Exposure to Indoor Tanning Without Burning and Melanoma Risk by Sunburn History

Rachel Isaksson Vogel, Rehana L. Ahmed, Heather H. Nelson, Marianne Berwick, Martin A. Weinstock, DeAnn Lazovich

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Correspondence to: DeAnn Lazovich, PhD, Division of Epidemiology & Community Health, University of Minnesota, 1300 South 2nd St, #300, Minneapolis, MN 55454 (e-mail: lazov001@umn.edu).

Indoor tanning is carcinogenic to humans. Individuals report that they tan indoors before planning to be in the sun to prevent sunburns, but whether skin cancer is subsequently reduced is unknown. Using a population-based case–control study, we calculated the association between melanoma and indoor tanning after excluding exposed participants reporting indoor tanning–related burns, stratified by their number of lifetime sunburns (0, 1–2, 3–5, >5). Confounding was addressed using propensity score analysis methods. All statistical tests were two-sided. We observed increased risk of melanoma across all sunburn categories for participants who had tanned indoors without burning compared with those who never tanned indoors, including those who reported zero lifetime sunburns (odds ratio = 3.87; 95% confidence interval = 1.68 to 8.91; P = .002). These data provide evidence that indoor tanning is a risk factor for melanoma even among persons who reported never experiencing burns from indoor tanning or outdoor sun exposure.


Melanoma accounts for most skin cancer deaths, and unlike many common cancers, the incidence is increasing in the United States (1,2). Although intermittent sun exposure and sunburn are established risk factors for melanoma (3), artificial ultraviolet (UV) radiation exposure by indoor tanning was only recently confirmed to be a human carcinogen by the International Agency for Research on Cancer (4). A common reason stated for tanning indoors is to prevent sunburn (5–7), with the implication that, by avoiding sunburn, skin cancer risk is reduced (8,9). However, whether this is the case has not been reported. We used data from our recently completed population-based case–control study (10), one of the few with detailed information on indoor tanning and sun exposure, to test this hypothesis by examining indoor tanning and risk of melanoma stratified by lifetime sunburn history from none to more than five. Because indoor tanning–related burns are fairly common (10,11) and we wanted to examine whether moderate use of indoor tanning, evidenced by the absence of burning, is associated with melanoma, we excluded exposed persons who reported experiencing a burn while tanning indoors.

Methods for the Skin Health Study have been published (10). The Institutional Review Board at the University of Minnesota (FWA00000312) approved the study. Briefly, persons diagnosed with invasive cutaneous melanoma in Minnesota between 2004 and 2007 at ages 25 to 59 years (case patients) were ascertained by the state cancer registry. Persons without melanoma (control subjects) were frequency matched to case patients on age and sex and were randomly selected from the state drivers’ license list (including persons with state identification cards). Among potential participants, 1167 case patients and 1101 control subjects (84.6% and 69.2% of eligible, respectively) provided written consent and completed a self-administered questionnaire and telephone interview.

Information about sun exposure, sunscreen use, indoor tanning use, education, income, and family history of melanoma was collected by telephone interview, as detailed elsewhere (10,12). Lifetime sunscreen use was calculated by averaging the reported frequency score of sunscreen use across all reported activities within a decade and across all decade years for each participant. To obtain lifetime sunburns, we asked whether participants had a history of painful sunburn lasting more than 1 day and summed the number of such sunburns for two time periods: before they were aged 18 years and from age 18 years to the reference date. To determine the number of burns from indoor tanning, we asked if participants had ever burned from indoor tanning and, if yes, then how many times in their lifetime. We collected information on skin, hair, and eye color and presence and pattern of freckles and moles by self-administered questionnaire. A phenotypic risk score for melanoma, ranging from 1 (low) to 5 (high) was calculated using hair and eye color and tanning ability (13). After restricting the study sample to persons who tanned indoors but never burned and persons who never tanned indoors, 1857 (81.7% of the total) participants were available for this analysis; all but five (0.3%) had data on lifetime sunburns. Multiple logistic regression models were used to calculate the association between melanoma and indoor tanning, stratified by the number of lifetime sunburns (0, 1–2, 3–5, >5). To control for confounding, propensity score analysis methods were used (14). Weights were estimated using logistic regression with indoor tanning as the dependent variable and sex, age at reference date (in years), eye color (gray/blue, green, hazel, brown), hair color (red, blond, light brown, dark brown/black), skin color (very fair, fair, light olive, dark olive/brown/very dark brown/black), freckles (none, very few, few, some/many), moles (none, very few, few, some/many), income ($≤60,000, >$60,000, missing), education (completed college, did not complete college), family history of melanoma (yes, no, missing), lifetime routine sun exposure (continuous), lifetime sun exposure from
Elevated risks of melanoma were observed across all outdoor sunburn categories when we compared those who tanned indoors without burning to those who did not tan indoors (Table 1). In particular, among individuals who reported zero lifetime sunburns, the odds of being an indoor tanning user were almost four times higher in those who were diagnosed with melanoma compared with control subjects after adjustment for potential confounders (OR = 3.87; 95% CI = 1.68 to 8.91; P = .002). Sensitivity analyses found similar estimates of effects.

To further understand the observed associations, we sought to describe the phenotypic risk, sun sensitivity, and markers of sun protection, sun exposure, and indoor tanning use between case patients and control subjects according to their sunburn history (Table 2). As measured by total years or number of sessions, participants reported less use of indoor tanning as their history of sunburns increased; among those who reported no sunburns, case patients initiated tanning at a younger age and reported the highest number of years and sessions of indoor tanning use compared with case patients in any other sunburn group.

The main limitation of this analysis is the small sample size of participants upon stratification. As a case–control study, selection and recall bias are concerns, but an ancillary study that we performed did not reveal our previously reported odds ratios for indoor tanning and melanoma risk to be substantially biased (10). In addition, the proportion of participants in this analysis who reported skin sensitivity to the sun was lowest among case patients and control subjects who reported no burns from sun or indoor tanning, suggesting that these self-reported measures were reasonably accurate.

Several possibilities exist to understand our findings. First, tanning of the skin is the biological response to indicate that DNA damage from UV radiation has occurred. DNA repair mechanisms are not perfect, and some mutations may remain after repair processes. These mutations can lead to cell death and apoptosis, or they may accumulate and lead to skin cancer. Furthermore, previous studies have shown that DNA damage from UV radiation can cause mutations in the skin that may lead to melanoma development. Therefore, it is possible that individuals who engage in indoor tanning are more likely to develop skin cancer due to the accumulation of mutations from UV radiation.

In conclusion, our study provides evidence that indoor tanning is associated with an increased risk of melanoma, even among individuals who report no sunburns. These findings highlight the importance of sun safety measures and the need for public health interventions to reduce indoor tanning and skin cancer risk.
occurred; burns are not required to elicit this response (15,16). Second, tanning indoors without burning may allow for greater cumulative exposure to the damaging effects of artificial and/or solar UV radiation. Third, the intensity and proportion of UV-A and UV-B emitted by tanning devices have been shown to differ from the sun in ways that could increase risks associated with indoor tanning (17–19). Finally, the results could be biased if persons at risk of melanoma based on inherited characteristics were more likely to use indoor tanning to avoid intermittent sun exposure and sunburns; however, our data describing case patients and control subjects across sunburn categories do not support this explanation. In summary, our results expand upon the current scientific evidence by demonstrating that indoor tanning, even when used in a way that does not produce burns, is a risk factor for melanoma.

References


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Affiliations of authors: Masonic Cancer Center (RIV, HHN, DL), Department of Dermatology (RLA), and Division of Epidemiology and Community Health (HHN, DL), University of Minnesota, Minneapolis, MN; Department of Internal Medicine and University of New Mexico Cancer Center, Albuquerque, NM (MB); Division of Epidemiology and Biostatistics, University of New Mexico, Albuquerque, NM (MB); Dermatopelidemiology Unit, VA Medical Center, Providence, RI (MAW); Departments of Dermatology and Community Health, Brown University, Providence, RI (MAW).