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A Comparison of Cancer Incidence among Physician Specialists and the General Population: A Taiwanese Cohort Study

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Abstract: A Comparison of Cancer Incidence among Physician Specialists and the General Population: A Taiwanese Cohort Study: Shih-Yi LIN, *et al*. Graduate Institute of Clinical Medical Science, College of Medicine, China Medical University, Taiwan—Background: Physicians are frequently studied as a population that experiences extremely high stress, burnout, and prolonged working hours that might harm one's health. However, they have sound medical knowledge and have easy access to medical resources. We studied the incidence of cancer among Taiwanese physicians using a nationwide cohort study design. **Methods:** Data were obtained from the National Health Insurance (NHI) system in Taiwan. The physician cohort contained 22,309 physicians, and each physician was randomly frequency-matched according to age and sex with 4 people from the general population. **Results:** The overall incidence ratio of cancer was 27% lower in the physician cohort than in the nonphysician comparison cohort (33.9 vs. 46.5 people per 10,000 person-years, crude hazard ratio (HR)=0.73, 95% CI=0.70, 0.76). The adjusted HR was 0.78 (95% CI=0.72, 0.84). Female physicians experienced a higher incidence rate ratio of overall cancer, compared to male physicians (crude HR=1.17, 95% CI=1.03, 1.33 vs. crude HR=0.70, 95% CI=0.67, 0.74, respectively). Physicians were at a significantly higher risk of thyroid cancer (HR 1.75, 95% CI=1.14, 2.68), prostate cancer (HR=1.54, 95% CI=1.21, 1.97), breast cancer (HR=1.45, 95% CI=1.00, 2.09), and non-cervical gynecological cancer (HR=4.03, 95% CI=1.77, 9.17), compared with the general population. **Conclusions:** Physicians are at lower overall risk of cancer than the general population, apart from cancer of the thyroid, prostate, breast, and non-cervical gynecological cancer.
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Key words: Cancer incidence, Cohort study, Physician specialists

Physicians play a key role in health care systems by providing a professional medical service. Emerging evidence shows that depression, fatigue, burnout, or emotional exhaustion among physicians might negatively affect physicians' abilities to care for their patients and form sound clinical decisions[1−3]. Furthermore, physicians who are unable to cope with their occupational stress are at a relatively high risk for substance abuse, relationship problems, and suicide[4]. Physicians who are unwell mentally or physically are less able to coordinate their practice with the broader health care system and thus are more prone to providing suboptimal patient care. Numerous studies have investigated the mental health, on-call hours, work loading, workplace nutrition, or health behaviors of physicians and the associated impact on medical errors[5, 6]. The research on physical health of physicians has been limited, and has often focused on mortality analysis[7, 8]. Furthermore, these studies have always adopted study methods that rely on self-report, which is affected by recall bias.

Cancer is the leading cause of death in many countries. The pathogenesis of cancer involves genetics, environmental toxins, lifestyle, and mental health[9].

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Because physicians experience high levels of work-related stress but also have a higher social status and greater medical knowledge than the general population, an analysis of the risks of all cancer types among physicians is worthwhile. Further, analysis could examine differences in cancer sites among various medical specialists.

In 1996, Taiwan launched the National Health Insurance (NHI) system, which provides medical coverage to more than 99% of Taiwanese residents[10]. The increasing number of insured patients raises the pressure and workloads on physicians and the level of stress in the medical environment. However, the NHI provides comprehensive electronic medical information for disease identification and use of medication, as well as a cancer registry, patient demographics (including incomes), and physician categories. We analyzed data from the NHI database to study a retrospective cohort of physicians in Taiwan; the results are reported in this paper.

Materials and Methods

Data sources

For this retrospective cohort study, we obtained claims data of the NHI from the National Health Research Institute (NHRI) in Taiwan. The NHI insurance program provides medical coverage to more than 99% of the population and has contracts with 97% of hospitals and clinics in Taiwan[10]. The claims data are subject to periodic review by the Bureau of NHI to ensure accuracy. The identification system is scrambled to safeguard the privacy and confidentiality of the insured population. We used four different data files: registry of beneficiaries, inpatient claims, board-certified specialists and the Catastrophic Illness Patients Database. These data files are linkable through an encrypted but unique personal identification number and thus provide patient level information on demographic characteristics and medical history. We retrieved diagnostic information according to the codes of the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM). The withdrawal rate (including death) from National Health Insurance Program is about 1.89%.

Study participants

From the registry for board-certified specialists, we identified 22,309 physician specialists whose physician licenses had been issued before 2000; this group comprised the physician study cohort. Physicians in radiology or with incomplete data were excluded. January 1, 2000, was defined as the index date. The sex and age distributions were different between physicians and the entire insured population. Both sex and age are important confounding factors strongly related to the cancer risk. For establishing a comparable nonphysician comparison cohort, we randomly selected 4 persons from all NHI beneficiaries frequency-matched with each physician by age and sex. Individuals with any diagnosis of cancer at the baseline were excluded from both cohorts in this study. We did not use comorbidities as the eligible factors for the selection of study cohorts. Instead, comorbidities that might have potential association with cancer risk were identified at the baseline and included in the data analysis as covariates.

Outcome measures

All subjects were linked to the registry of the Catastrophic Illness Patient Database to identify participants diagnosed with cancer in the NHI program. The subjects of both study cohorts were followed until a diagnosis of cancer was made, until the patient case was lost to follow- up, until death, until withdrawal from insurance, or until the end of 2010. The baseline comorbidity history for each participant was determined from inpatient claims data. We examined the following comorbidities: diabetes (ICD-9-CM code 250), hyperlipidemia (ICD-9-CM code 272), hypertension (ICD-9-CM codes 401 to 405), peptic ulcer disease (ICD-9-CM codes 531–534.9), autoimmune disease (ICD-9-CM codes 710.0, 710.1, 714.0, 714.30–714.33, 446.0, 446.2, 446.4, 446.5, 443.1, 446.7, 710.3, and 136.1), hepatitis C (ICD-9-CM codes 070.51, 070.54, 070.44, and 070.41), hepatitis B (ICD-9-CM codes 070.2,070.21, 070.22, 070.23, 070.31, 070,32, and 070.33), cirrhosis (ICD-9-CM codes 456.2,456.21,571.5,571.2, and 571.6), and end-stage renal disease (ESRD) (ICD-9-CM code 585). The baseline comorbidities that may be associated with cancer were identified before the end dates (the date of cancer diagnosis, date the patient was lost to follow- up, date of death, date of withdrawal from insurance or last day of 2010) subjects in both cohorts.

Statistical analysis

In the initial stage of data analysis, we assessed differences between the physician cohort and the comparison cohort for age, sex, and baseline comorbidities, using the χ^2 test. We compared the incidence of cancer between the 2 cohorts stratified by sex. Cox proportional hazard regression analysis was used to assess the effects of physician variables on the risk of cancer, adjusting for variables that emerged as significant in the χ^2 test. Hazard ratios (HRs) and 95% confidence intervals (CIs) were measured in the Cox model. Cancer site-specific incidence rates and HRs were also determined.

In the second stage of data analysis, we evaluated

the categories of doctors at high risk for cancer. The statistical significance level was set at a probability value of <0.05 (SAS software, version 9.2, SAS Institute Inc, Cary, NC, USA).

Results

We identified 22,309 physicians and 89,236 nonphysician comparison patients. The physician cohort was followed up for 10.6 ± 1.5 years, and the control cohort was followed up for 10.0 ± 2.51 years. The mean age of the physician group was 43.7 years (SD 10.8 years), and 90.5% of the physicians were men (Table 1). The age and sex distributions among the nonphysician comparison group were similar to those of the physician group. The physician cohort showed low prevalence rates for diabetes (4.18%), hypertension (9.17%), hyperlipidemia (3.45%), peptic ulcer (2.54%), hepatitis C (0.39%), hepatitis B (0.44%), cirrhosis (0.46%), and ESRD (0.51%). The crude HR for cancer was 27% lower among the physician cohort than in the comparison cohort, which represented a significant difference (33.9 vs. 46.5 people per 10,000

Table 1. Comparisons in demographic characteristics and comorbidities between study physician and nonphysician cohorts

	Nonphysicians (n=89,236)	Physicians (n=22,309)	*p*-value
Age, mean ± SD	43.8 ± 11.0	43.7 ± 10.8	0.47*
Stratified age			
≤35	17,920 (20.1)	4,480 (20.1)	0.99
36–45	38,428 (43.1)	9,607 (43.1)	
46–55	20,488 (23.0)	5,122 (23.0)	
>55	12,400 (13.9)	3,100 (13.9)	
Gender			
Female	8,504 (9.50)	2,126 (9.50)	0.99
Male	80,732 (90.5)	20,183 (90.5)	
Comorbidity			
Diabetes	6,285 (7.04)	933 (4.18)	<0.0001
Hypertension	10,063 (11.3)	2,045 (9.17)	<0.0001
Hyperlipidemia	3,335 (3.74)	769 (3.45)	<0.0001
Peptic ulcer disease	5,960 (6.68)	566 (2.54)	<0.0001
Autoimmune disease	173 (0.19)	43 (0.19)	0.97
Hepatitis C	805 (0.90)	87 (0.39)	<0.0001
Hepatitis B	503 (0.56)	98 (0.44)	0.02
Cirrhosis	1,894 (2.12)	103 (0.46)	<0.0001
ESRD	691 (0.77)	113 (0.51)	<0.0001

Chi-Square test; *Two-sample *t*-test. ESRD: end-stage renal disease.

Table 2. Incidence and adjusted hazard ratio of cancer stratified by sex compared between study physician and nonphysician cohorts

	Nonphysician			Physician			Crude HR* (95% CI)	Adjusted HR† (95% CI)
	Event	PY	Rate#	Event	PY	Rate#		
Cancer‡	4,150	893,347	46.5	804	236,886	33.9	0.73 (0.70, 0.76)**	0.78 (0.72, 0.84)**
Gender								
Female	259	86,821	29.8	79	22,687	34.8	1.17 (1.03, 1.33)*	1.16 (1.03, 1.29)*
Male	3,891	806,526	48.2	725	214,200	33.8	0.70 (0.67, 0.74)**	1 (Reference)

Cancer‡: ICD-9-CM 140.xx–208.xx. Rate#, incidence rate, per 10,000 person-years. Crude HR*, incidence rate ratio, per 10,000 person-years. Adjusted HR†: multivariable analysis including age and comorbidities. PY: person-years. *p<0.05, **p<0.01.

person-years, crude HR=0.73, 95% CI=0.70, 0.76); the adjusted HR was 0.78 (95% CI=0.72, 0.84) (Table 2). Sex-specific analysis showed that the female physician cohort had higher rate ratio than the male physician cohort (crude HR=1.17, 95% CI=1.03, 1.33 vs. crude HR=0.70, 95% CI=0.67, 0.74, respectively). The adjusted HR for cancer was 1.16 (95% CI=1.03, 1.29) for women, compared with men.

Table 3 shows the results of the analysis of specific cancer types. Physicians were at significantly lower risk for hepatoma and malignant tumors in the head and neck, esophagus, and lung, compared with the general population. However, physicians were at significantly higher risk for thyroid cancer (adjusted HR=1.75, 95% CI=1.14, 2.68), and male physicians were at significantly higher risk of prostate cancer (adjusted HR=1.54, 95% CI=1.21, 1.97). Female physicians were at significantly higher risk of breast and uterus and ovary cancer (adjusted HR=1.45, 95% CI=1.00, 2.09; adjusted HR=4.03, 95% CI=1.77, 9.17, respectively). Table 4 shows the incidence, incidence rate ratio and adjusted hazard ratio of subdivisions of cancer between study physician and nonphysician cohorts by sex. Male physicians had a lower risk of overall cancer (adjusted HR=0.69, 95% CI=0.63, 0.74), head and neck cancer (adjusted HR=0.69, 95% CI=0.63, 0.74), esophagus cancer (adjusted HR=0.21, 95% CI=0.15, 0.28), stomach cancer (adjusted HR=0.26, 95% CI=0.15, 0.47), and lung cancer (adjusted HR=0.73, 95% CI=0.69, 0.78) than male nonphysicians. Female physicians had a higher risk of uterine and ovarian cancer (adjusted HR=4.68, 95% CI=2.02, 10.8). Table 5 shows the incidence and crude and adjusted HRs for all cancer types, female breast cancer and uterine and ovarian, prostate and thyroid cancers among medical categories. Internist physicians had a 33% lower overall risk of cancer than nonphysicians (adjusted HR=0.67, 95% CI=0.57, 0.80), and pediatric physicians were at 27% lower risk of cancer than nonphysicians (adjusted HR=0.73, 95% CI=0.57, 0.92). Pediatric physicians had a higher risk of breast cancer than nonphysicians (adjusted HR=3.26, 95% CI=1.66, 6.40). Gynecologists were at higher risk of uterine and ovarian cancer than nonphysicians (adjusted HR=7.23, 95% CI=2.14, 24.5). Gynecologists and surgeons had a higher risk of prostate cancer than nonphysicians (adjusted HR=2.31, 95% CI=1.46, 3.68 for gynecologists; adjusted HR=1.74, 95% CI=1.16–2.62 for surgeons). Surgeons were at higher risk of thyroid cancer than nonphysicians (adjusted HR=2.72, 95% CI=1.45, 5.10).

Table 3. Incidence, incidence rate ratio and adjusted hazard ratio of subdivisions of cancer between study physician and nonphysician cohorts

	Nonphysician		Physician		Crude HR* (95 % CI)	Adjusted HR† (95 % CI)
Cancer (ICD-9-CM)	Event	Rate#	Event	Rate#		
Head and neck cancer (140–149)	712	7.97	39	1.65	0.20 (0.19, 0.22)**	0.20 (0.15, 0.28)**
Esophagus cancer (150)	174	1.95	12	0.51	0.25 (0.22, 0.27)**	0.26 (0.15, 0.47)**
Stomach cancer (151)	220	2.46	42	1.77	0.71 (0.67, 0.75)**	0.81 (0.58, 1.12)
Colorectal cancer (153, 154)	564	6.31	143	6.04	0.95 (0.90, 1.00)*	0.94 (0.79, 1.13)
Hepatoma (155)	735	8.23	97	4.09	0.51 (0.48, 0.54)**	0.80 (0.65, 0.99)*
Pancreas (157)	66	0.74	16	0.68	0.87 (0.82, 0.93)**	0.88 (0.51, 1.52)
Lung cancer (162)	483	5.41	79	3.33	0.61 (0.57, 0.65)**	0.60 (0.48, 0.76)**
Skin cancer (173)	51	0.57	8	0.34	0.57 (0.53, 0.61)**	0.56 (0.27, 1.18)
Female breast (174)	91	1.02	38	1.60	1.51 (1.44, 1.59)**	1.45 (1.00, 2.09)*
Uterus and ovary (179, 183)	11	0.12	12	0.51	4.11 (3.92, 4.32)**	4.03 (1.77, 9.17)**
Cervix (180–182)	36	0.40	9	0.38	0.92 (0.86, 0.98)**	0.90 (0.43, 1.86)
Vagina and vulva (184)	1	0.01	0	0.00	—	—
Prostate (185)	209	2.34	88	3.71	1.59 (1.52, 1.66)**	1.54 (1.21, 1.97)**
Bladder cancer (188)	137	1.53	24	1.01	0.73 (0.68, 0.77)**	0.72 (0.48, 1.09)
Kidney cancer (189)	94	1.05	30	1.27	1.32 (1.26, 1.39)**	1.34 (0.90, 1.97)
Thyroid (193)	64	0.72	30	1.27	1.74 (1.66, 1.83)**	1.75 (1.14, 2.68)*
Hematologic (200–208)	161	1.80	58	2.45	1.31 (1.25, 1.38)**	1.31 (0.97, 1.76)
Others	341	3.82	79	3.33	0.87 (0.83, 0.92)**	0.87 (0.68, 1.11)

Rate#, incidence rate, per 10,000 person-years. Adjusted HR†: multivariable analysis including age and comorbidities. *p<0.05; **p<0.01.

Table 4. Incidence, incidence rate ratio and adjusted hazard ratio of subdivisions of cancer between study physician and non-physician cohorts by sex

	Male						Female					
	Nonphysician		Physician		Crude HR* (95 % CI)	Adjusted HR† (95 % CI)	Nonphysician		Physician		Crude HR* (95 % CI)	Adjusted HR† (95 % CI)
Cancer (ICD-9-CM)	Event	Rate#	Event	Rate#			Event	Rate#	Event	Rate#		
All	3,891	48.2	725	33.9	0.70 (0.67, 0.74)**	0.69 (0.63, 0.74)**	259	29.8	79	34.8	1.17 (1.03, 1.33)*	1.17 (0.91, 1.51)
Head and neck cancer (140–149)	699	8.67	39	1.82	0.21 (0.19, 0.23)**	0.21 (0.15, 0.28)**	13	1.50	0	0.00	—	—
Esophagus cancer (150)	174	2.16	12	0.56	0.25 (0.22, 0.27)**	0.26 (0.15, 0.47)**	0	0.00	0	0.00	—	—
Stomach cancer (151)	213	2.64	42	1.96	0.73 (0.69, 0.78)**	0.73 (0.69, 0.78)**	7	0.81	0	0.00	—	—
Colorectal cancer (153, 154)	538	6.67	138	6.44	0.96 (0.91, 1.01)	0.95 (0.79, 1.14)	26	2.99	5	2.20	0.71 (0.59, 0.86)**	0.71 (0.27, 1.86)**
Hepatoma (155)	721	8.94	97	4.53	0.52 (0.49, 0.55)**	0.82 (0.67, 1.01)	14	1.61	0	0.00	—	—
Pancreas (157)	63	0.78	15	0.70	0.86 (0.80, 0.91)**	0.86 (0.49, 1.50)	3	0.35	1	0.44	1.28 (1.07, 1.53)**	1.52 (0.16, 14.9)
Lung cancer (162)	472	5.85	74	3.45	0.58 (0.54, 0.61)**	0.57 (0.45, 0.73)**	11	1.27	5	2.20	1.91 (1.65, 2.22)**	1.85 (0.69, 4.95)
Skin cancer (173)	48	0.60	8	0.37	0.60 (0.56, 0.65)**	0.60 (0.28, 1.26)	3	0.35	0	0.00	—	—
Female breast (174)	—	—	—	—	—	—	91	10.5	38	16.8	1.55 (1.36, 1.76)**	1.57 (1.09, 2.27)*
Uterus and ovary (179, 183)	—	—	—	—	—	—	11	1.27	12	5.29	4.59 (4.00, 5.28)**	4.68 (2.02, 10.8)**
Cervix (180–182)	—	—	—	—	—	—	36	4.15	9	3.97	0.83 (0.69, 0.99)*	0.86 (0.40, 1.84)
Vagina and vulva (184)	—	—	—	—	—	—	1	0.12	0	0.00	—	—
Prostate (185)	209	2.59	88	4.11	1.58 (1.51, 1.66)**	1.54 (1.21, 1.96)**	—	—	—	—	—	—
Bladder cancer (188)	135	1.67	24	1.12	0.74 (0.69, 0.78)**	0.73 (0.49, 1.11)	2	0.23	0	0.00	—	—
Kidney cancer (189)	90	1.12	30	1.40	1.38 (1.30, 1.45)**	1.39 (0.94, 2.06)	4	0.46	0	0.00	—	—
Thyroid (193)	46	0.57	26	1.21	2.12 (2.01, 2.23)**	2.12 (1.32, 3.40)**	18	2.07	4	1.76	0.81 (0.67, 0.97)*	0.80 (0.27, 2.34)
Hematologic (200–208)	152	1.88	54	2.52	1.29 (1.22, 1.36)**	1.29 (0.95, 1.75)	9	1.04	4	1.76	1.71 (1.45, 1.99)**	1.64 (0.50, 5.32)
Others	331	4.10	78	3.64	0.88 (0.83, 0.93)**	0.88 (0.69, 1.12)	10	1.15	1	0.44	0.64 (0.52, 0.78)**	0.66 (0.15, 2.94)

Rate#, incidence rate, per 10,000 person-years. Adjusted HR†: multivariable analysis including age and comorbidities. *p<0.05, **p<0.01.

Table 5. Incidence, crude and adjusted hazard ratios of subdivisions of cancer among medical categories between study physician and nonphysician cohorts

Cancer	Event	Rate#	Crude HR* (95% CI)	Adjusted HR† (95% CI)
Control	4,150	46.5	1 (Reference)	1 (Reference)
Internist	137	26.1	0.58 (0.49, 0.69)**	0.67 (0.57, 0.80)**
Surgeon	198	35.7	0.80 (0.70, 0.93)**	0.82 (0.71, 0.95)**
Gynecologist	101	44.9	1.01 (0.84, 1.24)	0.84 (0.69, 1.02)
Pediatrician	69	30.2	0.68 (0.54, 0.86)**	0.73 (0.57, 0.92)**
Female breast‡				
Control	91	1.02	1 (Reference)	1 (Reference)
Internist	6	1.14	0.91 (0.40, 2.06)	0.88 (0.39, 2.01)
Surgeon	6	1.08	0.86 (0.38, 1.95)	0.85 (0.38, 1.93)
Gynecologist	5	2.22	1.81 (0.74, 4.41)	1.86 (0.76, 4.54)
Pediatrician	9	3.94	3.28 (1.67, 6.45)**	3.26 (1.66, 6.40)**
Uterus and ovary (only women)‡				
Control	11	0.12	1 (Reference)	1 (Reference)
Internist	1	0.19	0.92 (0.13, 6.86)	0.90 (0.12, 6.68)
Surgeon	3	0.54	2.88 (0.86, 9.70)	2.83 (0.84, 9.53)
Gynecologist	3	1.33	7.32 (2.12, 24.7)**	7.23 (2.14, 24.5)**
Pediatrician	1	0.44	2.19 (0.30, 16.2)	2.11 (0.28, 15.6)
Prostate (only men)‡				
Control	209	2.34	1 (Reference)	1 (Reference)
Internist	12	2.29	0.81 (0.45, 1.44)	1.08 (0.61, 1.92)
Surgeon	25	4.51	1.66 (1.10, 2.50)*	1.74 (1.16, 2.62)**
Gynecologist	19	8.44	3.15 (1.98, 5.00)**	2.31 (1.46, 3.68)**
Pediatrician	7	3.07	1.09 (0.52, 2.31)	1.24 (0.59, 2.63)
Thyroid‡				
Control	64	0.72	1 (Reference)	1 (Reference)
Internist	7	1.33	1.57 (0.73, 3.38)	1.66 (0.77, 3.59)
Surgeon	11	1.98	2.43 (1.30, 4.56)**	2.72 (1.45, 5.10)**
Gynecologist	4	1.78	2.08 (0.77, 5.66)**	2.07 (0.76, 5.63)
Pediatrician	1	0.44	0.50 (0.07, 3.55)	0.42 (0.06, 3.04)

Rate#, incidence rate, per 10,000 person-years. Adjusted HR†: multivariable analysis including sex, age and comorbidities. *p<0.05; **p<0.01. ‡ Cancer, ICD-9-CM 140-208; Female breast, ICD-9-CM 174; Uterus and ovary, ICD-9-CM 179, 183; Prostate, ICD-9-CM 185; Thyroid, ICD-9-CM 193.

Discussion

This study showed that male physicians experienced lower rates of overall cancer and cancers of the head and neck, esophagus, stomach, liver, pancreas, and lung compared with the general population. Furthermore, the results showed that female physicians were at higher risk of all types of cancer than male physicians. Physicians had higher rates of thyroid, breast, prostate, and uterine and ovarian cancer, compared with the general population. Gynecologists had the highest incidence of diagnosed cancer of the uterus and ovary and prostate cancer, and surgeons had the highest incidence of thyroid cancer. To the best of our knowledge, this is the first nationwide cohort study to investigate the relationships between cancer risks and Western physician specialties among an Asian population.

We found it interesting that female physicians had higher rates of all cancer types than male physicians. This result seemed contradictory to previous reports that female physicians display better physical health and health behaviors than their male counterparts[11, 12]. We conducted further analyses, which showed that

extremely high risks of cancer of the breast (HR=1.45) and cancer of the uterus and ovary (HR=3.14) might account for the discrepancy. Furthermore, gynecologists displayed the highest incidence of uterine and ovarine cancer among all specialties. Because the detection of initially asymptomatic breast cancer and uterine and ovarine cancer requires a high awareness and willingness to receive examinations, we hypothesized that the high incidence of these cancers among female physicians might result from an increased chance of diagnosis. One Taiwanese study showed that the introduction of screening programs contributed to an apparent increase in breast cancer incidence[13]. Physicians are reported to engage in more screening behavior for breast, cervical, colorectal, and prostate cancer, compared with general population estimates[14]. Such reports strengthened our hypothesis that an apparent increase in the incidence of breast and uterine and ovarine cancers might actually reflect enhanced diagnosis and detection. The same explanation might apply to the high incidence of prostate cancer among male physicians[15]. Besides, of the top 10 cancers in Taiwan, female breast cancer and uterine/ovarian cancer were first and ninth[16]. Therefore, we suspect that 1) the high incidence of these cancers and 2) enhanced diagnosis and detection of these cancers account for the discrepancy in cancer risks between female and male physicians.

Our findings were similar to those of Pukkala *et al*., who conducted follow-up studies on career-related cancer patterns in 5 Nordic countries[17]. They reported a standardized incidence ratio of 1.36 for breast cancer and 1.19 for endometrial cancer among female physicians, and of 1.10 for prostate cancer among male physicians[17]. However, another possible reason for the difference between female physicians and women in the general population is that a higher level of education and the delay of a first pregnancy may be associated with an increased risk of breast cancer; thus, women in certain occupations might be at differential risk[18]. For men, the relatively high rate of prostate cancer among physicians might also be associated both with diagnostic activity and with occupation; for example, a higher social status might imply greater access to health care.

Altered circadian rhythms might be related to an increased risk of breast cancer and uterine and ovarine cancer among female physicians and prostate cancer among male physicians. Working at night can result in sleep deprivation, circadian disruption, and depressed melatonin levels, all of which may increase the risk of cancer[19]. The circadian rhythm regulates key aspects of cell growth, including the cell cycle, response to DNA damage, senescence, and cellular metabolism[20]. Lie *et al*. showed that night shift nurses had an odds ratio of 2.21 for risk of breast cancer, compared with referents[21]. Other studies have shown that night shift work might be associated with increased risks for breast cancer, endometrial cancers, and prostate cancer[22–24]. However, most of these studies focused on occupational groups, such as nurses, airline cabin attendants, and general workers. Further research is required to clarify the possible relationship between circadian rhythm disruption and cancer risk among physicians.

Our results reveal that the male physician cohort had decreased risks of head and neck cancer, stomach cancer, liver cancer, esophageal cancer, and pancreas cancer than male nonphysician cohort. Interestingly, these cancers are known to be related with lifestyle risk factors, such as hot drink consumption, alcohol consumption, smoking, and intake of dietary nitrate[25–29]. Lantz *et al*. discovered that the health risk behaviors are associated with income[30]. Kilander *et al*. reported that smoking, physical activity and dietary factors explained half of the excess cancer mortality in lower educated groups[31]. Therefore, the reason for the lower risk factors of male physicians than male non-physicians might be lifestyle.

For baseline comorbidities, the physician cohort in this study showed lower rates of hypertension, diabetes, hyperlipidemia, peptic ulcer, hepatitis C, cirrhosis, and ESRD, compared with the general population. This finding might be attributable to the generally healthy behavior that physicians would be expected to follow. Frank *et al*. reported that American and Canadian physicians smoked less, exercised more hours per week, attended more physical checkups, and maintained a healthier body weight, compared with the general population[12, 32]. In addition, the estimated rate of medical self-care among physicians ranged from 39 to 99%[33]. Hem *et al*. reported that high levels of self-prescribing behavior were noted among young Norwegian physicians[34]. Similarly, Evans *et al*. stated that neurologists commonly treated themselves and their family members[35]. Therefore, another possible explanation for the relatively low rates of comorbidities among our physician cohort might be that these doctors were self-prescribing and self-treating, without leaving documented records in the NHI database. This might account for some of the discrepancy between the physician group and the general population.

The main strengths of this study were its large sample and its cohort design. Nevertheless, the study was subject to certain limitations. First, this was a retrospective study based on the NHI research database. Selection bias and misclassification bias might have occurred because of limited and incomplete information at the time of enrollment. However,

the NHI insurance program provides medical coverage to more than 99% of the population, and we selected only subjects with the same ICD code more than three times. Therefore, these biases would be minimized and might not be overlooked. Second, the NHI database does not provide details of the staging of cancer at initial diagnosis. This weakness was offset by the maintenance of a Taiwanese NHI nationwide registry of cancer cases, which we consulted for the study period. Furthermore, our purpose was to investigate the diagnosed cancer incidence among physicians; thus, lack of data on cancer staging and cancer mortality would not invalidate our findings. The second limitation was that the database did not provide information on participants' lifestyles and personal health behavior, including smoking, drinking, and betel nut chewing; these variables are known to be variously related to lung, liver, oral, or esophageal cancer. Wen *et al*. reported that betel nut chewing increased the risks of all-cause cancer as well as cancers of the esophagus, liver, pancreas, and larynx[36]. Wen *et al*. analyzed the synergistic interaction between betel nut chewing and cigarette smoking among the Taiwanese population. Physicians presumably possess greater medical knowledge and follow healthy behavior to a larger extent than the general population. Thus, we assumed that our physician cohort would chew less betel nut, smoke fewer cigarettes, and drink less alcohol than the comparison group, and that these habits might have represented minor health issues in this particular population.

In conclusion, this study reports on a comprehensive risk evaluation of cancer among physicians. We analyzed cancer risk according to physician specialization and sex among the Taiwanese physician population. The findings showed that female physicians were at higher risk than male physicians for cancer overall. Furthermore, we analyzed the associations between physician specialization and the risk of specific cancer sites. Gynecologists were subject to the highest incidence of diagnosed uterine and ovarine cancer and prostate cancer, and surgeons were subject to the highest incidence of thyroid cancer. These findings all warrant further research.

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