96; Table 3). Table 4 shows the risks of specific cancer types for physicians and the general population. Relative to the general population, physicians had significantly higher risks of prostate and thyroid cancer respectively.

Table 2: Hazard ratios and confidence intervals (CI) estimated from the Cox regression model of the all-cancer risk of physician and general population

Variable	*Cancer* *NO*	*Yes*	*P-value*	*Crude HR (95% CI)*	*P-value*	*Adj. HR (95% CI)*	*P-value*
Group			< 0.001				
General population	28180 (94.84)	1533 (5.16)		1.00		1.00	
Physician	28387 (95.54)	1326 (4.46)		0.87 (0.81 - 0.94)	<0.001	0.90 (0.83 - 0.96)	0.003
Sex			< 0.001				
Female	6223 (97.14)	183 (2.86)		1.00		1.00	
Male	50344 (94.95)	2676 (5.05)		1.74 (1.50 - 2.03)	<0.001	0.86 (0.74 - 1.01)	0.061
Age			< 0.001				
≦ 34	15382 (98.96)	162 (1.04)		1.00		1.00	
35 - 44	19798 (97.91)	422 (2.09)		2.00 (1.66 - 2.39)	<0.001	1.75 (1.46 - 2.10)	< 0.001
45 - 54	11030 (94.84)	600 (5.16)		4.92 (4.14 - 5.85)	<0.001	3.87 (3.24 - 4.62)	< 0.001
55 - 64	3838 (89.97)	428 (10.03)		9.77 (8.15 - 11.70)	<0.001	6.60 (5.48 - 7.95)	< 0.001
≧ 65	6519 (83.94)	1247 (16.06)		15.91 (13.50 - 18.75)	<0.001	8.17 (6.87 - 9.72)	< 0.001
Residence, level of urbanization			< 0.001				
Level 1	22805 (95.53)	1067 (4.47)		1.00		1.00	
Level 2 & 3	25864 (95.24)	1292 (4.76)		1.05 (0.97 - 1.14)	0.252	0.96 (0.89 - 1.04)	0.338
Level 4 & 5	6012 (94.32)	362 (5.68)		1.25 (1.11 - 1.41)	<0.001	0.90 (0.79 - 1.01)	0.071
Level 6 & 7	1886 (93.18)	138 (6.82)		1.49 (1.24 - 1.77)	<0.001	0.96 (0.80 - 1.15)	0.657
CCI*			< 0.001				
0	9210 (99.74)	24 (0.26)		1.00		1.00	
1 - 3	22881 (97.88)	496 (2.12)		8.18 (5.43 - 12.32)	<0.001	7.49 (4.97 - 11.28)	< 0.001
4 - 6	14058 (94.64)	796 (5.36)		20.76 (13.83 - 31.14)	<0.001	15.23 (10.14 - 22.87)	< 0.001
7 - 9	6639 (89.62)	769 (10.38)		40.27 (26.83 - 60.43)	<0.001	22.51 (14.97 - 33.84)	< 0.001
≧ 10	3779 (83.00)	774 (17.00)		68.46 (45.62 - 102.74)	<0.001	29.75 (19.76 - 44.80)	< 0.001

*CCI = Charlson comorbidity index

When compared with the general population, the physician group had a significantly lower risk of hepatoma (adj. HR = 0.68; 95% CI = 0.56 – 0.83), lung cancer (adj. HR = 0.69; 95% CI = 0.56 – 0.86), oral and hypopharyngeal cancer (adj. HR = 0.17; 95% CI = 0.11 – 0.26), esophageal cancer (adj. HR = 0.26; 95% CI = 0.15 – 0.45), and bladder cancer (adj. HR = 0.64; 95% CI = 0.44 – 0.94). However, no statistically significant increases in risks were found for colorectal, breast, stomach, cervical, uterus, skin, nasopharyngeal, and other cancers between the physicians and the general population. The results of the sex-stratified analysis are summarized in Table 5.

Table 3: Crude and adjusted hazard ratios and 95% confidence intervals of all-cancer and associated factors among physician

Variable	*Crude HR (95% CI)*	*P-value*	*Adj. HR (95% CI)*	*P-value*
Sex				
Male	1.00		1.00	
Female	0.75 (0.61 - 0.91)	0.005	1.59 (1.28 - 1.96)	< 0.001
Age (yr)				
≦ 34	1.00		1.00	
35 - 44	1.59 (1.23 - 2.06)	< 0.001	1.52 (1.17 - 1.97)	0.002
45 - 54	3.77 (2.95 - 4.82)	< 0.001	3.38 (2.63 - 4.35)	< 0.001
55 - 64	8.12 (6.29 - 10.48)	< 0.001	6.41 (4.92 - 8.35)	< 0.001
≧ 65	14.99 (11.96 - 18.79)	< 0.001	8.93 (7.01 - 11.39)	< 0.001
Residence, level of urbanization				
Level 1	1.00		1.00	
Level 2 & 3	1.00 (0.89 - 1.12)	0.961	0.93 (0.82 - 1.05)	0.222
Level 4 & 5	1.14 (0.96 - 1.37)	0.139	0.83 (0.70 - 1.00)	0.048
Level 6 & 7	1.52 (1.17 - 1.96)	0.001	0.99 (0.76 - 1.28)	0.934
CCI*				
0	1.00		1.00	
1 - 3	8.31 (4.55 - 15.17)	< 0.001	8.08 (4.42 - 14.77)	< 0.001
4 - 6	19.76 (10.86 - 35.98)	< 0.001	14.79 (8.11 - 26.96)	< 0.001
7 - 9	42.68 (23.45 - 77.69)	< 0.001	23.45 (12.84 - 42.82)	< 0.001
≧ 10	63.41 (34.79 - 115.55)	< 0.001	26.67 (14.56 - 48.86)	< 0.001

*CCI = Charlson comorbidity index

Table 4: Incidence, incidence rate ratio and adjusted hazard ratio of subdivisions of cancer between physician and general population

Cancer	*General population*		*Physician*		*Crude HR (95% CI)*	*P-value*	*Adj. HR (95% CI)* [d]	*P-value*
	event	*incidence* [a]	*event*	*incidence* [a]				
Colorectal cancer	227	69.67	235	72.10	1.04 (0.86 - 1.24)	0.712	1.03 (0.86 - 1.24)	0.742
Hepatoma	232	71.21	158	48.44	0.68 (0.56 - 0.83)	< 0.001	0.68 (0.56 - 0.83)	< 0.001
Lung cancer	209	64.12	146	44.75	0.70 (0.57 - 0.86)	< 0.001	0.69 (0.56 - 0.86)	< 0.001
Prostate cancer [b]	130	44.65	165	56.71	1.27 (1.01 - 1.60)	0.042	1.26 (1.00 - 1.59)	0.046
Breast cancer [c]	30	85.47	47	134.20	1.57 (0.99 - 2.48)	0.053	1.58 (1.00 - 2.49)	0.052
Oral and hypopharyngeal cancer	147	45.05	25	7.65	0.17 (0.11 - 0.26)	< 0.001	0.17 (0.11 - 0.26)	< 0.001
Stomach cancer	76	23.27	81	24.80	1.07 (0.78 - 1.46)	0.690	1.06 (0.78 - 1.45)	0.716
Cervical cancer [c]	3	8.51	3	8.51	1.00 (0.20 - 4.96)	1.000	1.00 (0.20 - 4.94)	0.997
Uterus cancer [c]	2	5.68	6	17.04	3.00 (0.61 - 14.87)	0.178	3.00 (0.61 - 14.85)	0.179
Skin cancer	20	6.12	13	3.98	0.65 (0.32 - 1.31)	0.226	0.65 (0.32 - 1.31)	0.226
Esophageal Cancer	61	18.67	16	4.89	0.26 (0.15 - 0.46)	< 0.001	0.26 (0.15 - 0.45)	< 0.001
Bladder Cancer	67	20.51	43	13.16	0.64 (0.44 - 0.94)	0.023	0.64 (0.44 - 0.94)	0.022
Nasopharyngeal Cancer	45	13.77	29	8.87	0.64 (0.40 - 1.03)	0.065	0.65 (0.41 - 1.03)	0.066
Thyroid cancer	13	3.98	41	12.54	3.16 (1.69 - 5.89)	< 0.001	3.16 (1.69 - 5.90)	< 0.001
Ovarian cancer [c]	0	0.00	11	31.24		-	-	-
Others	283	86.92	317	97.43	1.12 (0.96 - 1.32)	0.163	1.12 (0.95 - 1.31)	0.170

a. incidence: per 100,000 person-year; b. Male only; c. Female only; d. adjusted HR: multivariable analysis sex and age

In the sex-stratified analysis, we demonstrated that male physicians had increased risks of prostate cancer (adj. HR = 1.26; 95% CI = 1.00 – 1.59) and thyroid cancer (adj. HR = 3.01, 95% CI = 1.52 – 5.95), and lower risks of hepatoma, lung, oral and hypopharyngeal, esophageal, and bladder cancers. No significant difference in the risk of cancers between female physicians and the general population was noted.

Table 5: Incidence, incidence rate ratio and adjusted hazard ratio of subdivisions of cancer between physician and general population by sex

Cancer	*Male*						*Female*					
	General population		**Physician**		**Crude HR (95% CI)**	**Adj. HR (95% CI) [d]**	**General population**		**Physician**		**Crude HR (95% CI)**	**Adj. HR (95% CI) [d]**
	Event	**Rate [a]**	**Event**	**Rate [a]**			**Event**	**Rate [a]**	**Event**	**Rate [a]**		
Colorectal cancer	216	74.32	226	77.74	1.05 (0.87 - 1.26)	1.04 (0.87 - 1.26)	11	31.25	9	25.55	0.82 (0.34 - 1.97)	0.81 (0.34 - 1.96)
Hepatoma	228	78.47	156	53.62	0.68 (0.56 - 0.84)***	0.68 (0.56 - 0.84)***	4	11.35	2	5.67	0.50 (0.09 - 2.73)	0.50 (0.09 - 2.75)
Lung cancer	202	69.48	141	48.45	0.70 (0.56 - 0.87)***	0.69 (0.56 - 0.86)***	7	19.87	5	14.20	0.71 (0.23 - 2.25)	0.72 (0.23 - 2.26)
Prostate cancer [b]	130	44.65	165	56.71	1.27 (1.01 - 1.60)*	1.26 (1.00 - 1.59)*	--	--	--	--	--	--
Breast cancer [c]	--	--	--	--	-	--	30	85.47	47	134.20	1.57 (0.99 - 2.48)	1.58 (1.00 - 2.49)
Oral and hypopharyngeal cancer	147	50.51	25	8.57	0.17 (0.11 - 0.26)***	0.17 (0.11 - 0.26)***	0	0.00	0	0.00		
Stomach cancer	75	25.74	78	26.77	1.04 (0.76 - 1.43)	1.03 (0.75 - 1.42)	1	2.84	3	8.51	3.00 (0.31 - 28.84)	3.02 (0.31 - 29.04)
Cervical cancer [c]	--	--	--	--	-	-	3	8.51	3	8.51	1.00 (0.20 - 4.96)	1.00 (0.20 - 4.94)
Uterus cancer [c]	--	--	--	--	--	-	2	5.68	6	17.04	3.00 (0.61 - 14.87)	3.00 (0.61 - 14.85)
Skin cancer	20	6.86	12	4.11	0.60 (0.29 - 1.23)	0.60 (0.29 - 1.23)	0	0.00	1	2.84	-	-
Esophageal Cancer	61	20.93	16	5.49	0.26 (0.15 - 0.45)***	0.26 (0.15 - 0.45)***	0	0.00	0	0.00	- -	-
Bladder Cancer	67	22.99	42	14.41	0.63 (0.43 - 0.92)*	0.62 (0.42 - 0.92)*	0	0.00	1	2.84	-	-
Nasopharyngeal Cancer	44	15.09	28	9.60	0.64 (0.40 - 1.02)	0.64 (0.40 - 1.02)	1	2.84	1	2.84	1.00 (0.06 - 15.99)	1.00 (0.06 - 15.95)
Thyroid cancer	11	3.77	33	11.31	3.00 (1.52 - 5.94)**	3.01 (1.52 - 5.95)**	2	5.68	8	22.72	4.00 (0.85 - 18.85)	4.01 (0.85 - 18.86)
Ovarian cancer [c]	--	--	--	--	-	-	0	0.00	11	31.24	-	-
Others	272	93.67	301	103.73	1.11 (0.94 - 1.31)	1.11 (0.94 - 1.30)	11	31.25	16	45.48	1.46 (0.68 - 3.14)	1.45 (0.68 - 3.13)

Discussion

The results of the present study are consistent with those of some epidemiological studies, which used different study designs and reported a lower cancer incidence rate among physicians than among the general population (4, 5, 9). This may potentially be attributed to several factors. First, physicians have higher-than-average socioeconomic status (SES) in Taiwan (10, 11). Second, physicians were reported to have healthier lifestyles than the general population because of their professional medical knowledge (12, 13). Third, physicians have better-than-average access to medical care, which provides them with opportunities to counteract work-related risk factors (14, 15). Finally, considerable reduction in the risk of cancer incidence in physicians was a likely consequence, at least to some extent, of a healthy worker effect (16). Good health is usually required for people to continue employment.

Physicians had lower risks of hepatoma than the general population. In Taiwan, infections with chronic hepatitis B or C are important factors associated with hepatoma. Physicians had a lower prevalence of liver diseases and hepatitis B or C than the general population, which may be attributed to high vaccination rates and education (17).

The current study also found that physicians had lower risks of lung, hypopharyngeal, esophageal, and urinary bladder cancers than the general population. Lower frequencies of smoking and betel nut chewing among the physicians, along with healthy lifestyles (eating more fruits and vegetables, less fat) and frequent health screenings among female physicians (13, 18), might partially account for the reduced risks of these cancers when compared with the general population.

Although physicians are usually expected to be healthier than the general population, several studies have reported higher risks of certain cancers among physicians (4, 9). Regarding specific cancer types, the physicians had higher risks of prostate and thyroid cancer in the present study. The melatonin pathway, which is closely related to circadian rhythms, is frequently implicated in the elevated risk of health problems, including cancer, among night shift workers (19). To the best of our knowledge, no studies have focused only on prostate cancer in physicians; however, previous studies have shown that working through the night might be associated with increased risk of prostate cancer (20, 21). Physicians in Taiwan have excessive workload and stress with regular night shift duties. The melatonin pathway was the most frequently implicated in the observed elevated risk of cancer among night shift workers. Similarly, previous study showed that melatonin could directly inhibit the proliferation of prostate cancer cells in vitro and in vivo (22). Our findings were similar to the study by Pukkala et al, which reported a standardized incidence ratio of 1.10 for prostate cancer among male physicians in five Nordic countries (23).

Furthermore, consistent with previous studies, the risk for thyroid cancer was significantly higher in physicians than in the general population in the current study (4, 24, 25); this may be due to factors such as heavy work stress, night shifts, and exposure to medical radiation. The average work time of Taiwanese physicians is 65.6 h/week, which is much higher than that of the general population (average, 43.7 h/week) (26). Heavy work stress was also associated with autoimmune thyroid diseases, including hyperthyroidism, hypothyroidism, and thyroiditis, through the mechanism of immune modulation (27). In addition to work stress, some physicians had rotating night shifts, which is suggested to be a risk factor for thyroid diseases, including thyroid cancer and autoimmune thyroid diseases (27, 28). Decreased secretion of thyroid stimulating hormone following night shift work is suspected to be an underlying mechanism associated with thyroid cancer (28). In addition to heavy work stress and the night shifts, physicians may be exposed to medical radiation, particularly in radiology, cardiology, and orthopedics; exposure to radiation is a risk factor for thyroid diseases. Insomnia itself is also a risk factor for thyroid cancer (29).

One interesting finding in our analysis was that female physicians had higher rates of all types of cancer than male physicians did. Besides, unlike male physicians who had mostly lower cancer risks when compared with the males in the general population, female physicians had mostly comparable risks of cancer with the females in the general population. This result seemed contradictory to previous reports where female physicians displayed better physical health and health behaviors than their male counterparts. In Taiwan, women who are mothers are urged to take responsibility for their families and houses regardless of whether they have jobs or not, even if those women are doctors. At their job sites, female physicians cannot waive their night shift duties. In addition, our previous research reported higher risks of advanced cancer stages in female physicians than in female non-physicians; however, no such findings were noted among the male physicians and male non-physicians (30). Based on these results, we believe that the health of female physicians deserves further attention.

The current study has some limitations. The 10-yr period for collection of cases from the database may not be adequate to demonstrate an association between cancer patients and the general population, owing to the low number of cancer cases. Limited by the characteristics of our data, we could not determine the severity of the cancers, frequency of rotating night shifts, numbers of working hours, amounts of radiation exposure, lifestyle factors and individual behavior, all of which might have confounded the study results.

Conclusion

The physicians in this study had lower rates of risk for all cancers than did the general population. Female physicians had higher cancer risks than male physicians. Male physicians had higher risks of thyroid and prostate cancer than did the general population.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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