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# The association of indoor tanning and melanoma in adults: Systematic review and meta-analysis

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**Background:** Tanning beds are associated with increased risk of melanoma.

**Objective:** We sought to update the evidence of the association of melanoma and indoor tanning focusing on frequency of use and exposure to newer tanning beds.

**Methods:** We searched Scopus, MEDLINE, and Cumulative Index to Nursing and Allied Health Literature on August 14, 2013. We included all observational studies that included patients with melanoma who had indoor tanned. Odds ratios (OR) with 95% confidence intervals (CI) were extracted and combined using generic inverse variance methods assuming a random effects model.

**Results:** In all, 31 studies were included with data available on 14,956 melanoma cases and 233,106 controls. Compared with never using, the OR for melanoma associated with ever using indoor tanning beds was 1.16 (95% CI 1.05-1.28). Similar findings were identified in recent studies with enrollment occurring in the year 2000 onward (OR 1.22, 95% CI 1.03-1.45) and in subjects attending more than 10 tanning sessions (OR 1.34, 95% CI 1.05-1.71).

**Limitations:** The quality of evidence contributing to review results ranges from poor to mediocre.

**Conclusion:** Using tanning beds is associated with a subsequent melanoma diagnosis. Exposure from more than 10 tanning sessions is most strongly associated and there was no statistically significant difference in this association before and after 2000, suggesting that newer tanning technology is not safer than older models. (J Am Acad Dermatol 2014;70:847-57.)

**Key words:** indoor tanning; melanoma; meta-analysis; risk factor; skin cancer; solaria; systematic review; tanning beds.

Melanoma is a major public health concern worldwide. During the past 5 decades, incidence rates have increased in fair-skinned populations in North America,<sup>1</sup> Europe,<sup>2</sup> and Oceania.<sup>3-5</sup> Recent evidence suggests that the incidence of melanoma may have stabilized in North America, Australia, New Zealand, and Norway; however, incidence rates are increasing in southern and eastern Europe.<sup>6</sup>

Radiation from sunbeds is a “known human carcinogen”<sup>7</sup> increasing an individual’s likelihood

#### Abbreviations used:

CI:	confidence interval
IARC:	International Agency for Research on Cancer
OR:	odds ratio
UV:	ultraviolet

of developing melanoma.<sup>8,9</sup> A recent meta-analysis examined the burden of melanoma associated with use of indoor tanning globally.<sup>9</sup> To our knowledge,

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Funding sources: None.

Conflicts of interest: None declared.

Supplemental tables and figures are available at <http://www.jaad.org>.

Accepted for publication November 26, 2013.

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Published online March 14, 2014.  
0190-9622/\$36.00

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<http://dx.doi.org/10.1016/j.jaad.2013.11.050>

no meta-analysis to date has separately examined the association in geographic subgroups (North America, Europe, Oceania) and in persons younger than 25 years. In addition, a dose-dependent relationship between sunbed use and the association of melanoma is vaguely defined in the literature as “high use” versus never.<sup>9</sup> It is important to quantify this association in metrics that are more easily understood and personally relevant to patients.

Recent estimates report that 30 million North Americans expose themselves to indoor tanning and of those 2.3 million are adolescents.<sup>10</sup> The highest use is among Caucasian American women aged 18 to 21 years and 22 to 25 years with a prevalence of 31.8% and 29.6% use in the past year, respectively.<sup>11</sup> The prevalence of ever using sunbeds in Germany is 39.2% and within the past year was 14.6%.<sup>12</sup> Tanning bed use within the past year in Denmark was estimated to be 29% and with females aged 15 to 19 years comprising the highest users, 59%.<sup>13</sup> Sunbed use in Australia is lower than in North America and Europe with 10.6% of adults and 2.5% of teens reporting ever using tanning beds and the most frequent users being women age 18 to 24 years (17.1%) and 25 to 44 years (20.7%).<sup>14</sup>

The purpose of this systematic review and meta-analysis is to determine the association of melanoma from the use of indoor tanning beds worldwide in terms of frequency of use, and use of newer tanning beds.

## METHODS

### Study selection

Included studies were all cohort, case-control, and cross-sectional studies that examined patients given the diagnosis of melanoma who were exposed or not to indoor tanning. For retrospective studies, the main measurement outcome was development of melanoma (yes/no). For prospective studies, the main measurement outcome was time to melanoma diagnosis. Excluded studies were reviews, ecological studies, case reports, editorials, commentaries, letters, news, perspectives, conference proceedings, *in vitro*/*in vivo* studies, and studies with irrelevant content. Theses and unpublished studies were excluded (Supplemental Table I). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis of Observational

Studies in Epidemiology (MOOSE) checklists were followed to report the meta-analysis findings.<sup>15,16</sup>

### Literature search

A search for all relevant observational studies in Scopus (from 1996), MEDLINE (from 1946), and Cumulative Index to Nursing and Allied Health Literature (from 1937) was performed up to August 14, 2013. One author performed the search with assistance from a medical librarian with expertise in searching research bibliographies. No limits to date or language were applied. Translations were obtained for articles that were published in languages other than English or French. A manual search was conducted on references

cited in selected articles and meta-analyses/systematic reviews on this topic.<sup>9,17-20</sup> Efforts were made to contact the authors of 6 studies.<sup>21-26</sup> Authors from 3 studies<sup>23-25</sup> responded and none were able to locate their original data sets as they were 20 to 40 years old. Subsequently, these 6 studies were included in the systematic review but were excluded from the meta-analysis because they did not include an estimate of odds of melanoma.

The electronic search strategy to identify relevant articles included searching for articles containing the key word “melanoma” in combination with any of the following key words to identify indoor tanning exposure: “sunbed,” “sun bed,” “sunbathing,” “indoor tanning,” “tanning bed,” “tanning parlor,” “tanning salon,” “tanning booth,” “solaria,” “solarium,” “sun lamp,” “artificial UV,” “artificial ultraviolet,” and “artificial light” (see Supplemental Table II for full search strategy). Key words were truncated appropriately to catch all variations and word endings to assure that studies pertaining to melanoma and indoor tanning were identified.

### Data extraction and statistical analyses

Two authors checked titles and abstracts found in this search and determined the eligibility of the article using the defined inclusion criteria (Supplemental Table I). Information was extracted from the articles meeting the inclusion criteria by 2 authors and 1 entered it into Review Manager software (RevMan5)<sup>27</sup> for analysis. Data were extracted following RevMan5<sup>27</sup> criteria developed by Cochrane Review. Two authors assessed the risk of selection bias, recall bias, and interview bias. Studies

### CAPSULE SUMMARY

- Indoor tanning increases melanoma risk.
- This meta-analysis observes increased risk particularly after 10 tanning sessions, and this risk persists despite lower-risk technical changes to ultraviolet bulbs.
- Risk estimates based on number of sessions facilitates patient risk assessment and patient education.

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