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Cancer Epidemiology, Biomarkers & Prevention

Null Results in Brief

Tanning Bed Use Is Not Associated with Internal Cancer Risk: Evidence from a Large Cohort Study

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Abstract

Background: Increased risk of skin cancer by indoor tanning has drawn public attention. However, there are arguments that tanning bed use increases vitamin D production, which may therefore prevent internal cancers.

Methods: We followed 73,358 female nurses for 20 years (1989–2009) in the Nurses' Health Study II and investigated the frequency of tanning bed use during high school/college and at ages 25 to 35 in relation to the incidence of total cancers (excluding skin cancers). We used multivariate Cox proportional hazards models to estimate the HRs and 95% confidence intervals (CI) of total cancers and each individual major cancer with more than 100 cases.

Results: During follow-up, a total of 4,271 internal cancer–related cases were diagnosed. No association was found between tanning bed use and risk of total cancers (multivariable-adjusted HR, 0.99; 95% CI, 0.95–1.04 for every 4 times/y use on average during high school/college and at ages 25–35). In addition, no association was found for the risk of any individual major cancers, such as breast cancer, thyroid cancer, colorectal cancer, non-Hodgkin lymphoma, or endometrial cancer.

Conclusions: Our data do not suggest any association between the use of tanning beds and risk of internal cancers.

Impact: On the basis of the strong evidence of increase in skin cancer risk and no evidence of reduction in internal cancer risk by tanning bed use, it is important to warn the public against indoor tanning. *Cancer Epidemiol Biomarkers Prev; 22(12); 2425–9. ©2013 AACR.*

Introduction

We previously reported that use of tanning beds increased the risk of all three types of skin cancers (basal cell carcinoma, squamous cell carcinoma, and melanoma) by following up 73,494 female nurses for 20 years in the Nurses' Health Study II (NHSII; ref. 1). Our findings were further confirmed by two recent meta-analyses for both melanoma and nonmelanoma skin cancers (2, 3). However, there are arguments that use of tanning beds may be a good source of vitamin D, which has potential health benefits (4). Here, we report our investigation on tanning bed use in relation to the incidence of total internal cancers as well as individual major cancers in the same cohort. We carefully adjusted for outdoor sun exposure, UV index of residence, and dietary and supplemental vitamin D intake in addition to the known risk factors for cancers.

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Materials and Methods

Study population

Our study population consisted of participants in the NHSII, a prospective cohort study established in 1989 and enrolled 116,678 female registered nurses ages 25 to 42 and residing in the United States. Details of this cohort have been described previously (5). The protocol for this study was approved by the Institutional Review Board at Brigham and Women's Hospital and the Harvard School of Public Health (Boston, MA).

In the 2005 questionnaire, we collected information on the frequency of tanning bed use during high school/college and at ages 25 to 35 (none, 1–2 times/y, 3–5 times/y, 6–11 times/y, 12–23 times/y, and 24+ times/y). We obtained information about outdoor UV exposure, dietary and supplemental vitamin D intake, and other risk factors for cancer from the follow-up questionnaires. More details were described in our previous publications (6).

Eligible cases consisted of women with incident cancers diagnosed any time after the baseline up to the 2009 follow-up cycle. Only pathologically confirmed invasive cancer-related cases were included, except for breast cancer, which included both invasive and *in situ* cases.

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Table 1. Basic characteristics of participants in different categories of tanning bed use

	Tanning bed use during high school/college				Tanning bed use at ages 25 to 35			
Characteristics[a]	None	1 to 2 times/y	3 to 5 times/y	>6 times/y	None	1 to 2 times/y	3 to 5 times/y	>6 times/y
Mean age at baseline (y)	34.8	32.8	32.3	31.6	35.0	33.2	32.7	32.2
Height, m (SD)	1.6 (0.1)	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)	1.6 (0.1)	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)
BMI, kg/m (SD)	24.0 (5.0)	23.5 (4.7)	23.4 (4.4)	23.4 (4.4)	24.0 (5.0)	23.3 (4.3)	23.6 (4.5)	23.6 (4.7)
BMI at age 18, kg/m (SD)	21.3 (3.3)	21.0 (3.1)	20.9 (2.8)	20.9 (3.3)	21.3 (3.2)	21.0 (3.1)	21.2 (3.3)	21.2 (3.4)
Alcohol consumption at 1991, g/d (SD)	3.2 (6.1)	3.9 (7.6)	4.2 (6.7)	3.5 (5.8)	3.0 (6.0)	4.0 (6.7)	3.9 (6.3)	4.0 (7.1)
Physical activity, met • h/wk (SD)	27.2 (66.6)	27.9 (65.1)	36.5 (92.7)	29.8 (52.1)	26.5 (65.0)	30.4 (70.2)	34.4 (81.6)	32.0 (68.5)
Multivitamin use, %	45.8	49.1	49.3	48.8	46.1	47.8	47.8	44.9
Current smoker, %	11.8	13.7	13.6	14.6	11.0	14.0	15.5	18.8
Current oral contraceptive use, %	12.1	13.5	14.7	15.6	11.3	14.2	16.0	16.9
Postmenopausal women, %	5.8	5.9	4.2	6.3	5.3	7.4	7.8	9.6
History of benign breast disease, %	29.1	31.7	33.0	31.7	29.0	29.6	32.2	31.5
Family history of breast cancer, %	5.9	6.6	7.6	6.2	6.0	5.6	6.0	5.8
Age at menarche, y	13.4 (1.4)	13.5 (1.4)	13.5 (1.4)	13.4 (1.5)	13.4 (1.4)	13.4 (1.5)	13.5 (1.4)	13.4 (1.5)
Age at first birth, y (SD)	25.6 (3.9)	25.8 (4.4)	25.9 (4.4)	25.4 (4.7)	25.7 (3.9)	24.9 (4.2)	24.6 (4.4)	24.1 (4.3)
Parity among parous women, times	1.5 (1.2)	1.3 (1.2)	1.3 (1.2)	1.3 (1.2)	1.5 (1.2)	1.3 (1.2)	1.3 (1.2)	1.3 (1.1)
Vitamin D intake at 1991, IU/d (SD)	380.2 (249.6)	387.0 (256.2)	389.5 (258.3)	387.5 (259.3)	384.5 (249.8)	376.2 (260.1)	379.4 (254.1)	357.8 (261.2)
Outdoor sun exposure, 5+ h/wk (%)								
At high school/college	60	64.2	72.3	75.5	59.6	62.6	65.1	71
At ages 25 to 35	50.2	52.9	59.2	60.2	48.7	54.3	57.5	66.4
UV index in the state of residence, 7+ (%)								
At birth	18.5	19.9	20	22.1	18.2	20	20.5	23.8
At age 15	18.8	19.3	18.7	21.1	18.5	20.1	20.6	24.1
At age 30	25.1	26	24.3	27.2	25.1	24.8	25.2	27.3

Abbreviation: BMI, body mass index.

[a]On the basis of the information collected in baseline questionnaire in 1989 unless otherwise specified.

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Table 2. Use of tanning beds and cancer risk

		Average use of tanning beds (4 times/y)[a]		Use of tanning beds during high school/college (4 times/y)		Use of tanning beds at ages 25 to 35 (4 times/y)	
Cancers	**Cases (717,310 person-years)**	**Age-adjusted HR (95% CI)**	**Multivariable-adjusted HR[b] (95% CI)**	**Age-adjusted HR (95% CI)**	**Multivariable-adjusted HR[b] (95% CI)**	**Age-adjusted HR (95% CI)**	**Multivariable-adjusted HR[b] (95% CI)**
Total cancer	4,271	0.99 (0.95–1.04)	0.99 (0.95–1.04)	1.02 (0.97–1.07)	1.02 (0.97–1.07)	0.99 (0.96–1.02)	0.99 (0.96–1.02)
Breast cancer	2,779	1.00 (0.94–1.06)	0.99 (0.94–1.06)[c]	1.04 (0.99–1.10)	1.03 (0.98–1.09)[c]	0.98 (0.94–1.02)	0.98 (0.94–1.02)[c]
Thyroid cancer	306	0.95 (0.80–1.13)	0.97 (0.81–1.16)	1.01 (0.85–1.19)	1.01 (0.86–1.20)	0.95 (0.84–1.07)	0.97 (0.86–1.09)
Colorectal cancer	186	1.06 (0.86–1.30)	1.07 (0.86–1.31)	0.87 (0.63–1.20)	0.87 (0.63–1.20)	1.05 (0.92–1.20)	1.06 (0.92–1.21)
Non-Hodgkin lymphoma	185	1.10 (0.90–1.34)	1.10 (0.90–1.34)	1.09 (0.89–1.33)	1.09 (0.89–1.33)	1.05 (0.92–1.21)	1.05 (0.91–1.20)
Endometrial cancer	100	0.80 (0.50–1.27)	0.82 (0.52–1.30)[d]	0.93 (0.60–1.43)	0.97 (0.64–1.50)[d]	0.86 (0.63–1.16)	0.89 (0.66–1.19)[d]
Other cancers	715	0.97 (0.87–1.09)	0.95 (0.85–1.07)	0.93 (0.82–1.06)	0.92 (0.81–1.05)	1.01 (0.94–1.08)	0.99 (0.92–1.06)

[a]Average number of tanning bed use during high school/college and at ages 25 to 35.

[b]Adjusted for age, body mass index (BMI, <25, 25–29, 30–34, 35+ kg/m^2), alcohol consumption (none, 1–4, 5–9, 10–14, 15+ g/wk), physical activity (<3, 3–8, 9–17, 18–26, 27+ met • h/wk), multivitamin use (yes, no), smoking status (never, past smoker, current smoker), oral contraceptive use (never, past use, current use), menopausal status and use of hormone replacement therapy (premenopause, postmenopause without hormone replacement therapy, postmenopause with hormone replacement therapy), outdoor sun exposure during high school/college and at ages 25 to 35, UV index of residence (at birth, age 15, and age 30), as well as dietary and supplemental vitamin D intake.

[c]In addition adjusted for the history of benign breast disease (yes, no), family history of breast cancer (yes, no), parity and age at first birth (nulliparous, age at first birth <25 and parity 1–2, age at first birth 25–29 and parity 1–2, age at first birth 30+ and parity 1–2, age at first birth <25 and parity 3+, and age at first birth 25+ and parity 3+), age at menarche (<12, 12, 13, 14+), height (<1.60, 1.60–1.64, 1.65–1.70, 1.70+ m), and BMI at age 18 (<20, 20–22.4, 22.5–24, 25+ kg/m^2).

[d]In addition adjusted for parity and age at first birth (nulliparous, age at first birth <25 and parity 1–2, age at first birth 25–29 and parity 1–2, age at first birth 30+ and parity 1–2, age at first birth < 25 and parity 3+, and age at first birth 25+ and parity 3+), and age at menarche (<12, 12, 13, 14+).

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Statistical analysis

All participants in this analysis were U.S. non-Hispanic Caucasians. We also excluded the participants with missing information on tanning bed use or with self-reported cancers at baseline. We grouped women into four categories based on their self-reported frequency of tanning bed use (none, 1–2 times/y, 3–5 times/y, and ≥6 times/y) and created a continuous variable for linear trend test using the median value of each category. Participants contributed person-time data from the baseline in June 1989 to the first report (followed by confirmation) of a primary cancer, death, or the end of follow-up, whichever came earlier. We used age-adjusted and multivariate Cox proportional hazards models to calculate the HRs and 95% confidence intervals (CI) of total cancer and each type of major cancer with more than 100 cases. All of the statistical analyses were carried out using Statistical Analysis System software (version 9.1.3; SAS Institute). All *P* values were two-sided.

Results

During the 20-year follow-up of 73,358 female nurses from 1989 to 2009, a total of 4,271 cancer-related cases (excluding skin cancers) were diagnosed. The first primary cancers for which at least 100 cases were diagnosed were breast cancer ($n = 2,779$), thyroid cancer ($n = 306$), colorectal cancer ($n = 186$), non-Hodgkin lymphoma ($n = 185$), and endometrial cancer ($n = 100$). In Table 1, we present the basic characteristics of participants according to the frequencies of tanning bed use based on information collected in baseline questionnaire in 1989. People who used tanning beds more often either during high school/college or from ages 25 to 35 were more likely to be current smokers and oral contraceptive users. No substantial difference was found for other cancer risk factors across the different categories.

As a result, no association was found between tanning bed use and total cancer risk (Table 2). Both age- and multivariable-adjusted HRs were 0.99 (95% CI, 0.95–1.04) for an average of every 4 times/y use during high school/college and at ages 25 to 35. Separately for the use during high school/college and at ages 25 to 35, no association was found for the use during either period of time (multivariable-adjusted HR, 1.02; 95% CI, 0.97–1.07 for an average of 4 times/y use during high school/college; and multivariable-adjusted HR, 0.99; 95% CI, 0.96–1.02 for an average of 4 times/y use at ages 25–35). In addition, none of the individual major cancers (with at least 100 cases) was associated with tanning bed use in our cohort (Table 2).

We further conducted a secondary analysis restricted to incident cancer-related cases diagnosed after their report of tanning bed use in 2005 ($n = 1,315$). The results were very similar to those of our primary analysis using overall cases (multivariable-adjusted HR for total cancers, 0.94; 95% CI, 0.86–1.03 for an average of 4 times/y use during high school and at ages 25–35). No substantial difference was found for the risks of individual major cancers, nor did we find any significant association between dietary and supplemental vitamin D intake and cancer risk in the multivariable models (data not shown).

Discussion

In this large, well-characterized cohort study, we found no inverse association between tanning bed use and the risk of internal cancer after following 73,358 female nurses for 20 years. Our finding provided epidemiologic evidence to dispute against the claims by the indoor tanning industry that tanning bed use may has potential health benefits on cancer prevention by promoting vitamin D production. Of note, we have previously reported significantly increased risk of skin cancers with a dose–response relationship for the use of tanning beds in the same cohort (1), which further suggested an overall harmful effect of tanning bed use.

One limitation of our study is that we collected information on tanning bed use in the 2005 questionnaire cycle, which may introduce survival bias. To address this issue, we have conducted a secondary analysis restricted to the incident cancer-related cases diagnosed after report of tanning bed use in the 2005 questionnaire cycle; the results were very similar to those of our primary analysis using overall cases (multivariable-adjusted HR, 0.94; 95% CI, 0.86–1.03 vs. multivariable-adjusted HR, 0.99; 95% CI, 0.95–1.04 for every 4 times/y use).

In conclusion, our data do not suggest any association between the use of tanning beds and internal cancer risk. On the basis of the strong evidence of increase in risk of skin cancers (including melanoma) and no evidence of reduction in risk of internal cancers, it is important to warn the public against indoor tanning and increase regulations on the tanning industry.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: M. Zhang, D.J. Hunter, A.A. Qureshi, J. Han
Development of methodology: M. Zhang, F. Song, J. Han
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): M. Zhang, F. Song, D.J. Hunter, J. Han
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): M. Zhang, F. Song, D.J. Hunter, A.A. Qureshi, J. Han
Writing, review, and/or revision of the manuscript: M. Zhang, D.J. Hunter, A.A. Qureshi, J. Han
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): M. Zhang, F. Song, D.J. Hunter, J. Han
Study supervision: M. Zhang, J. Han

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