Cancer Incidence among Physicians in Israel

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ABSTRACT: **Background:** Physicians' occupational environment includes exposures to potential carcinogenic factors on a regular basis. The prevalence of specific tumor types and subsequent mortality are reported to be elevated in physicians.

Objectives: To assess the incidence of various cancer types among Israeli physicians of various specialties, as compared with the general population, and to determine the role, if any, of gender and ethnicity.

Methods: This historical retrospective cohort analysis incorporated data on Israeli officially licensed physicians and information retrieved from the Israel National Cancer Registry database (INCR). Physicians were divided into five groups: non-specialists, internists, pediatricians, surgeons, and potentially at-risk specialties. Data were collected retrospectively for the years 1980–2007.

Results: The study cohort comprised 37,789 physicians, of whom 33,393 (88.37%) were Jews and 4396 (11.63%) were Arabs. Comparing Jewish physicians to the general population revealed higher rates of: a) breast cancer among female specialized physicians, and b) melanoma among specialized male and female physicians. All cancer types were more prevalent in the Arab physicians than in the general Arab population.

Conclusions: This study revealed incidences of specific cancer types among different medical specialties as compared to the general population. Hopefully, these findings will prompt changes in the occupational environment of physicians of particular specialties in order to reduce their high risk for cancer occurrence.

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Physicians are a particular group of workers whose occupational environment includes multiple exposures to potential carcinogenic factors. These factors include physical hazards associated with ionizing radiation [1], chemical hazards (e.g., cytostatic drugs, disinfectants and anesthetic gases) [2,3], and biological hazards (such as viral hepatitis or human deficiency virus) [4,5].

It has been previously reported that physicians have an elevated incidence of specific tumor types and subsequent mortality [6-9]. However, solid evidence is missing regarding the incidence of various cancer types among Israeli physicians as compared to the general population in terms of the physician's medical specialty, gender and ethnicity (Jews and Arabs). Accordingly, the main goal of the current study was to assess the incidence of various cancer types among male and female Israeli physicians of various specialties, Jews and Arabs, as compared to the general population. Data were collected for the years 1980–2007. Prospective findings may serve to motivate adjustments in the occupational environment of physicians of particular specialties and thereby reduce their high risk for cancer occurrence.

SUBJECTS AND METHODS

The current incidence-cohort study incorporated data of Israeli officially licensed physicians and information retrieved from the Israel National Cancer Registry database. Since physicians in Israel are licensed by the government, the official database of all licensed physicians was retrieved from the Ministry of Health.

Data items that were included in the database included: a) personal identification number (given to all Israeli citizens upon birth or immigration), b) gender, c) name, d) date and place of birth, e) date of immigration (if applicable), f) ethnic subgroup (Jews or Arabs), g) date of medical license, and h) date of specialization license (if applicable).

Information regarding cancer occurrence was retrieved from the INCR, which was previously described in detail [10]. In summary, the INCR is a population-based central tumor registry that was established in 1960; since 1982 reporting to the registry is mandatory. All medical facilities, both public and private, as well as pathology laboratories, that diagnose or treat cancer patients send a copy of their medical summary to the Registry. The INCR also collects data on cancer deaths from district health authorities and the Central Population Registry.

The personal identification number identifies an individual in all his/her contacts with all organizations in the country, including the health system. All demographic data,

INCR = Israel National Cancer Registry

including place of birth and immigration date, as well as residential and other personal data are stored in the Central Population Registry. Additionally, data on cancer incidence date, cancer site, morphology and behavior were retrieved from the INCR database. The INCR is linked to this Registry and each cancer patient's personal data are then retrieved and validated. The last audit of data completeness (2007) concluded that registration was > 95%. In the INCR, in addition to demographic data, all data available on malignant tumors and benign tumors of the central nervous system (excluding basal and squamous cell carcinomas of the skin) are registered including date of diagnosis, tumor location and morphology using the International Classification of Diseases for Oncology (ICD-O) version-3 codes. Other relevant data are coded in accordance with the US-SEER codes [11].

The physicians' cohort was electronically linked to the INCR. The linkage involved matching the personal identification number, names, gender, and date of birth between the two databases and assigning a score for a complete or partial match. Additional required information was sought manually using the database. Cases of cancer in the physicians' cohort were identified using the recorded linkage with the INCR since 1960. For the purpose of this study, if a physician had more than one Cancer, then only the first cancer, in chronological order, was considered (and counting the cohort's person-years was stopped at that point). We also included benign tumors of the CNS and cervical intraepithelial neoplasia III cases, since both are routinely registered in Israel.

Person-years for each subject in the physicians' cohort were calculated from birth until death, from arrival in Israel, from the date cancer was diagnosed, or the end of 2006 – whichever occurred first. (For some physicians, especially those who are not native Israelis, person-years were calculated using alternative methods, namely those mentioned above.) A person-year is a statistical concept used to analyze the risk of a particular event occurring. It can be applied to predict the probability of the event occurring during 1 year of follow-up.

Data were collected retrospectively for the years 1980–2007 using annual reference rates. The expected incidence of cancer in the physicians' cohort was calculated using an ad hoc analysis, which applied the respective age, gender, and cancer rates of the general population (and ethnic group where appropriate) of Israel to the person-year distribution of the physicians' cohort. We analyzed separately the standardized incidence ratio for male and female and for Jewish and Arab origin. SIR was calculated by dividing the observed cancer cases in the cohort by the corresponding expected number. The 95% confidence intervals were derived assuming Poisson distribution. The SIRs were calculated for separate leading cancer sites according to the accepted international definitions, and for the different specialty groups listed below. Medical specialization is controlled by the Ministry of Health which licenses specialists (board-certified physicians). On average, a specialization is 4–6 full years and it is assumed that specialists indeed serve in their field of specialty. The physicians' cohort was divided into five distinct groups of various specialties, which are characterized by a comparable occupational environment:

- **Non-specialists**, general practitioners with no particular medical specialty
- **Internists** (hematologists, endocrinologists, neurologists, family physicians, rheumatologists, public health physicians)
- **Pediatricians** and neonatologists
- **Surgeons** (general surgeons, and specialists such as neurosurgeons, thoracic surgeons, orthopedists, plastic surgeons, urologists, gynecologists/obstetricians, otolaryngologists, ophthalmologists)
- **Potentially at-risk specialists** (radiologists, gastroenterologists, cardiologists, nuclear medicine physicians, anesthesiologists, pathologists). The specialties included in this group are presumably affiliated with higher cancer risk from ionizing radiations and/or potentially hazardous chemical substances.

We did not have information regarding physicians who left the country or were not working in medicine, nor did we have information on possible malignant diseases they eventually had abroad. We can estimate that their share in the entire physicians' cohort is less than 5%.

RESULTS

PHYSICIANS' COHORT

The entire study cohort comprised 37,789 ever-licensed physicians (in contrast to actively performing physicians), of whom 33,393 (88.37%) were Jews and 4396 (11.63%) were Arabs [Table 1]. Among the Jewish physicians, 15,908 (47.6%) were females and 17,485 (52.4%) were males. The corresponding numbers among the Arab physicians were 1215 (27.64%) females and 3181 (72.36%) males.

CANCER DISTRIBUTION

In the entire study cohort, 4322 physicians (11.44%) were diagnosed with cancer. Of all cancer cases, 2044 occurred among Jewish male physicians (11.7% of all Jewish male physicians, 47.3% of all cancer cases), 1483 among Jewish female physicians (9.3% of all Jewish female physicians, 34.3% of all cancer cases), 585 among Arab male physicians (18.4% of all Arab male physicians, 13.5% of all cancer cases), and 210 among Arab female physicians (17.3% of all Arab female physicians, 4.9% of all cancer cases).

A total of 851,469 person-years were included in the analysis: 457,165 person-years (53.7%) for Jewish male phy-

SIR = standardized incidence ratio

Table 1. The study cohort by ethnicity, gender and specialization group

	Jews				Arabs			
Specialty group	**Male**	**Female**	**Total**	**%**	**Male**	**Female**	**Total**	**%**
No specialty	9007	7900	16,907	50.6%	1773	767	2540	57.8%
Internal medicine	4297	2651	6948	20.8%	635	238	873	19.9%
Pediatrics	1357	1250	2607	7.8%	200	90	290	6.6%
Surgery	1450	3442	4892	14.6%	404	66	470	10.7%
Radiology	1374	665	2039	6.1%	169	54	223	5.1%
Total	17,485	15,908	33,393		3181	1215	4396	

sicians, 303,023 (35.6%) for Jewish female physicians, 73,472 (8.6%) for Arab male physicians and 27,799 (3.2%) for Arab female physicians.

Regarding the occurrence of cancer of all types combined in the Jewish cohort according to specialty group and gender, cancer cases occurred most frequently among surgeons (12.55% of the corresponding cohort), closely followed by pediatricians (12.39% of the corresponding cohort). Cancer cases were least frequently reported in those with no specialty (9.29% of the corresponding cohort).

Table 2 compared the cancer incidence between (A) the study cohorts (Jewish specialized as well as non-specialized physicians) vs. the general population, and (B) Jewish specialized physicians vs. non-specialized physicians. Data are presented as standardized incidence rate and lower and upper 95% CI limits. Significant differences in cancer incidence ratios are shown in Figure 1.

Comparing cancer incidence between the study cohort (Jewish specialized as well as non-specialized physicians) and the general population yielded significant differences with regard to breast cancer and melanoma, while all sites combined also yielded a significant difference in the non-specialized cohort. Namely, higher rates of breast cancer were detected in female specialized physicians, and higher rates of melanoma were observed among specialized male and female physicians. Addressing the comparison between Jewish specialized physicians vs. non-specialized physicians revealed significant differences regarding all cancer types.

Focusing on the physicians with no specialty, both male and female physicians had a lower cancer incidence compared to the corresponding general population in all cancer sites combined.

Male pediatricians and surgeons exhibited a higher melanoma frequency than male non-specialized physicians. Concerning colorectal cancer, male internists, surgeons and radiologists showed a higher prevalence as compared to male non-specialized physicians. Similarly, the colorectal cancer incidence was higher among female radiologists than among female non-specialized physicians. Regarding prostate cancer, the data show a higher prevalence among male internists, pediatricians and radiologists than among non-specialized male physicians. Finally, a greater incidence of bladder cancer was noted among male internists and surgeons than among non-specialized physicians.

Regarding the general cancer incidence, the current study revealed that male and female internists, pediatricians, surgeons and radiologists demonstrated a higher cancer incidence compared with the male and female physicians with no specialty, respectively.

The comparison of Arab physicians with the general Arab population revealed that licensed male and female Arab physicians had significantly lower cancer incidences than the corresponding general Arab population, namely 0.33 (0.24–0.42) and 0.05 (0.00–0.11) times the cancer incidence of the general corresponding population, respectively (entries are presented as SIR and the lower and upper 95%CI limits).

DISCUSSION

The aim of the present study was to evaluate the incidence of various cancer types among male and female Israeli physicians, including Jewish and Arab physicians, of various specialties. Physicians may differ from the general population by exposure to potentially carcinogenic substances (such as ionizing radiation and cytotoxic materials) both in common practice and laboratories linked to the medical specialty. Consequently, we compared the rates in the specialized vs. non-specialized cohorts, and vs. those of the general population. Our findings indicate that both comparisons yielded notable specialty-, gender- and ethnicity-dependent differences. The main findings relating to the major cancer types are:

A. Specialized and non-specialized physicians vs. the general population

Notably, licensed specialized female physicians in all specialty groups collectively demonstrated a significantly higher incidence of breast cancer compared to the corresponding general population. Specifically, female internists had a significantly higher incidence of breast cancer as compared to the corresponding general population. These findings are in line with a recent study on cancer prevalence in Nordic countries where a similar trend was demonstrated [12]. Similarly, female orthopedic surgeons were recently reported to have a higher prevalence of cancer, particularly breast cancer [13]. These findings could be attributed to several factors, all of which are relevant to female physicians in general and to internists in particular. First, specialized physicians are exposed to ionizing radiation at a greater frequency than is the general population [14,15]. Second, it was reported that childbirth at an advanced age might enhance the risk of developing cancer [13,16,17]. Third,

CI = confidence intervals

Table 2. Comparison of standardized cancer incidence ratios between **[A]** the study cohort (Jewish specialized as well as non-specialized physicians) vs. the general population, and **[B]** Jewish specialized physicians vs. non-specialized physicians

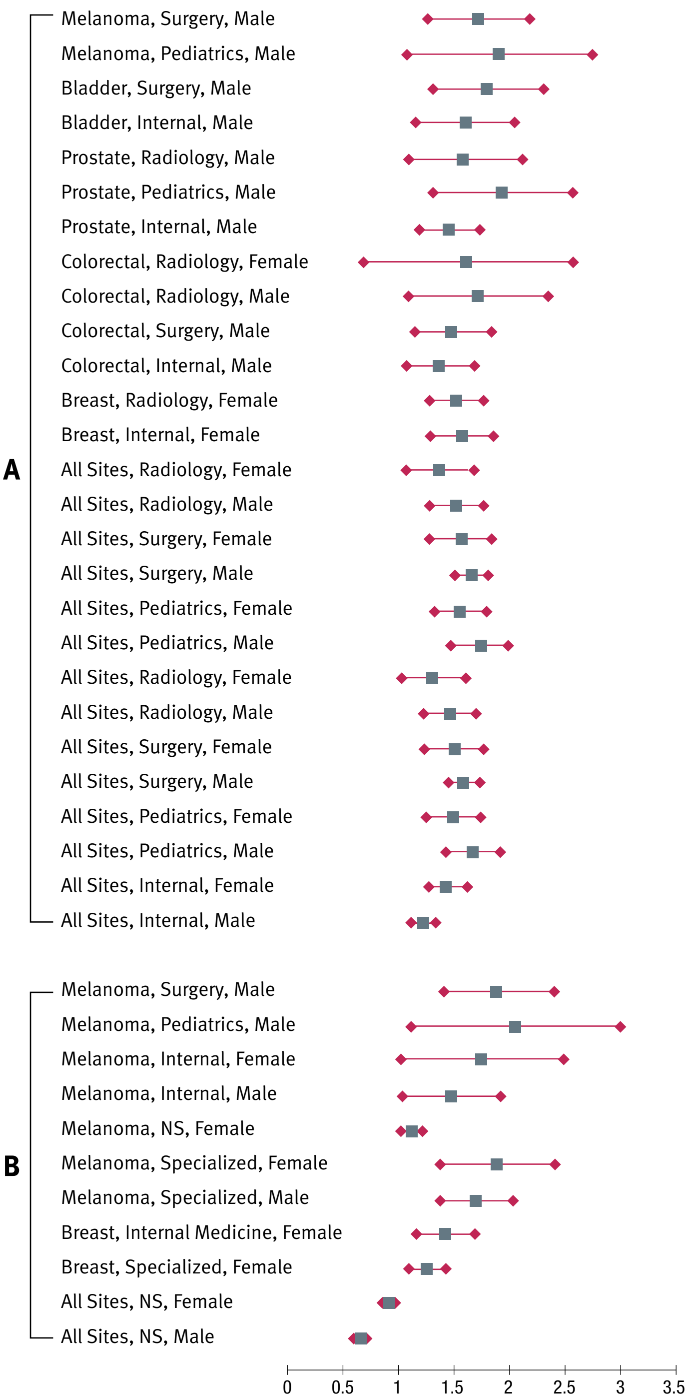
	Specialized groups (1-4)		Non-Specialized (0)		Internal medicine (1)		Pediatrics (2)		Surgery (3)		Radiology (4)		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
A														
All sites combined	0.85 (0.81-0.88)	1.06 (0.97-1.16)	* 0.66 (0.61-0.71)	* 0.92 (0.86-0.98)	0.97 (0.89-1.05)	1.15 (1.01-1.29)	1.04 (0.88-1.20)	1.17 (0.99-1.35)	0.99 (0.90-1.07)	1.17 (0.96-1.38)	0.92 (0.77-1.06)	1.06 (0.83-1.29)		
n	1327	629	717	854	513	270	160	163	498	116	156	80	2044	1483
Breast		* 1.26 (1.1-1.43)		0.98 (0.87-1.09)		* 1.43 (1.16-1.69)		1.29 (0.95-1.62)		1.05 (0.69-1.40)		0.94 (0.56-1.33)		
n	2	225	3	310	0	112	0	57	2	33	0	23	5	535
Colorectal	0.91 (0.76 -1.05)	0.79 (0.58-1.0)	0.68 (0.55-0.81)	0.94 (0.74-1.13)	0.87 (0.67-1.08)	0.79 (0.42-1.15)	0.63 (0.30-0.95)	0.79 (0.36-1.22)	0.96 (0.74-1.19)	0.96 (0.55-1.37)	1.12 (0.70-1.53)	1.46 (0.60-2.32)		
n	184	63	10	93	70	18	14	13	72	21	28	11	194	156
Prostate	0.85 (0.76-0.93)		0.70 (0.59-0.82)		0.98 (0.79-1.18)		1.31 (0.88-1.73)		0.79 (0.61-0.97)		1.07 (0.71-1.44)			
n	243	–	140	–	99	–	36	–	74	–	34	–	383	–
Bladder	0.79 (0.67-0.90)	1.20 (0.84-1.56)	0.59 (0.44-0.74)	1.10 (0.52-1.69)	0.93 (0.66-1.20)	2.02 (0.52-3.52)	0.98 (0.47-1.49)	1.17 (0-2.50)	1.03 (0.74-1.32)	1.09 (0-2.61)	0.69 (0.28-1.09)	1.79 (0-4.26)		
n	121	14	59	17	47	7	14	3	49	2	11	2	180	31
Melanoma	* 1.71 (1.39-2.03)	* 1.89 (1.37-2.42)	1.13 (0.86-1.40)	* 1.13 (1.04-1.22)	* 1.49 (1.04-1.93)	* 1.75 (1.02-2.49)	* 2.06 (1.14-2.99)	1.81 (0.79-2.84)	* 1.90 (1.40-2.40)	1.94 (0.67-3.21)	1.42 (0.68-2.16)	0.78 (0-1.67)		
n	131	46	68	49	43	22	19	12	55	9	14	3	199	95
B														
All sites combined					* 1.22 (1.10-1.34)	* 1.45 (1.28-1.63)	* 1.68 (1.43-1.65)	* 1.50 (1.27-1.73)	* 1.60 (1.46-1.74)	* 1.51 (1.23-1.78)	* 1.47 (1.23-1.71)	* 1.32 (1.03-1.61)		
Breast					* 1.31 (1.01-1.61)	* 1.52 (1.24-1.80)		1.33 (0.98-1.68)		1.08 (0.71-1.44)		* 1.47 (1.23-1.71)		
Colorectal	-Not Applicable-					0.86 (0.46-1.25)	0.93 (0.44-1.41)	0.87 (0.39-1.34)	* 1.42 (1.09-1.76)	1.77 (0.97-2.56)	* 1.65 (1.04-2.26)	* 1.56 (0.63-2.48)		
Prostate					* 1.39 (1.13-1.66)		* 1.86 (1.25-2.47)		1.13 (0.87-1.38)		* 1.52 (1.01-2.03)			
Bladder					* 1.54 (1.09-1.97)	1.82 (0.47-3.17)	1.66 (0.79-2.54)	0.97 (0-2.07)	* 1.73 (1.25-2.22)	0.90 (0-2.07)	1.16 (0.47-1.84)	1.18 (0-3.78)		
Melanoma					1.28 (0.89-1.66)	1.58 (0.91-2.23)	* 1.84 (1.01-2.66)	1.58 (0.68-2.47)	* 1.65 (1.21-2.09)	1.69 (0.58-2.79)	1.26 (0.60-1.92)	0.81 (0-1.54)		

Data are presented as standardized incidence ratio and the lower and upper the lower and upper 95% confidence interval limits, n represents the sample size
$^{*}P \leq 0.05$

a review and meta-analysis by Megdal et al. [18] suggested that night-shift work collectively causes an increased breast cancer risk among women. Moreover, a recent study of approximately 50,000 nurses demonstrated that an increased risk of breast cancer may be related to a larger number of consecutive night shifts. This corroborates previous reports linking elevated risk of breast cancer with longer periods of rotating night work. Additional factors increasing the cancer prevalence among female physicians may be a higher level of education [13,20], use of exogenous hormones, and alcohol consumption [13]. Accordingly, specialized female physicians may be prone to develop breast cancer at a higher prevalence as compared to the general population.

With regard to melanoma, male and female physicians of all specialty groups together had a higher occurrence compared to the corresponding general population; the high occurrence was seen particularly among male and female internists. The frequency was higher among male pediatricians and surgeons compared to the corresponding general population. Skin melanoma was the only cancer type with a higher prevalence among non-specialized female physicians. These findings corroborate previous reports of a higher prevalence of melanoma, regardless of specialty, among white male physicians and among physicians of both genders [12,21]. A possible explanation may be that physicians generally are not exposed to the sun routinely, but are more inclined to concentrated leisure-

Figure 1. Significant ($P \leq 0.05$) comparisons of standardized cancer incidence ratios between **[A]** Jewish specialized physicians vs. non-specialized physicians, and **[B]** the study cohort (Jewish specialized as well as non-specialized physicians) vs. the general population. Data are presented as standardized incidence ratio and the lower and upper 95% confidence interval limits



NS = non-specialized

time sun exposure which is often followed by sunburn. Such conduct is the major cause of malignant melanoma among susceptible people [12,21].

B. Specialized vs. non-specialized physicians

The incidence of breast cancer was significantly higher among female internists and radiologists compared to the female non-specialized cohort. This may be due to the longer and more frequent night shifts worked by female internists and radiologists, a finding associated with a higher prevalence of breast cancer [17-19]. This can be attributed to the fact that female non-specialized doctors may not practice medicine, let alone work the night shift.

Furthermore, alterations or disruptions of biological rhythms, recognized in shift work and sleep deprivation, are linked to several harmful processes, including impaired hormonal secretion patterns and increased risk of breast cancer [22]. It has also been reported that endocrine changes caused by circadian disruption with melatonin suppression through light at night may lead to the oncogenic targeting of the endocrine-responsive breast in women [23]. Furthermore, repeated phase-shifting with internal desynchronization could lead to defects in the regulation of the circadian cell cycle, favoring uncontrolled growth, while sleep deprivation leads to the suppression of immune surveillance that may permit the establishment and/or growth of malignant clones [23].

Finally, with regard to ethnicity, we observed a lower cancer incidence among male and female Arab physicians compared to the corresponding general Arab population. An explanation for the lower incidence among female Arab physicians compared to the corresponding general Arab population may be their higher utilization of screening procedures for preventing the development of malignant tumors, such as the fecal occult blood test for colorectal cancer and the Pap smear for cervical cancer. In other words, being in the medical field they have easy access to these medical tests. Although no significant link was found between academic education and higher utilization of screening tests [24], a study on the personal health of physicians found that preventive screening tests were performed significantly more often among physicians than in the general population, specifically the Pap smear test, sigmoidoscopy and colonoscopy [25].

LIMITATIONS

A major limitation of this study is that it deals with licensed physicians and not practicing physicians, and, therefore, some of them may not actually work in medical services. Another limitation regards those who left the country and are considered "lost to follow-up." On the other hand, these two categories comprise a small minority of physicians; moreover, they are relatively young (including those in the specialization process), most having graduated in the mid-1990s. We therefore believe that in a cohort of more than 800,000 person-years their weight is not sufficient to have an effect on the overall results. Finally, both the Jewish and Arab physicians represent a selective social group that is distinctive in terms of education, socioeconomic status and accessibility to medical services. This may partly account for the differences in cancer incidence between Jewish and Arab physicians and their corresponding general populations.

CONCLUSIONS

To the best of our knowledge, this study is the first to explore cancer incidence among physicians in Israel. We focused on general results and on several malignancies but the data require further investigation. We did not find a higher incidence in disciplines that are theoretically at higher risk (exposure to ionizing radiations and chemical substances), which is most likely due to implementation of safety regulations in the work environment.

The significance of the current study lies in its potential to encourage additional studies that may better delineate the potentially greater cancer risk of physicians. Moreover, the current study may motivate appropriate adjustments in the occupational environment of physicians of specific specialties in Israel and thus diminish their increased chances for cancer occurrence Such an undertaking will promote the well-being of physicians in Israel and substantially contribute to their quality of life.

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