BRIEF COMMUNICATION

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

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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 never experiencing burns from indoor tanning or outdoor sun exposure.


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. Several possibilities exist to understand this increased risk. There could be increased sensitivity to DNA damage from UV radiation, increased exposure to UV radiation, or a combination of both. To further understand the observed increased risk, 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).

### Table 1. Risk of melanoma by ever use of indoor tanning among individuals who tanned indoors without burning and never users stratified by lifetime burns from sun as estimated using logistic regression (n = 1892)*

<table>
<thead>
<tr>
<th>Burns from sun†</th>
<th>Case patients (n = 906)</th>
<th>Control subjects (n = 946)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (% exposed)</td>
<td>No. (% exposed)</td>
</tr>
<tr>
<td>0</td>
<td>32 (78.1)</td>
<td>67 (40.3)</td>
</tr>
<tr>
<td>1–2</td>
<td>142 (56.3)</td>
<td>199 (45.2)</td>
</tr>
<tr>
<td>3–5</td>
<td>172 (54.7)</td>
<td>188 (47.9)</td>
</tr>
<tr>
<td>&gt;5</td>
<td>560 (48.9)</td>
<td>492 (41.1)</td>
</tr>
</tbody>
</table>

* CI = confidence interval; OR = odds ratio.
† Adjusted for sex, age at reference date (in years), eye color (gray/blue, green, hazel, or brown), hair color (red, blond, light brown, or dark brown/black), skin color (very fair, fair, light olive, vs dark olive, brown, very dark brown, or 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 outdoor activities (continuous), lifetime sun exposure from outdoor jobs (continuous), and lifetime sunscreen use (continuous) as independent variables. All statistical tests were two-sided.

### Table 2. Risk factors for melanoma by lifetime burns from sun among case patients and control subjects who reported tanning indoors but never burned from use (n = 886)*

<table>
<thead>
<tr>
<th>Burns from sun (lasting &gt;1 day)</th>
<th>Case patients</th>
<th>Control subjects</th>
<th>Case patients</th>
<th>Control subjects</th>
<th>Case patients</th>
<th>Control subjects</th>
<th>Case patients</th>
<th>Control subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>41.1 ± 9.3</td>
<td>45.5 ± 9.7</td>
<td>45.5 ± 9.3</td>
<td>43.4 ± 9.5</td>
<td>44.6 ± 9.3</td>
<td>44.0 ± 8.9</td>
<td>46.2 ± 8.2</td>
<td>45.2 ± 8.6</td>
</tr>
<tr>
<td>1–2</td>
<td>2.8 ± 0.9</td>
<td>2.7 ± 0.9</td>
<td>3.0 ± 1.0</td>
<td>2.6 ± 1.0</td>
<td>3.0 ± 1.0</td>
<td>2.9 ± 0.9</td>
<td>3.1 ± 0.9</td>
<td>2.7 ± 0.9</td>
</tr>
<tr>
<td>3–5</td>
<td>12.0</td>
<td>11.1</td>
<td>21.5</td>
<td>21.4</td>
<td>34.0</td>
<td>24.7</td>
<td>44.6</td>
<td>34.7</td>
</tr>
<tr>
<td>&gt;5</td>
<td>13.4 ± 1.4</td>
<td>12.1 ± 1.1</td>
<td>15.4 ± 1.3</td>
<td>15.1 ± 1.2</td>
<td>1.5 ± 1.0</td>
<td>1.4 ± 1.1</td>
<td>1.5 ± 1.0</td>
<td>1.4 ± 0.9</td>
</tr>
</tbody>
</table>

* SD = standard deviation.
† 0 (never) to 5 (almost always).
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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