American Suntanning Association

March 25, 2016

Office of Science Quality
Centers for Disease Control and Prevention
InfoQuality@cdc.gov

This is a submission of an information quality request for correction.

Detailed description of the specific information that needs to be corrected.

The information that needs to be corrected is the first and second bullet points under the heading "Statistics" appearing in the section of the CDC's website titled "Indoor Tanning is not Safe" at http://www.cdc.gov/cancer/skin/basic_info/indoor_tanning.htm , as follows:

" -- A 2014 study by Wehner and colleagues (http://www.ncbi.nlm.nih.gov/pubmed/24477278) estimated that more than 400,000 cases of skin cancer may be related to indoor tanning in the United States each year – causing 245,000 basal cell carcinomas, 168,000 squamous cell carcinomas, and 6,000 melanomas."

The specific reasons for believing the information does not comply with OMB, HHS or CDC guidelines and is in error.

The referenced 2014 study by Wehner and colleagues is of such poor scientific quality that all mention of it should be deleted from the CDC's website. See "Critical Review of Wehner et al. 2014 Estimates of the Prevalence of Ever Exposure to Indoor Tanning in Adults and the Number of Excess Cases of Skin Cancer by Diana B. Petitti, M.D., M.P.H., dated January 16, 2016 attached hereto as Exhibit A. The objected-to sentence quoted above is an incorrect statement of science. Incorrect statements of science are not compliant with CDC and HHS guidelines.

The specific recommendation for correcting the information

We recommend deletion of the following language appearing in the section of the CDC's website titled "Indoor Tanning is not Safe" at http://www.cdc.gov/cancer/skin/basic_info/indoor_tanning.htm:

" -- A 2014 study by Wehner and colleagues (http://www.ncbi.nlm.nih.gov/pubmed/24477278) estimated that more than 400,000 cases of skin cancer may be related to indoor tanning in the United States each year – causing 245,000 basal cell carcinomas, 168,000 squamous cell carcinomas, and 6,000 melanomas."

Description of how the person submitting this complaint is affected by the information error

The American Suntanning Association represents the owners of approximately 1,000 indoor tanning salons in 31 states of the U.S. The information error harms the business of indoor tanning salons by disseminating incorrect information about the risks of tanning.

The name, mailing address, telephone number and e-mail address of the person making this complaint

The person making this complaint is the American Suntanning Association, which is a trade association of indoor tanning salon owners in the United States. The mailing address, telephone number and e-mail address of the American Suntanning Association is:

American Suntanning Association
Attn: Barton D. Bonn, President
PO Box 1907
Jackson, MI 49204
Telephone 402-968-6936
E-mail address bonnbart@gmail.com
Copy to: Allen Miller apmillerlaw@aol.com
Telephone 214-766-7283

Respectfully submitted,

American Suntanning Association

By: /s/
Barton D. Bonn, President

Attachments:

Exhibit A – Critical Review of Wehner et al. 2014 Estimates of the Prevalence of Ever Exposure to Indoor Tanning in Adults and the Number of Excess Cases of Skin Cancer, Diana B. Petitti, M.D., M.P.H., January 16, 2016.

Exhibit A

Critical Review of Wehner et al. 2014 Estimates of the Prevalence of Ever Exposure to Indoor Tanning in Adults and the Number of Excess Cases of Skin Cancer

Diana B. Petitti, M.D., M.P.H.
January 19, 2016

Address correspondence to:
Dr. Diana Petitti
1711 W. Lodge Drive
Phoenix, Arizona 85041

diana.petitti@yahoo.com
(602) 803-8798

Funding Source: This review was conducted for the American Suntanning Association. Dr. Petitti was compensated for her time in preparing the review. The American Suntanning Association did not have rights to modify the final report. Dr. Petitti is solely responsible for the content of the report and its conclusions.

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Summary

Overview of Reviewed Publication

This report is a critical review of the Wehner et al. (2014) publication titled "International Prevalence of Indoor Tanning: a Systematic Review and Meta-analysis." The Wehner et al. (2014) publication presents estimates of the prevalence of ever exposure to indoor tanning and exposure to indoor tanning in the past year among adults, adolescents, and university students in the United States, Northern and Western Europe, and Australia. The publication also presents the results of a model that uses the meta-analytically-derived summary estimates of the prevalence of ever exposure to indoor tanning in adults based on the studies identified in the systematic review in conjunction with other data (described in more detail below) to estimate of the number of squamous cell skin cancers, basal cell cancers and malignant melanomas attributable each year to indoor tanning in the United States, Northern and Western Europa, and Australia.

Based on their systematic review and meta-analysis, Wehner et al. (2014) conclude that the prevalence of ever exposure to indoor tanning is 35% in adults in the United States, 42% in adults in Northern and Western Europe and 11% in adults in Australia. Using these prevalence estimates and other data, Wehner et al. (2014) conclude that 419,245 skin cancers, including 6,199 melanomas, are attributable each year to indoor tanning in the United States; that 26,484 skin cancers, including 4,874 melanomas, are attributable each year to indoor tanning in Northern and Western Europe; and that 18,441 skin cancers, including 301 melanomas, are attributable each year to indoor tanning in Australia.

Estimates of the number of skin cancers attributable each to indoor tanning in the United States are presented as facts about the effects of indoor tanning at the Centers for Disease Control and Prevention (CDC) website http://www.cdc.gov/cancer/skin/basic_info/indoor_tanning.htm (access 11/14/2015) . They are featured in a 2015 CDC grand rounds that is available at the CDC website www.cdc.gov/cdcgrandrounds/pdf/archives/2015/april2015.pdf. The prevalence estimate for ever exposure to indoor tanning in adults in the United States and the estimates of the number of skins cancer attributable to tanning in the United States are cited in a December 18, 2015 New York times article about indoor tanning (http://www.nytimes.com/2015/12/19/health/fda-proposes-ban-on-indoor-tanning-for-minors-to-fight-skin-cancer.html)

Scope of Comments in the Report

My comments about the Wehner et al. (2014) publication pertain to the systematic review and meta-analysis that identified the studies that were used to derive summary estimates of the prevalence of ever exposure to indoor tanning in adults in the United States, Northern and

Western Europe, and Australia and to the use of these prevalence estimates to derive an estimate of the number of skin cancers attributable each year to indoor tanning in the United States, Northern and Western Europe, and Australia.

My Conclusions

United States

None of the studies reporting the prevalence of ever exposure to indoor tanning in adults that Wehner et al. 2014 identified in their systematic review provide data representative of the general adult population of the United States. Several of the studies are from haphazard samples. For example, one study, *Mawn and Fleischer 1993* (Wehner et al. reference 23) collected data using self-administered questionnaires distributed to "477 persons in a shopping mall, at a social gathering, and on a vacation cruise ship." Another study, *Hoerster et al. 2007* (Wehner reference 40) collected data about the prevalence of ever exposure to indoor tanning in adults in the United States from a telephone survey of households that were selected because they had a high likelihood of having a child 14, 15, 16, or 17. Responses about ever exposure to indoor tanning in adults pertain to households with an adult who had a child age 14, 15, 16, or 17 years. One study, *Lazovich et al. 2008* (Wehner reference 36), collected data about the prevalence of ever exposure to indoor tanning in adults in the United States using an interviewer-administered questionnaire given to a 26 adults recruited from an undergraduate psychology seminar and a convenience sample of adult staff and friends in Virginia and from flyers, announcements, and advertisements in Massachusetts. One study *Cohen et al. 2013* (Wehner reference 29) collected data about the prevalence of ever exposure to indoor tanning in adults in the United States using a self-administered questionnaire given to a "convenience" sample of 100 parents of children being seen in three pediatric practices in Chicago.

One study, *Mawn and Fleischer 1993* (Wehner et al. reference 23), collected data in 1992, more than two decades before 2014, the year for which the estimate of the prevalence of ever exposure to indoor tanning in adults was made. Several other studies collected data more than a decade before 2014.

The meta-analytically derived estimate of the prevalence of ever exposure to indoor tanning for adults in the United States based on the studies identified by Wehner et al. (2014) is meaningless; the estimate of the number of skin cancers attributable to indoor tanning in the United State based on this meaningless estimate is meaningless.

Northern and Western Europe

The Wehner et al. (2014) systematic review identified studies of the prevalence of ever exposure to indoor tanning adults that were done in the United Kingdom, Ireland, France, Germany, Denmark, and Sweden. Only one study, Borner et al. (2009) had a sampling frame that could have yielded data representative of Germany but the r response rate was very low (13%). Germany is not representative of all of Northern and Western Europe. Austria, Belgium, Luxembourg, the Netherlands, Estonia, Finland, Iceland, Latvia, Lithuania, Norway and Switzerland are countries in Northern and Western Europe for which no prevalence data were identified.

One study, *Bränstrom et al. 2004 (*Wehner reference 28), collected data about the prevalence of ever exposure to indoor tanning in adults based on population-based sample limited to adults age 18-37 years in Stockholm County, Sweden One study, *Pertl et al. 2010* (Wehner reference 37), collected data about the prevalence of ever exposure to indoor tanning in adults using an interviewer-administered questionnaire given to "convenience sample" of adults between age 16 and 27 recruited in "various locations around Ireland (e.g., schools, sports clubs, universities and train stations."

One study, *Jackson et al. 1999*, (Wehner reference 33) collected data in 1995, nineteen years before 2014, the year for which the estimate of prevalence was made. Several other studies collected data more than a decade before 2014.

The meta-analytically derived estimate of the prevalence of ever exposure to indoor tanning for adults in Northern and Western Europe based on the studies identified by Wehner et al. (2014) is meaningless; the estimate of the number of skin cancers attributable to indoor tanning in Northern and Western Europe based on this meaningless estimate is meaningless.

Australia

The Wehner et al. (2014) systematic review identified one study (Francis et al. 2010) that reported a measure of the prevalence of ever exposure to indoor tanning adults in Australia that is probably "in the ball park." The prevalence measure based on data collected in 2007/2008 is reasonably current considering 2014 as the year for which the estimate was made. The sources of data on the annual number of incident melanoma and non-melanoma skin cancers in Australia is credible and I was able to verify the accuracy of these estimates.

Summary of the Systematic Review and Meta-analysis

Wehner et al.'s state (p. 391) that their systematic review sought to obtain prevalence estimates "representative of the general population." Specifically excluded as non-representative (page 391) were "studies of groups recruited based on factors that could be related to indoor tanning (e.g., studies of indoor tanners, skin cancer screening participants, dermatology clinic patients, and patients with skin cancer)." Also excluded (page 391) were case-control studies.

Wehner et al. (2014) do not specify the criteria used to define an estimate of prevalence as representative of the general population other than by applying these exclusions.

The systematic review identified 17 studies reporting on the prevalence of ever exposure to indoor tanning in adults that the authors concluded met the eligibility criterion as representative of the general population. (Mawn and Fleisher 1991; Moore et al. 2003; Lazovich et al. 2005; Woodruff et al. 2006; Hoerster et al. 2007; Lazovich et al. 2008; Cohen et al. 2013; Jackson et al. 1999; Boldeman et al. 2001; Bränstrom et al. 2004; Ezzedine et al. 2008; Börner et al. 2009; Schneider et al. 2009; Pertl et al. 2010; Køster et al. 2011; Schneider et al. 2013; Lawlor et al. 2006; Francis et al. 2010. These studies reported 22 estimates of the prevalence of ever exposure to indoor tanning in adults. The estimates of prevalence of ever exposure to indoor tanning in adults in these 17 studies are shown in Wehner et al.'s Figure 2 forest plot (page 393).

Seven studies (Mawn and Fleisher 1991; Moore et al. 2003; Lazovich et al. 2005; Woodruff et al. 2006; Hoerster et al. 2007; Lazovich et al. 2008; Cohen et al. 2013) met the Wehner et al. (2104) eligibility criterion as representative of ever exposure to indoor tanning in United States adults. These studies yielded seven estimates of prevalence of ever exposure to indoor tanning in adults in the United States.

Nine studies identified in the systematic review (Jackson et al. 1999; Boldeman et al. 2001; Bränstrom et al. 2004; Ezzedine et al. 2008; Börner et al. 2009; Schneider et al. 2009; Pertl et al. 2010; Køster et al. 2011; Schneider et al. 2013) met the Wehner et al. (2014) eligibility criterion as representative of the prevalence of ever exposure to indoor tanning in adults in Northern and Western Europe. These studies yielded 13 estimates of prevalence of ever exposure to indoor tanning in adults in Northern and Western Europe.

Two studies identified in the systematic review (Lawlor et al. 2006; Francis et al. 2010) met the Wehner et al. (2104) eligibility criterion as representative of the prevalence of ever exposure to indoor tanning in Australia adults;. These studies yielded three estimates of prevalence of ever exposure to indoor tanning in adults in Australia.

Measures of Exposure Prevalence Representative of the General Population

Exposure prevalence is the proportion of individuals in a defined population that have been exposed to a factor that affects or might affect disease or health. Exposure prevalence is measured in relation to a specified point in time (point prevalence) or during a specified period of time (period prevalence). For indoor tanning, possible measures of exposure prevalence include ever exposure in a lifetime and exposure in the last day, month, year, or some other time period.

Exposure prevalence is usually measured by collecting information directly from potentially exposed individuals using surveys or questionnaires, although for some conditions that are considered exposures (e.g., obesity, low hemoglobin), exposure prevalence might be measured using physical examination or laboratory measurement of blood or bodily fluids. For indoor tanning, exposure prevalence has been measured by collecting information directly from potentially exposed individuals.

Measures of exposure prevalence that represent exposure in the general population are often of public health interest. They are used to guide policies that seek to mitigate the adverse effects of the exposure on health with the aim of improving health and well-being.

It is difficult to obtain measures of exposure prevalence that are representative of the general population. To accomplish this aim requires drawing samples (generally large samples) that are representative of the general population (or drawing samples that can be made to represent the general population, such as stratified samples and appropriate weighted analysis); collecting data systematically with scrupulous attention to quality control in data collection; obtaining high response rates or obtaining responses that are representative of those asked to provide data; and appropriately analyzing data.

To be useful for making policy pertinent to the general population of a country or a region or the world, exposure prevalence data must be reasonably current.

Several on-going periodic surveys—e.g., the National Health Interview Survey (NHIS) and the Behavioral Risk Factor Surveillance System (BRFSS) in the United States and comparable surveys in other countries—collect information on the current prevalence of various exposures using methods that attempt to assure that exposure prevalence is representative of the general population.

Description of Studies in the Systematic Review and Meta-analysis Considered Representative of the General Population

Summary

The description of the studies considered to be eligible as representative of the prevalence of ever exposure to indoor tanning in adults appears in Wehner et al.'s (2014) e-Appendix. Absent from this e-Appendix description are statements about the survey method (e.g., self-administered questionnaire, interviewer administered questionnaire, phone survey, mailed survey, web survey), detail about the methods for selecting potential participants and/or the sampling frame, and response rates.

I read the full text of each of 16 of the 17 publications that Wehner et al. (2014) identified as yielding an estimate of the prevalence of ever exposure to indoor tanning in adults representative of the general population. The full text of one study (Mawn and Fleischer 1993) could not be obtained but the abstract presented detail on the study methods. I prepared a table (Table 1) that describes the survey method, the sampling frame / data collection method, and the response rate from the 17 publications. The exact wording from the methods section of several papers is presented in the table in several instances. Table 1 provides information on the year of data collection, which appears also in the Wehner et al. (2014) e-Appendix.

My Table1 includes my comments on the representativeness of the data for the country/region for which the data are meant to be representative and delineates other concerns about using the data to draw conclusions about the prevalence of ever exposure to indoor tanning in adults for the general population of the United States, Northern and Western Europe, and Australia. A summary of the studies and my comments on each study considering the representativeness of the data for the general population is summarized below.

United States

Mawn and Fleischer 1993 (Wehner reference 23) collected data about the prevalence of ever exposure to indoor tanning in adults in 1992 using self-administered questionnaires distributed to "477 persons in a shopping mall, at a social gathering, and on a vacation cruise ship." The response rate was not reported in the abstract.

Comment. The data are not current. The sample is haphazard. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Moore et al. 2003 (Wehner reference 25) collected data about the prevalence of ever exposure to indoor tanning in adults in 2002 using a self-administered questionnaire "distributed randomly by nursing staff to patients over the age of 18 who had a routine appointment" in a single primary care clinic in rural northeaster North Dakota. The response rate was not reported.

Comment. The data are not current. The sample is a convenience sample, not a representative sample. The data on the prevalence of exposure to indoor tanning reported in this study are not representative of the general population of adults in the United States.

Lazovich et al. 2005 (Wehner reference 24) collected data about the prevalence of ever exposure to indoor tanning in adults in 2002 using a telephone survey of adults from randomly selected households in Minnesota. The response rate was 45%.

Comment: The data are not current. The response rate is probably high enough to yield a sample that is representative of adults in Minnesota. Minnesota is not, however, representative of the entire United States. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Woodruff et al. 2006 (Wehner reference 40) collected data in 2004 about the prevalence of ever exposure to indoor tanning in adults in the United States in a telephone survey of households in Columbia, South Carolina and New Haven Connecticut that were selected because they had a high likelihood of having a child age 14, 15, 16, or 17. Responses about ever exposure to indoor tanning in adults pertain to adults living in households that had a child age 14, 15, 16, or 17 years. The response rate was 50% with an introductory letter and 45% without. This study was a pilot study for the study reported by Hoerster et al. (2007).

Comment: The data are not current. The response rate is probably high enough to yield a sample that is representative of adults in Columbia, South Carolina and New Haven, Connecticut living in households that have a child age 14-17 years. Data on the prevalence of exposure to indoor tanning in adults living in households that have a child in the age range 14-17 years are not representative of all adults. Data from adults in Columbia, South Carolina and New Have Connecticut are not representative of adults in the entire United States. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Hoerster et al. 2007 (Wehner reference 40) collected data in 2005 about the prevalence of ever exposure to indoor tanning in adults in the United States from a telephone survey of households that were selected because they had a high likelihood of having a child 14, 15, 16, or 17. Responses about ever exposure to indoor tanning in adults pertain to households with an adult who had a child age 14, 15, 16, or 17 years. The sampled households in this study were in the 100 largest cities in the United States. The response rate was 75%.

Comment: The data are not current. The response rate is high enough to yield a sample that is representative of adults in the 100 largest cities in the United States living in households that have a child age 14-17 years. Data about adults living in the 100 largest cities would approximate data from adults living in the entire United States only if a very high proportion of all adults in the United States live in these 100 cities; the proportion of the United States adult population living in these 100 cities is not discussed. Data on the prevalence of exposure to

indoor tanning in adults living in households that have a child in the age range 14-17 years are not representative of all adults. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Lazovich et al. 2008 (Wehner reference 36) collected data in 2006 about the prevalence of ever exposure to indoor tanning in adults in the United States using an interviewer-administered questionnaire given to a 26 adults recruited from an undergraduate psychology seminar and a convenience sample of adult staff and friends in Viriginia and from flyers, announcements, and advertisements in Massachusetts. The response rate was not reported.

Comment: The data are reasonably current. The sample is haphazard. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Cohen et al. 2013 (Wehner reference 29) collected data in 2010 about the prevalence of ever exposure to indoor tanning in adults in the United States using a self-administered questionnaire given to a "convenience" sample of 100 parents of children being seen in three pediatric practices in Chicago. The response rate was not reported.

Comment: The data are reasonably current. Data on the prevalence of ever exposure to indoor tanning in parents of children being seen in a pediatric practice in Chicago are not representative of adults in Chicago. Data on the prevalence of ever exposure to indoor tanning in adults in Chicago is not representative of adults in the entire United States. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in the United States.

Northern and Western Europe

Jackson et al. 1999 (Wehner reference 33) collected data about the prevalence of ever exposure to indoor tanning in adults in 1995 using a self-administered questionnaire given to randomly selected patients age 16+ years being seen for a GP consultation in 18 randomly selected group practices in Crewe and Macclesfield Health Districts in Cheshire, United Kingdom. The response rate was 89% for practices asked to participate. The response rate was 69% in patients asked to respond.

Comment: The exposure prevalence data are not current. The response rate for both practices and patients is high enough to yield a sample that is representative of adults who are being seen for a GP consultation in this area of the United Kingdom. It is not certain whether adults being seen by a GP in these health districts are representative of all adults in these health districts. Adults in this area of the UK are not representative of all adults in the UK. The UK is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Boldeman et al. 2001 (Wehner reference 26) collected data about the prevalence of ever exposure to indoor tanning in adults in 1999 using a questionnaire mailed to a random sample of adults age 20-50 years in Stockholm County, Sweden The response rate was 68%.

Comment: The exposure prevalence data are not current. The response rate is high enough to yield a sample that is representative of adults age 20-50 years in Stockholm County, Sweden. Adults age 20-50 years in Stockholm County are not representative of all adults in Sweden. Sweden is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

*Bränstrom et al. 2004 (*Wehner reference 28) collected data about the prevalence of ever exposure to indoor tanning in adults in 2001 using a questionnaire mailed to a "random population-based sample" of adults age 18-37 years in Stockholm County, Sweden The response rate was 55%.

Comment: The exposure prevalence data are not current. The response rate is high enough to yield a sample that is representative of adults age 20-37 years in Stockholm County, Sweden. Adults age 20-37 years in Stockholm County are not representative of all adults in Sweden. Sweden is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Ezzedine et al. 2008 (Wehner reference 30) collected data about the prevalence of ever exposure to indoor tanning in adults in 2001 using a questionnaire—the "sun survey"--mailed to 12,741 participants in a French cohort study that was assembled in 1994-1995. The response rate to the "sun survey" among cohort members was 57%.

Comment: The exposure prevalence data are not current. The response rate is probably high enough to yield data that representative of all cohort members. While the original cohort was assembled to be representative of French adults in 1994-1995, the representativeness of the cohort of French adults in 2001 is uncertain. France is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Börner et al. 2009 (Wehner reference 27) collected data about the prevalence of ever exposure to indoor tanning in adults in 2007 using a telephone survey of a nationally representative sample of Germans age 14+ years contacted using random digit dialing. The response rate was 13%.

Comment: The exposure prevalence data are reasonably current. The response rate is very low and the data may not be representative of Germans 14+ years of age given the low

response rate. Germany is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Schneider et al. 2009 (Wehner reference 39) collected data about the prevalence of ever exposure to indoor tanning in adults in 2007 using a telephone survey of households in Mannheim, Germany. Households with an adult 18-45 years were identified and one adult per household provided a response to the survey. The response rate was 38%.

Comment: The exposure prevalence data are reasonably current. The response rate is marginal and the data may not be representative of adults in Mannheim, Germany age 18-45 given the low response rate. Even if the data are representative of adults 18-45 years in Mannheim, Germany, adults 18-45 years are not representative of all adults in Mannheim, Germany. Mannheim, Germany is not representative of all of Germany. Germany is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Pertl et al. 2010 (Wehner reference 37) collected data about the prevalence of ever exposure to indoor tanning in adults in late 2007 and early 2008 using an interviewer-administered questionnaire given to "convenience sample" of adults between age 16 and 27 recruited in "various locations around Ireland (e.g., schools, sports clubs, universities and train stations)." The response rate was not reported.

Comment: The exposure prevalence data are reasonably current. The sample is haphazard. The data pertain to adults between 16 and 27 years of age in Ireland and adults 16-27 years of age are not representative of all adults in Ireland. Ireland is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Køster et al. 2011 (Wehner reference 34) collected data about the prevalence of ever exposure to indoor tanning in adults in March 2007, August 2007, August 2008, and August 2009 using web and telephone surveys of a nationally representative sample of residents of Denmark. Reported analyses of the prevalence of exposure to indoor tanning excluded adults age 60+ years. The response rates varied by survey year and ranged from 26% in 2009 to 47% in August 2007.

Comment: The exposure prevalence data are reasonably current. The response rates are marginal and the respondents may not be representative of Danish adults age <60 years. Adults age <60 years are not representative of all Danish adults. Denmark is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Schneider et al. 2013 (Wehner reference 38) collected data about the prevalence of ever exposure to indoor tanning in adults in 2012 using a telephone survey of households Germany. Using a multistage sampling strategy, households with an adult 14-45 years were identified and one adult per household provided a response to the survey. The response rate was 28%.

Comment: The exposure prevalence data are current. The response rate is low and the data may not be representative of adults in Germany age 18-45 given the low response rate. Even if the data are representative of adults age 18-45 years in Germany, adults 18-45 years are not representative of all adults in Germany. Germany is not representative of all of Northern and Western Europe. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Northern and Western Europe.

Australia

Lawlor et al. 2006 (Wehner reference 35) collected data about the prevalence of ever exposure to indoor tanning in adults in 2004 using a telephone survey of residents of Queensland, Australia age 20-75 years. Households with a landline were identified using a stratified random sampling method. The analysis accounted for the stratified nature of the sample. The response rate was not reported.

Comment: The exposure prevalence data are not current. The lack of information about the response rate is a limitation when judging representativeness. The sampling frame is an appropriate one for generating data that are representative of adults in Queensland, Australia. Queensland is not representative of all of Australia. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not representative of the general population of adults in Australia.

Francis et al. 2010 (Wehner reference 31) collected data about the prevalence of ever exposure to indoor tanning in adults in 2003/2004 and again in 2007/2008 using a telephone survey of residents of Australia age 18-69 years. A representative sample of households with a landline were identified and contacted. The response rate was 24% in 2003/2004 and 18% in 2007/2008.

Comment: The exposure prevalence data for 2003/2004 data are not current. The exposure prevalence data for 2007/2008 are reasonably current. The sampling frame is an appropriate one for generating data that are representative of adults age 18-69 in Australia. The response rate for both 2003/2004 and 2007/2008 is low. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not assured to representative of the general population of adults in Australia in 2004 given the low response rates. The restricted age range for the sample is a limitation when generalized to all adults in Australia. The Francis et al. (2010) study is the only study identified in the Wehner et al. (2014) systematic review that provides information about the prevalence of ever exposure to indoor tanning in adults in a country (Australia) that is probably "in the ballpark."

Conclusion

None of the seven studies that provide data on the prevalence of ever exposure to indoor tanning in adults in the United States yielded prevalence estimates representative of the general population of adults in the United States. Two studies (Mawn and Fleischer 1993; Lazovich et al. 2008) are based on samples that are haphazard and one of these (Mawn and Fleischer 1993) presents data that is obsolete. Two studies (Moore et al. 2003; Cohen et al. 2013) use "convenience" samples of patients being seen in highly selected clinical practices in a small and unrepresentative region of the United States. Of the studies, only the study by Lazovich et al. (2005) had a sampling frame—randomly selected households in Minnesota—that is appropriate for drawing conclusions about the general population of adults in Minnesota but Minnesota adults are not representative of all adults in the United States.

None of the nine studies that provide data on the prevalence of ever exposure to indoor tanning in adults in Northern and Western Europe yielded prevalence estimates representative of the general population of adults in Northern and Western Europe. Only one study done in a country in Northern/Western Europe, the Borner et al. (2007) study, was based on nationally representative sample of German adults of all ages but this study had a response rate of only 13%.

One study (Frances et al. 2010) provides data on the prevalence of ever exposure to indoor tanning in adults in Australia (Frances et al. 2010) for two different periods—2003/2004 and 2006-2007—that is based on a nationally representative sample of adults 18-69 years. The response rate was only 24% in 2003/2004 and 18% in 2006/2007 and this is a limitation. This study is the only study identified in the Wehner et al. (2014) systematic review that provides information about the prevalence of ever exposure to indoor tanning in adults in a country (Australia) that is probably "in the ball park."

The Model Used to Estimate the Number of Skin Cancers Attributable Each Year to Indoor Tanning

Description of the Model

Wehner et al.'s Figure 2 forest plot (page 393) shows the estimates of the prevalence of ever exposure to indoor tanning in adults for the seventeen studies that were considered to provide prevalence estimates representative of the general population (23 estimates) along with a summary estimate of the prevalence of ever exposure to indoor tanning for each region and overall based on a random effects meta-analysis. Wehner et al. (2104) used the meta-analytically derived summary prevalence estimates to derive an estimate of the number of incident (new) skin cancers attributable each year to indoor tanning in the United States, in Northern and Western Europe, and in Australia. The estimates of the number of incident skins cancers attributable each year to indoor tanning were made in two steps.

Step 1. The first step was to estimate the population proportional attributable risk of skin cancer (separately for squamous cell carcinoma, basal cell carcinoma and malignant melanoma in each of the three regions) based on the following formula:

population proportional attributable risk =
(prevalence of exposure x [RR – 1.0]) / 1 + (prevalence of exposure x [RR – 1.0])

where RR is the relative risk of the skin cancer (squamous cell carcinoma, basal cell carcinoma and malignant melanoma in those with ever exposure to indoor tanning.

Step 2. The next step was to apply the estimate of the population proportional attributable risk of skin cancer calculated in Step 1--again separately for squamous cell carcinoma, basal cell carcinoma and malignant melanoma in each of the three regions--to estimates of the annual number of incident cases of each type of skin cancer in the United States, Northern and Western Europe, and Australia. This step yielded an estimate of the number of incident skin cancers of each type attributable to ever exposure to indoor tanning for each region. These estimates were summed to yield an estimate of the total number of incident skin cancer of all types attributable each year to indoor tanning.

Data Sources

Estimates of the Relative Risk of Skin Cancer for Individuals Ever Exposed to Indoor Tanning

Estimates of the relative risks (RR) for the three types of skin cancer were based on two published systematic reviews and meta-analyses (Boniol et al. 2012; Wehner et al. 2012). The meta-analytically derived summary RR of malignant melanoma for ever exposure to indoor tanning in the Boniol et al. (2012) meta-analysis was 1.25. The meta-analytically derived summary RR of basal cell carcinoma for ever exposure to indoor tanning in the Wehner et al. (2012) systematic review was 1.29; the summary RR of squamous cell carcinoma was 1.67.

Comment: I identified two other published systematic reviews that presented summary estimates of the RR of malignant melanoma in ever users of indoor tanning were identified (Colantonio, Bracken and Bleecker 2014; IARC 2007). The summary RR of malignant melanoma in ever users of indoor tanning was 1.16 (95% CI 1.05-1.28) in Colantonio, Bracken and Beecker 2014; it was 1.15 (95% CI, 1.00-1.31) in IARC 2007.

I did not identify any other systematic reviews that calculated estimates of the RR of basal cell carcinoma or squamous cell carcinoma.

Wehner et al. (2014) state that they used the Boniol et al. 2012 systematic review as the source of their summary estimate of the RR of malignant melanoma in ever users of indoor tanning because it was "rigorous" had been published in the "last year." The Colantonio, Bracken and

Beecker (2014) systematic review of melanoma and ever exposure to indoor tanning was equally rigorous and was published later than the Boniol et al. (2012) systematic review. It is possible, however, that the Colantonio, Bracken, and Beecker (2014) systematic review was not known to Wehner et al. (2014). The difference in the summary estimates of the RR of malignant melanoma in ever users of indoor tanning comparing Boniol et al. (2012) and Colantonio, Bracken and Bleecker (2014) is negligible—1.25 and 1.15 respectively.

Estimates of the Prevalence of Ever Use of Indoor Tanning in Adults

United States

Comment: None of the studies reporting the prevalence of ever exposure to indoor tanning in adults that Wehner et al. 2014 identified in their systematic review provide data representative of the general population of the United States. Several of the studies are from haphazard samples.

The prevalence data for the seven studies that were meta-analyzed in order to derive a summary estimate of the prevalence of ever exposure to indoor tanning were extremely heterogeneous ($I^2 = 96.5\%$; $p < .001$), which is not surprising given the heterogeneous nature of the studies contributing to the estimate. In the face of such extreme statistical and methodologic heterogeneity, the validity of a meta-analytically derived summary measure of prevalence is highly questionable. The summary estimate of prevalence of ever exposure to indoor tanning in adults in the United States based on the studies identified by Wehner et al. (2014) is meaningless.

The estimates of prevalence of ever exposure to indoor tanning from the seven studies that Wehner et al. (2014) used to estimate prevalence are based on samples that are younger than the United States population. More than 80% of all melanoma and about 70% of non-melanoma skin cancers in the United States occur in people who are age 65 years or more. (Rogers et al. 2010;http://seer.cancer.gov/csr/1975_2012/browse_csr.php?sectionSEL=18&pageSEL=sect_18_table.07.html accessed 1/1/2016.) Applying a prevalence estimate that pertains to younger adults to estimates of the number of skin cancers occurring in adults of all ages, influenced prominently by adults 65+ years, yields a grossly upwardly biased estimate.

Northern and Western Europe

Comment: The Wehner et al. (2014) systematic review identified studies of the prevalence of ever exposure to indoor tanning adults that were done in the United Kingdom, Ireland, France, Germany, Denmark, and Sweden. Only one study, Borner et al. (2009) had a sampling frame that could have yielded data representative of Germany but the r response rate was very low (13%). Germany is not representative of all of Northern and Western Europe.

Austria, Belgium, Luxembourg, the Netherlands, Estonia, Finland, Iceland, Latvia, Lithuania, Norway and Switzerland are countries in Northern and Western Europe for which no prevalence data were identified.

The prevalence data for the studies that were meta-analyzed in order to derive a summary estimate of the prevalence of ever exposure to indoor tanning were extremely heterogeneous ($I^2 = 99.9\%$; $p < .001$), which is not surprising given the heterogeneous nature of the studies contributing to the estimate. In the face of such extreme statistical and methodologic heterogeneity, the validity of a meta-analytically derived summary measure of prevalence is highly questionable.

Australia

Comment: The Wehner et al. (2014) systematic review identified one study (Francis et al. 2010) that reported a measure of the prevalence of ever exposure to indoor tanning adults in Australia that is probably "in the ball park." The measure for 2007/2008 is reasonably current. The source of data on the annual number of incident melanoma and non-melanoma skin cancers in Australia is credible and the accuracy of the estimates were verified.

Wehner et al. (2014) report that the data on prevalence of ever exposure to indoor tanning that were used to derive a summary estimate of the prevalence of ever exposure to indoor tanning were extremely heterogeneous ($I^2 = 99.9\%$; $p < .001$). This is surprising since the three estimates of prevalence for Australia are identical with narrow and virtually identical:

Lawler et al. 2006	0.11 (95% CI 0.10-0.11)
Francis et al. 2010	0.11 (95% CI 0.10-0.12)
Francis et al. 2010	0.11 (95% CI 0.10-0.11)

I conclude that a mistake was made in calculating I^2.

Estimates of the Number of Incident Cases of Cancer in the United States, Northern and Western Europe and Australia

United States

Malignant Melanoma

Data on the annual number of incident melanomas in the United States in 2012 were obtained from the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) program (US National Cancer Institute 2013; Wehner et al. reference 94).

Comment: SEER is a credible source of data on the annual number of malignant melanomas in the United States. I was able to verify that the number cited in Wehner et al. (2014) is as the number was reported in SEER.

Non-melanoma Skin Cancer

The number of incident non-melanoma skin cancers in the United States was based on a complex analysis by Rogers et al. (2010) that used census data, the Centers for Medicare and Medicaid Services 2007 Trustee's report and three different databases--the Centers for Medicare and Medicaid Services Fee-for-Service Medicare physician/supplier procedure summary master file (the "Total Claims Data Set"), the CMS Medicare Limited Data Set Standard Analytic File 5% Sample Physician Supplier Data (the "5% Sample Data Set"), and the National Ambulatory Medical Care Service database. The methods section of the Rogers et al. (2010) publication that explains how these data sources were used to obtain an estimate of the number of non-melanoma skin cancers is reproduced in the Appendix.

Roger's et al. (2012) estimated that the total number of non-melanoma skin cancers treated in 2006 in the United States was 3,507,693. In Rogers et al. (2010), 2,482,801 of the non-melanoma skin cancers (71%) were ascribed to patients 65 years of age or older. Based on a ratio of skin cancers treated per affected patient of 1.63, Rogers et al. estimated that 2,152,500 people were treated for non-melanoma skin cancer in the United States in 2006.

Comment: The claims data pertain to procedures used to treat possible non-melanoma skin that also have an ICD-9-CM code for cancer. The problem of upcoding in claims databases is well-known. The large increase in the number of claims for procedures to treat skin cancer in the Medicare fee-for-service population that Rogers et al. (2012) document—from 1,158,298 in 1992 to 2,048,517 in 2006—raises questions about the data.

In estimating the number of non-melanoma skin cancers attributable to indoor tanning, Wehner et al. (2014) allocated 75% of the 3,507,693 skin cancers to basal cell carcinoma (n=2,630,770) and 25% to squamous cell carcinoma (n=876,923) without citing a source for this allocation ratio, which does not appear in Rogers et al.'s.

Northern and Western Europe

Malignant Melanoma

Wehner et al. (2014) estimated the number of incident cases of malignant melanoma in Northern and Western Europe by multiplying the incidence of melanoma in Northern and Western Europe reported for 2008 in the IARC GLOBOCAN database (IARC GLOBOCAN database; Wehner et al. reference 93) by 285,763,000, which was the size of the adult population of Northern and Western Europe in 2008. The estimated incidence rate for melanoma used was 18.1 per 100,000. Thus,

$$18.1 \text{ per } 100{,}000 \times 285{,}763{,}000 = 51{,}740$$

Comment: I was not able to locate an estimate for the incidence of malignant melanoma of 18.1 per 100,000 for the countries that comprise Northern and Western Europe at the IARC GLOBOCAN website. The countries that comprise Northern and Western Europe are: Austria,

Belgium, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Sweden, Switzerland, UK. I was able to determine an average crude rate of malignant melanoma for these 17 countries for 2012 based on data on the individual crude rates of malignant melanoma per 100,000 for these 17 countries and a population-weighted rate of malignant melanoma for the whole of Northern and Western Europe. These estimates are shown in Table 2 of this report.

Based on the data I was able to obtain from the GLOBOCAN database, the estimated malignant melanoma incidence rate for Northern and Western Europe is 20.4 per 100,000 (average crude rate for all 17 countries) or 20.9 per 100,000 (population weighted). The use of the estimate 18.1 per 100,000 by Wehner et al. (2014) seems reasonable.

Non-Melanoma Skin Cancer

Overview

Wehner et al. cited a systematic review of the incidence of non-melanoma skin cancer by Lomas et al. 2012 (Wehner reference 95) as the source of the estimate of the number of incident cases of basal cell carcinoma and squamous cell carcinoma that they used in their model to estimate the number of non-melanoma skin cancer attributable to indoor tanning.

Basal Cell Carcinoma

For basal cell carcinoma incidence was (page 397, footnote e to Table 2):

> "calculated using a yearly incidence rate of 50 per 100,000 (lower-bound conservative estimate from Lomas et al. for 2000-2005) multiplied by the 2008 Northern and Western European population of 285,762,000"

Comment: The Lomas et al. (2012) systematic review presented estimates of the age-standardized incidence of basal cell carcinoma per 100,000 in European males from 1968-2005 from studies in Denmark, Finland, Germany, Italy, Netherlands, Scotland, South Wales, Slovakia, Switzerland, UK, and Wales (page 1076, Figure 3). These rates varied from 20 per 100,000 in Finland in 1968 to 130 per 100,000 (interpolated) in South Wales in 2002 (interpolated).

On page 1074, in Table 2, Lomas et al. (2012) present data on directly standardized annual incidence for non-melanoma skin cancer, basal cell carcinoma, and squamous cell carcinoma in the UK for 2000-2006. Estimates of the standardized incidence of basal cell carcinoma in the UK ranged from 0.24 per 100,000 (London) to 121.29 per 100,000 (South-West England).

No data reporting on the incidence of basal cell carcinoma for the period 2000-2005 could be identified in the Lomas et al. (2012) publication. A value for the incidence of basal cell carcinoma of 50 per 100,000 could not be located anywhere in the Lomas et al. (2012) publication. The terms "lower-bound" and "conservative" could not be found in a search of the PDF file of the full text of the Lomas et al. (2012) publication.

Squamous Cell Carcinoma

For squamous cell carcinoma, incidence was (page 397, footnote f to Table 2):

> "calculated using a yearly incidence rate of 10 per 100,000 (lower-bound conservative estimate from Lomas et al. for 2000-2005) multiplied by the 2008 Northern and Western European population of 285,762,000"

Comment: The Lomas et al. (2012) systematic review presented estimates of the age-standardized incidence of squamous cell carcinoma per 100,000 in European males from 1958-2003 from studies in Denmark, Finland, Germany, Italy, Netherlands, Scotland, South Wales, Slovakia, Sweden, Switzerland, UK, and Wales (page 1076, Figure 4). These rates varied from 4 per 100,000 in Finland in 1958 (interpolated) to 32 per 100,000 in Germany in 1988 (interpolated).

Estimates of the standardized incidence of squamous cell carcinoma in the UK ranged from 14.98 per 100,000 (London) to 33.02 per 100,000 (South-West England).

No data about the incidence of squamous cell carcinoma pertaining to the period 2000-2005 could be identified in the Lomas et al. publication.

On page 1075, column 2, lines 18-19, Lomas et al. (2012) state that "Denmark reported very low rates of SCC [squamous cell carcinoma] of less than 10/100,000 person-years." This is the only place in the Lomas et al. publication that the figure 10/100,000 for the incidence of squamous cell carcinoma could be found.

The terms "lower-bound" and "conservative" could not be found in a search of the PDF file of the full text of the Lomas et al. (2012) publication.

Australia

Data on the annual number of incident non-melanoma skin cancers for Australia were obtained from the Australian Institute of Health and Welfare. (Cancer Australia & AIHW 2008; Wehner et al. reference 91. Data on the annual number of melanoma skin cancer for Australia were obtained from the Australian Institute for Health and Welfare. (Australian Institute of Health and Welfare; Wehner et al. reference 92).

Comment: I compared the number of incident non-melanoma and melanoma skin cancers reported in Wehner et al. (2014) with the data reported in sources cited and was able to confirm that the numbers of melanoma and non-melanoma skin cancer reported in Wehner et al. (2014) match the source data.

Conclusion

Estimates of the number of melanoma and non-melanoma skin cancers attributable to indoor tanning each year in the United States and in Northern and Western Europe, which are based on a model that uses meaningless prevalence estimates and poor data on non-melanoma skin cancer, are not credible. The publication that presents the meaningless data on the prevalence of ever exposure to indoor tanning in adults in the United States should be removed from the CDC website. The data about the number of melanoma and non-melanoma skin cancers in the United States attributable each year to indoor tanning should not be cited by the CDC or any other agency because these numbers are based on a meaningless estimate of prevalence and a poor estimate of the total number of non-melanoma skin cancers.

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Table 1. Information about Methods from Studies of the Prevalence of Exposure to Indoor Tanning Cited in the Systematic Review and Meta-analysis by Wehner et al. 2014, Figure 2 with Comments

Reference Number in Wehner	First Author and Year of Publication	Year of Data Collection	Method of Data Collection	Response Rate	N of Respondents	Methods for Obtaining Responses / Sampling Frame
United States						
23	Mawn and Fleischer 1993	1992	Self-administered questionnaire	NR	477	"A written, anonymous questionnaire was distributed to a sample of 477 persons in a shopping mall, at a social gathering, and on a vacation cruise ship"
COMMENT The data were collected in 1992 and are not current. The prevalence of exposure in 1992 is not representative of current or recent exposure. The non-response rate is unknown. Responses from people in shopping malls, social gatherings, and a vacation cruise ship are not representative of the general US adult population. The sample is haphazard.						
25	Moore et al. 2003	2002	Self-administered questionnaire	NR	106	A questionnaire was distributed randomly by the nursing staff to patients over the age of 18 who had a routine appointment at a local primary care clinic in rural northeastern North Dakota
COMMENT The data were collected in 2002 and are not current. The response rate is unknown. Responses from primary care clinic attendees in rural northeastern North Dakota are not representative of the general US adult population.						
24	Lazovich et al. 2005	2002	Telephone survey	45%	802	Adults from randomly selected households in Minnesota
COMMENT The data were collected in 2002 and are not current. The response rate is reasonable. Responses from residents of Minnesota are not representative of the general US adult population.						
40	Woodruff et al. 2006	2004	Telephone survey	50% with letter of introduction 45% without letter	94	Pilot study for Hoerster. Data collected in two cities not scheduled to be included in Hoerster study (reference 32) (Columbia, South Carolina and New Haven, Connecticut). Households were selected by a professional survey research organization as having a high probability of an adolescent 14, 15, 16 or 17 years of age living in the

						household. Parents in households that had an adolescent in the targeted age range provided information on their own use of indoor tanning.
COMMENT The data were collected in 2004 and are not current. The response rate is reasonable. Adults in households that have children age 14-17 years are not representative of all adults. Adults from residents of Columbia, South Carolina and New Haven, Connecticut are not representative of the general US adult populations.						
32	Hoerster et al. 2007	2005	Telephone survey	75%	5274	Data collected in the 100 largest cities in the United States. Methods as described in Woodruff (reference 40)
COMMENT The data were collected in 2005 and are not current. Adults in households that have children age 14-17 years are not representative of all adults. Adults from residents of the 100 largest cities in the United States cannot be certain to be representative of the general US adult populations without knowing what proportion of the US adult population resides in cities this size. .						
36	Lazovich et al. 2008	2006	Interviewer administered questionnaire	NR	24	"In Virginia, participants were recruited from an undergraduate psychology seminar and a convenience sample of young adult staff and friends. In Massachusetts, flyers posted in community businesses, announcements in online classified sites, and advertisements on the University of Massachusetts Medical School employee intranet were used. Participants in Tennessee were drawn from the Psychology Department Research Subject pool, while in New Hampshire, high school age girls were recruited through posters placed in their school. Individuals who had either used sunless tanning products or indoor tanning devices in the past were targeted for interviews."
COMMENT The data were collected in 2010 and are reasonably current. The response rate is unknown. The sample is haphazard. The study responses are not representative of the general population of adults in the United States.						
29	Cohen et al. 2013	2010	Interviewer administered questionnaire	NR	300	"Convenience sample" of 100 parents of children being seen in 3 pediatric practices in Chicago
COMMENT The data are current. The response rate is unknown. Adults with children being seen in pediatric clinics are not representative of all adults. Adults from Chicago are not representative of the general US adult populations.						
Europe						

33	Jackson et al. 1999	1995	Self-administered questionnaire	89% practices 69% patients	3105	18 randomly selected group practices in Crewe and Macclesfield Health Districts in Cheshire United Kingdom were asked to participate. In the 16 cooperating practices, randomly selected patients aged 16 years and over who attended their surgery for a GP consultation for any reason during a one-week period between September and November 1995 were invited by the reception staff to complete a questionnaire at the time or to return it by post after subsequent completion.
COMMENT The data were collected in 1995. The prevalence of exposure in 1995 is not representative of current or recent exposure. The response rate is reasonable both for practices and patients. The representativeness of attendees at a GP clinic for all patients seeing a GP is unknown. Attendees in a GP clinic in Cheshire United Kingdom are not representative of GP attendees in the entire UK. Cheshire UK is not representative of the general population of the UK or of the general population of Northern and Western Europe.						
26	Boldeman et al. 2001	1999	Mailed questionnaire	68%	2684	A random sample of 4000 adults age 20-50 years in Stockholm County were selected from the national census registry and sent a mailed questionnaire with two reminders.
COMMENT The data were collected in 1999. The prevalence of exposure in 1999 is not representative of current or recent exposure. The response rate is reasonable. The sample frame is appropriate for a question pertaining to adults in the restricted age range 20-50 years. Responses in this age range are not representative of all adults in Stockholm County. Stockholm County is not representative of all of Sweden. Stockholm county is not representative of all of Northern and Western Europe.						
28	Branstrom et al. 2004	2001	Mailed questionnaire	55%	1752	"A random population-based sample (n = 3200, 18–37 years of age) in the Stockholm County, Sweden, stratified by gender and age (in four age strata; 18–22, 23–27, 28–32 and 33–37), was selected from the Swedish census registry. In May 2001, they were mailed a questionnaire" with one reminder.
COMMENT The data were collected in 2001. The prevalence of exposure in 2001 is not representative of current or recent exposure. The response rate is reasonable. The sampling frame is appropriate for a question pertaining to adults in the restricted age range 18-37 years. Responses in this age range are not representative of all adults in Stockholm County. Stockholm County is not representative of all of Sweden. Stockholm county is not representative of all of Northern and Western Europe.						
30	Ezzedine et al. 2008	2001	Mailed questionnaire	57%	7303	12,741 participants in a French cohort study originally recruited in 1994-1995 were asked to complete a special "sun survey" in 2001.
COMMENT The data were collected in 2001. The prevalence of exposure in 2001 is not representative of current or recent exposure. The response rate is reasonable. The representativeness of the original cohort for all French adults is not established. France is not representative of all of Northern and Western Europe.						

27	Borner et al. 2009	2007	Telephone survey	13%	1419	A nationally representative sample of German age 14+ years was contacted using a random digit dial procedure to access households and then selecting the respondent according to the so-called "last birthday" method (selecting the household member age 14 or over who has had the last birthday).
COMMENT The data were collected in 2007 and are reasonably current. The response rate is very low. The sample frame is appropriate for estimating prevalence in Germany. Germany is not representative of all of Northern and Western Europe.						
39	Schneider et al. 2009	2007	Telephone survey	38%	500	A two stage sampling procedure was used. Households in Mannheim, Germany were selected using the official telephone register. Households with at least one member age 18-45 were asked to participate, selecting the respondent according to the "last birthday" method (selecting the household member age 18-45 who had the last birthday)
COMMENT The data were collected in 2007 and are reasonably current. The response rate is somewhat low. The sampling frame is appropriate for a question pertaining to adults in the restricted age range 18-45 years. Responses in this age range are not representative of all adults in Mannheim, Germany. Mannheim, Germany is not representative of all of Germany. Mannheim, Germany is not representative of all of Northern and Western Europe.						
37	Pertl et al. 2010	12/2007-1/2008	Interviewer administered questionnaire (some uncertainty if interviewer administered or self-administered)	NR	590	"Convenience sampling was used to recruit young adults, between the ages of 16 and 26 years, from the general public. Potential participants were approached by research assistants in various locations around Ireland (e.g. schools, sports clubs, universities and train stations) and a recruitment script was used to ensure that all participants were approached in the same way."
COMMENT The data were collected in 2007-2008 and are reasonably current. The non-response rate is not known. Responses from people in various locations in Ireland are not representative of the entire Irish population. Responses in the restricted age range 16 to 26 years are not representative of all Irish adults. Responses from adults in Ireland are not representative of all adults in Northern and Western Europe. The sample is haphazard.						
34	Koster et al. 2011	March 2007	Web/telephone	30%	3356	A nationally representative sample of residents of Denmark was identified using random digit dialing with data collected using interviews and the web in 2007, replaced by a web-only survey in 2008 and 2009. Analysis of sunbed use excluded residents age 60+ years
34	Koster et al. 2011	August 2007	Web/telephone	47%	3497	See above
34	Koster et al. 2011	August 2008	Web survey	36%	3915	See above
34	Koster et al. 2011	August	Web survey	26%	3746	See above

		2009				
COMMENT The data were collected in 2007-2009 and are reasonably current. The response rate is marginal. The study results are likely to be representative of adults less than 60 years in Denmark but not of all adults in Denmark. Denmark is not representative of all of Northern and Western Europe.						
38	Schneider et al. 2013	2012	Telephone survey	28%	4851	"The study included German residents aged 14 to 45 years. A multistage sampling process was used to randomly select study participants..... A pool of telephone numbers was generated and a telephone number was selected using a random algorithm, and the corresponding household was contacted by phone. If there was more than 1 person from the target population in that household, the person with the next birthday was chosen to participate."
COMMENT The data were collected in 2012 and are current. The response rate is low. The sample frame is appropriate for a question pertaining to adults in the restricted age range 14-45 years. Responses in this age range are not representative of all adults in Germany. Germany is not representative of all of Northern and Western Europe.						
Australia						
35	Lawler et al. 2006	2004	Telephone survey	NR	9298	English speaking adults age 20-75 years and residing in Queensland Australia were eligible. Households with a landline (95% in Queensland at the time of the study) were selected using a stratified random sampling method. Results were weighted to reflect stratified design.
COMMENT The data were collected in 2003/2004 and are not current. The response rate is unknown. The sample frame is appropriate for a question pertaining to adults in the age range 20-75 years. Responses are likely to be generally representative of adults in Queensland. Queensland is not representative of all of Australia						
31	Francis et al. 2010	2003/2004	Telephone survey	24%	5073	A representative sample of Australian adults (age 18–69 years) were recruited via weekly cross-sectional telephone calls to randomly selected households with a landline telephone.
31	Francis et al. 2010	2006/2007	Telephone survey	16%	5085	Same as above.
COMMENT Data were collected in 2003/2004 and in 2006/2007. The 2003/2004 data are not current. The sampling frame is an appropriate one for generating data that are representative of adults age 18-69 in Australia. The response rate for both 2003/2004 and 2007/2008 is low. The data on the prevalence of ever exposure to indoor tanning in adults reported in this study are not assured to representative of the general population of adults in Australia in 2004 because of the low response rate. The restricted age range for the sample is a limitation. This study is the only study identified in the Wehner et al. (2014) systematic review that provides credible information about the prevalence of ever exposure to indoor tanning in adults in a country—Australia.						

Table 2. Incidence of Malignant Melanoma in Countries Comprising Northern and Western Europe. IARC GLOBOCAN Database. 2012.

		2012	2012
Country	Population in 2010	Crude Rate per 100,000	Population Weighted
Austria	8,374,290	15.8	0.46
Belgium	10,839,905	18.0	0.68
Denmark	5,534,738	28.5	0.55
Estonia	1,340,127	12.4	0.06
Finland	5,351,427	22.4	0.42
France	62,791,000	15.6	3.41
Germany	81,802,257	20.6	5.86
Iceland	317,630	15.5	0.02
Ireland	4,467,854	18.8	0.29
Latvia	2,248,374	10.1	0.08
Lithuania	3,329,039	8.4	0.10
Luxembourg	502,066	16.4	0.03
Netherlands	16,574,989	28.7	1.65
Norway	4,858,199	30.4	0.51
Sweden	9,340,682	30.7	1.00
Switzerland	7,785,806	32.1	0.87
UK	62,026,962	23.0	4.96
All Countries	287,485,345	20.4	20.94

IARC. GLOBOCAN 2012: Estimated Cancer Incidence, Mortality and Prevalence Worldwide in 2012. On-line calculator. http://globocan.iarc.fr/Pages/summary_table_site_sel.aspx

Appendix

Methods Section Reproduced From Rogers et al. 2010

DATA SOURCES

Our analyses were based primarily on 2 distinct Medicare databases and on national survey data. The Medicare physician/ supplier procedure summary master file (hereinafter, Total Claims Data Set) was analyzed for the years 1992 and 1996 to 2006 (available years).[18] For our primary approach to the estimation of NMSC, the 2006 Total Claims Data Set was used to provide total numbers of approved fee-for-service Medicare claims categorized by Current Procedural Terminology (CPT) procedure code number.[19] However, the Total Claims Data Set does not contain information relating to patient age or *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis, associated with each procedure code.[20] The Medicare Limited Data Set Standard Analytic File 5% Sample Physician Supplier Data (hereinafter, 5% Sample Data Set) was available for 2002 to 2006.[21] This nationally sampled Medicare database contains information on claims filed for approved procedures with their associated *ICD-9-CM* diagnosis codes, patient age stratification, and counts of unique persons receiving the services. Hence, the 5% Sample Data Set allowed estimation of the proportion of procedures for skin cancer that were for NMSC, the proportion of procedures that were conducted on enrollees older than 65 years, and the mean number f procedures per enrollee with any procedures.

The National Ambulatory Medical Care Survey (NAMCS) is a cross-sectional survey system of ambulatory-based physicians wherein participating physicians complete a questionnaire for patient visits during a random 1-week period of the year.[22] These visit observations are then used to provide a national estimate of physician visits and limited characteristics of these visits for that year. The NAMCS allowed estimation of the proportion of visits for NMSC in the United States that were conducted in the population older than 65 years.

ESTIMATION OF THE TOTAL NUMBEROF NMSCs IN 2006

For this study, we define NMSC incidence in 2 ways: as newly diagnosed NMSCs and as persons with a newly diagnosed NMSC, with the latter as our primary definition, although we present both. The number of skin cancers in the fee-for-service Medicare population was estimated in this study as the total of approved skin cancer treatment procedures (malignant destructions, malignant excisions, and Mohs micrographic surgical procedures) for that year from the Total Claims Data Set. Thus, the crude number of skin cancers for a claims for skin cancer procedure code series (11600-11606, 11620-11626, and 11640-11646 for malignant excisions; 17260-17266, 17270-17276, and 17280-17286 for malignant destructions, 17304 for Mohs surgical procedures). The total specific to NMSC was determined by multiplying the estimated crude number of skin cancers by the proportion of skin cancer procedure code claims associated with

the *ICD-9-CM* diagnoses for invasive non-melanoma cutaneous malignancy (173.0-173.9) and in situ malignancy (232.0-232.9) from the 5% Sample Data Set. The number of procedures per affected individual and the number of unique persons that underwent at least 1 procedure were also derived from the 5% Sample Data Set.

Based on our *ICD-9-CM* code definition of NMSC, almost all of the skin cancers measured in this study were keratinocyte carcinomas (ie, BCC, invasive SCC, or SCC in situ). However, other varieties of skin cancer are also included in our totals, such as Merkel cell carcinoma, adnexal carcinomas, and malignant melanoma in situ. These cancers are relatively uncommon compared with BCC and SCC, and because of the imprecise nature of *ICD-9-CM* coding, we cannot separate procedures for these diagnoses. Excluded from our count were some forms of NMSC, such as cutaneous lymphoma and genital skin cancers that have separate *ICD-9-CM* codes. Therefore, although some malignant melanomas in situ are included in our estimates, and some NMSCs are excluded, the overall number of keratinocyte carcinomas is so much larger that these inclusions and exclusions should have a small effect on our overall estimate. For example, analysis of the Surveillance, Epidemiology, and End Results (SEER) database for 2006 estimates 49 710 new US cases of malignant melanoma in situ (1.4% of our total NMSC estimate).[23] For this article, we will use the common but admittedly imprecise term *NMSC*.

The number of NMSCs in the Medicare population 65 years or older was established from the Total Claims Data Set and the 5% Sample Data Set. The proportion of the entire US population (>=65 years) covered under Medicare was derived from the Center for Medicare and Medicaid Services 2007 Trustee's report and US census data, allowing estimation of the number of NMSCs in the entire population segment that was 65 years or older.[24,25] The proportion of total office visits for NMSC *ICD- 9-CM* codes (173.0-173.9 and 232.0-232.9) that were for the segment of the population that was 65 years or older in 2006 was obtained from the NAMCS. The number of NMSCs in the US population (_65 years old) was then divided by the proportion of office visits for NMSC in that group, allowing estimation of the total number of skin procedures for NMSC in the United States. The total number of persons in the United States diagnosed as having NMSC in that year was calculated from the skin cancer procedure totals and the number of NMSCs per affected Medicare patient. More detailed representation of the calculation described in this section is available at the Skin Cancer Center Web site.[26]

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