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The potential impact of reducing indoor tanning on melanoma prevention and treatment costs in the United States: An economic analysis

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Abstract

Background—Indoor tanning is associated with an increased risk of melanoma. The US Food and Drug Administration proposed prohibiting indoor tanning among minors younger than 18 years.

Objective—We sought to estimate the health and economic benefits of reducing indoor tanning in the United States.

Methods—We used a Markov model to estimate the expected number of melanoma cases and deaths averted, life-years saved, and melanoma treatment costs saved by reducing indoor tanning. We examined 5 scenarios: restricting indoor tanning among minors younger than 18 years, and reducing the prevalence by 20%, 50%, 80%, and 100%.

Results—Restricting indoor tanning among minors younger than 18 years was estimated to prevent 61,839 melanoma cases, prevent 6735 melanoma deaths, and save $342.9 million in treatment costs over the lifetime of the 61.2 million youth age 14 years or younger in the United States. The estimated health and economic benefits increased as indoor tanning was further reduced.

Limitations—Limitations include the reliance on available data and not examining compliance to indoor tanning laws.

Conclusions—Reducing indoor tanning has the potential to reduce melanoma incidence, mortality, and treatment costs. These findings help quantify and underscore the importance of continued efforts to reduce indoor tanning and prevent melanoma.

Keywords

indoor tanning; melanoma; prevention; skin cancer

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Indoor tanning is partially responsible for the increase in melanoma incidence rates, especially among young women.[1] The World Health Organization and the US Department of Health and Human Services has classified the ultraviolet radiation from indoor tanning devices as carcinogenic to human beings.[2,3] A recent meta-analysis estimated that more than 6000 melanomas are attributable to indoor tanning each year in the United States.[1] The risk of melanoma is higher among frequent tanners and those initiating indoor tanning at a younger age.[4,5]

Despite its risks, indoor tanning remains common in the United States.[6,7] An estimated 11.3 million Americans engaged in indoor tanning in 2013, 1.6 million of whom are younger than 18 years. Among high school students, 5% of boys and 20% of girls engaged in indoor tanning in 2013.[6,7] Among this population, frequent use is common, with over half of indoor tanners doing so more than 10 times per year.[6] The US Surgeon General has highlighted the importance of reducing the harms from indoor tanning.[8] In addition, the US Food and Drug Administration has announced important proposed steps to protect public health by prohibiting the use of indoor tanning among minors, younger than 18 years.[9]

An earlier study conducted in Australia examining the impact of indoor tanning laws, particularly age restrictions, found that such laws could prevent a substantial number of melanoma cases and result in significant reductions in melanoma treatment costs.[10] A similar study has not been conducted in the United States. The purpose of this study is to estimate the health benefits of reducing indoor tanning and the associated melanoma treatment cost-savings in the United States. Specifically, this study examines the impact of reducing indoor tanning under various scenarios on: (1) the expected number of melanoma cases averted, (2) the expected number of melanoma deaths averted, (3) the expected life-years (LYs) saved, and (4) the expected treatment costs saved.

METHODS

Health benefits and melanoma treatment cost-savings were estimated using a Markov model. The model follows the current cohort of 61.2 million individuals aged 14 years or younger in the United States[11] through their lifetime (until death from melanoma or from other causes) in 1-year cycles. At the end of each 1-year cycle, individuals could be in 1 of the following mutually exclusive health states: (1) never indoor tanned and no melanoma, (2) ever indoor tanned and no melanoma, (3) given a diagnosis of melanoma, (4) death from melanoma, and (5) death from other causes (Fig 1). During each 1-year cycle individuals face probabilities of outcomes given their current state and being 1 year older. For each health state or transition an outcome is assigned (eg, a diagnosis of melanoma and associated treatment costs). The aggregation of these outcomes over the life of the model is expected to vary between individuals based on the use of indoor tanning and its increased melanoma risk. The differences between these groups are the primary outputs of the model.

Model parameters and sources

Models inputs were obtained from existing data sources and the published literature. We estimated the current probability of ever indoor tanning by age using annual prevalence data among individuals age 15 through 18 years from the 2013 Youth Risk Behavior Survey,[12] and the prevalence of ever indoor tanning in the United States from a recent meta-analysis.[1] We fit an exponential equation using these values (Table I), and imputed the probability of ever indoor tanning among individuals age 19 through 76 years. We used a constant probability of ever indoor tanning after age 77 years, as suggested by the 2010 and 2013 National Health Interview Surveys.[13]

We obtained the age-specific invasive melanoma incidence rates from the 2007 to 2011 US Cancer Statistics data set.[14] Only invasive melanoma was considered, given that in situ cases are not generally associated with increased mortality and are likely to be underreported in central cancer registries.[15] Individuals initiating indoor tanning before age 35 years had a 59% higher risk of developing melanoma and individuals initiating use after age 35 years had a 20% higher risk, based on results from a systematic review and meta-analysis.[4,5]

We calculate the age-specific probabilities of death from melanoma from the reduced probabilities of surviving based on melanoma relative survival. Given the stabilization of relative survival 10 years after a melanoma diagnosis,[16] a melanoma diagnosis only increased an individual's mortality for the first 10 years after diagnosis. The age-specific probabilities of death from other causes were derived by subtracting melanoma mortality from all-cause mortality using 2011 US life tables.[17,18]

Melanoma treatment costs were obtained from the published literature.[19] Treatment costs were stratified by age at diagnosis (<65 and ≥65 years) and phase of care. The phase of care included the initial phase (the first 12 months after diagnosis), continuing phase (all years in between the initial phase and the last year of life), and the last year of life (the final 12 months of life). The costs for the last year of life were stratified by cause of death (ie, melanoma or death from other causes).[19] We used the same costs for each year in the continuing phase. Among individuals surviving melanoma for more than 5 years, we estimated melanoma treatment costs in the initial year, the following 4 years, and the last year of life. All costs were adjusted to 2014 US dollars using the medical care component of the Consumer Price Index.[20] All future costs were discounted at an annual rate of 3%. The study takes the US health care payer's perspective. The model was developed in TreeAge Pro 2014 Suite, Version 2.2 (TreeAge Software Inc, Williamstown, MA).

Scenarios

We considered 5 different scenarios: an age restriction on indoor tanning among minors younger than 18 years and indoor tanning prevalence reductions of 20%, 50%, 80%, and 100%. Under the age restriction scenario, the probability of ever indoor tanning was 0 for individuals younger than 18 years, 8.8% for those age 18 years (the same as the current probability of ever indoor tanning at age 15 years before an age restriction), and increased at the same rate as before the age restriction for individuals age 19 years and older. For the other 4 scenarios, the probabilities of ever indoor tanning were reduced by 20%, 50%, 80%, and 100% based on the current probability of ever indoor tanning.

Outcomes

The main outcome measures of this study for each scenario are as follows: (1) the expected number of melanoma cases averted, (2) the expected number of melanoma deaths averted,

(3) the expected LYs saved, and (4) the expected medical costs saved during the lifetime of the current cohort of 61.2 million individuals aged 14 years or younger in the United States. During each cycle 1 transition can occur, a transition at the beginning of a cycle would result in overestimation of LYs, whereas transition at the end would result in underestimation. To improve accuracy, we used a half-cycle correction to calculate LYs, in which the transition is determined to be in the middle of the cycle.[21]

Sensitivity analysis

One-way and probabilistic sensitivity analyses were performed to evaluate the robustness of the model outcomes and to address the uncertainty or variability of model parameter estimates. Parameter values and their statistical distributions used in sensitivity analyses are provided in Table I. In 1-way sensitivity analyses, we examined the individual effect of each selected parameter on the model's outcome. For probabilistic sensitivity analyses, we varied parameter values simultaneously according to their statistical distributions. We used beta distributions for transition probabilities, log-normal distributions for relative risks, gamma distributions for costs, and the uniform distribution for the discount factor. We performed probabilistic sensitivity analyses using 10,000 replications, and generated 95% uncertainty intervals formed by the 2.5 and 97.5 percentile values, for each model outcome.

Model validation

The model was validated by comparing the estimated LYs and the expected lifetime risk of melanoma for the US population with the 2011 US life tables[18] and the Surveillance, Epidemiology, and End Results program.[16]

RESULTS

Base-case results

Compared with no age restriction, prohibiting the use of indoor tanning among minors younger than 18 years was estimated to avert 61,839 melanoma cases (4.9% reduction) and 6735 melanoma deaths (4.7% reduction) over the lifetime of the 61.2 million youth age 14 years or younger in the United States (Table II). This would result in an overall gain of 142,659 LYs and more than $342 million in melanoma treatment cost-savings. The estimated health benefits and melanoma treatment cost-savings increased as the prevalence of indoor tanning was reduced. For example, when varying the reduction from 20% to 100%, the estimated number of melanoma cases averted increased from 40,410 to 202,662 (3.2% and 16.2% reductions, respectively), and the estimated number of melanoma deaths averted increased from 4286 to 23,266 (3.0% and 16.1% reductions, respectively). Meanwhile, the expected LYs saved increased from 91,229 to 458,592, and the expected melanoma treatment cost-savings increased from $219 million to $1.1 billion over the lifetime of the 61.2 million youth age 14 years or younger in the United States.

Sensitivity analysis

One-way sensitivity analyses indicated that the results were most sensitive to the relative risk of melanoma and the prevalence of indoor tanning. The results from probabilistic sensitivity analyses showed that variability in model parameters led to differences in magnitude of the estimated health benefits and treatment cost-savings. For example, with the scenario of under-18-years age restriction, the estimated number of melanoma cases averted ranged from 37,480 to 89,472; the estimated number of melanoma deaths averted ranged from 4299 to 10,235; the expected LYs saved ranged from 85,432 to 203,753 LYs; and the expected melanoma treatment cost-savings ranged from $139 to $870 million.

DISCUSSION

To our knowledge, this study provides the first quantitative estimates of the health benefits and melanoma treatment cost-savings of reducing indoor tanning in the United States. An age restriction for those younger than 18 years was estimated to avert 61,839 melanoma cases (4.9% of the total estimated cases), prevent 6735 melanoma deaths (4.7% of the total estimated deaths), and save $342.9 million in melanoma treatment costs over the lifetime of the 61.2 million youth age 14 years or younger in the United States. The estimated health benefits and melanoma treatment cost-savings increased as the prevalence of indoor tanning decreased. We estimate that an age restriction younger than 18 years reduced the prevalence of ever indoor tanning by 29%. Thus, the 20% reduction scenario represents the benefits if the age restriction were less effective in reducing indoor tanning, whereas the 50%, 80%, and 100% reduction scenarios represent estimates if the age restrictions were more effective in preventing individuals from ever indoor tanning.

As of July 2016, 13 states and the District of Columbia have restricted indoor tanning for all minors younger than 18 years. State laws in Oregon and Washington allow minors younger than 18 years to use indoor tanning facilities with a doctor's prescription.[22] Twelve additional states prohibit minors from indoor tanning at various ages younger than 18 years (ie, ages 14–17 years). Age restrictions are associated with lower rates of indoor tanning among minors, specifically the annual prevalence of indoor tanning among females was estimated to be 17% in states with age restrictions compared with 26% in states without age restrictions.[23]

A previous study conducted in Australia also using Markov modeling demonstrated that reductions in indoor tanning could result in favorable cost and health benefits. Specifically, the study estimated that among a cohort of 100,000 individuals aged 14 years or younger, an age restriction for those younger than 18 years and restrictions on use among those with fair skin could prevent 24 melanoma cases and save $53,169 (2014 US dollars) in melanoma treatment costs over the lifetime of the cohort.[10] Their study placed a different value on benefits estimated to occur in the future. When applying the same value in our analysis, we estimate that an age restriction among those younger than 18 years would prevent 17 melanoma cases and save $383,834 in melanoma treatment costs over the lifetime of a cohort of 100,000 individuals aged 14 years or younger in the United States. The estimated number of melanoma cases prevented is less in the United States than in Australia, which may be a result of the lower incidence rate of melanoma in the United States.[24] Meanwhile, the estimated treatment cost saved was higher in the United States than in Australia, likely because of higher cancer treatment costs in the United States.[19]

Additional comparisons of our results with other studies may be difficult because of different disease risk factors, population characteristics, and study methods. However, our estimates of LYs saved by reducing indoor tanning were comparable with other national preventive health services recommended by the US Preventive Services Task Force.[25] To illustrate, Fig 2 shows the expected LYs saved among the cohort of individuals age 14 years or younger in the United States from selected population-based preventive health services. Hypertension screening is estimated to result in 67,350 LY saved,[26] similar to the estimate of 91,229 LYs saved from a 20% reduction in indoor tanning reported in this article. Further, the current study estimates that 142,659 LYs could be saved from an under-18-years age restriction, similar to influenza immunization services (146,945 LYs).[26] Compared with other cancer-related preventive services, the estimated LYs saved from a 50% reduction in indoor tanning (228,990 LYs) was similar to the estimated LYs saved from colorectal cancer screening for people aged 50 years or older (251,032 LYs)[26]; and the estimated LYs saved from a 80% reduction indoor tanning (336,751 LYs) was similar to the estimated LYs saved from the National Breast and Cervical Cancer Early Detection Program for cervical cancer screening among women aged 18 to 64 years (367,751 LYs).[27]

This study is subject to some limitations. First, lifetime indoor tanning rates in our model were based on annual estimates and data from a published meta-analysis, because data on the probability of ever indoor tanning are not available. We accounted for uncertainty and variability around such estimates by conducting sensitivity analyses. Second, the cost analysis did not quantify the direct resources and costs needed for implementing interventions designed to reduce the prevalence of indoor tanning. Third, our analysis does not directly address compliance to laws restricting the use of indoor tanning among minors younger than 18 years. Poor compliance to indoor tanning laws as documented in the literature,[28–30] could reduce the effectiveness of such laws. Lastly, our findings likely underestimate the health benefits and melanoma treatment cost-savings from reducing indoor tanning. We did not include the benefits from preventing in situ melanomas, subsequent primary melanomas, or other types of skin cancer such as basal cell and squamous cell carcinoma, for which indoor tanning is associated with an estimated 413,000 cases each year in the United States.[1] The benefits of reducing indoor tanning are also likely underestimated because we did not adjust future costs for inflation or estimate the costs associated with premature mortality.

Conclusions

Estimates from this study indicate that reducing indoor tanning would be effective in preventing a substantial number of melanoma cases and deaths, and result in melanoma treatment cost-savings. Because the benefits increase as the prevalence of indoor tanning decreases, further efforts to reduce indoor tanning might be effective in reducing the burden of melanoma in the United States. These findings help quantify and underscore the potential benefits of reducing indoor tanning and of continued public health efforts to identify and implement effective strategies to prevent melanoma.

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References

1. Wehner MR, Chren M, Nameth D, et al. International prevalence of indoor tanning: a systematic review and meta-analysis. JAMA Dermatol. 2014; 150(4):390–400. [PubMed: 24477278]
2. National Toxicology Program. Report on carcinogens. 13. Research Triangle Park (NC): US Department of Health and Human Services, Public Health Service; 2014.
3. El Ghissassi F, Baan R, Straif K, et al. A review of human carcinogens–part D: radiation. Lancet Oncol. 2009; 10(8):751–752. [PubMed: 19655431]
4. Boniol M, Autier P, Boyle P, Gandini S. Cutaneous melanoma attributable to sunbed use: systematic review and meta-analysis. BMJ. 2012; 345:e4757. [PubMed: 22833605]
5. Boniol M, Autier P, Boyle P, Gandini S. Correction: cutaneous melanoma attributable to sunbed use: systematic review and meta-analysis. BMJ. 2012; 345:e8503.
6. Guy GP Jr, Berkowitz Z, Everett Jones S, Holman DM, Garnett E, Watson M. Trends in indoor tanning among US high school students, 2009–2013. JAMA Dermatol. 2015; 151(4):448–450. [PubMed: 25535810]
7. Guy GP Jr, Berkowitz Z, Holman DM, Hartman AM. Recent changes in the prevalence of and factors associated with frequency of indoor tanning among US adults. JAMA Dermatology. 2015; 151(11):1256–1259. [PubMed: 26131768]
8. US Department of Health and Human Services. The Surgeon General's call to action to prevent skin cancer. Washington (DC): US Department of Health and Human Services, Office of the Surgeon General; 2014.
9. U.S. Food and Drug Administration. [Accessed December 18, 2015] FDA proposes tanning bed age restrictions and other important safety measures. Available from: URL: http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm477434.htm
10. Hirst N, Gordon L, Gies P, Green AC. Estimation of avoidable skin cancers and cost-savings to government associated with regulation of the solarium industry in Australia. Health Policy. 2009; 89(3):303–311. [PubMed: 18760857]
11. U.S Census Bureau. [Accessed February 3, 2016] Annual estimates of the resident population for selected age groups by sex for the United States, states, counties and Puerto Rico Commonwealth and municipios: April 1, 2010 to July 1, 2013. Available from: URL: https://www.census.gov/popest/data/national/asrh/2015/index.html
12. Kann L, Kinchen S, Shanklin SL, et al. Centers for Disease Control and Prevention. Youth risk behavior surveillance — United States, 2013. MMWR Suppl. 2014; 63(4):1–168.
13. Centers for Disease Control and Prevention. Centers for Disease Control and Prevention; National Health Interview Survey. Available from: URL: http://www.cdc.gov/nchs/nhis.htm [Accessed April 9, 2013]
14. United States Cancer Statistics. [Accessed October 31, 2014] WONDER online database: 1999–2011 incidence. Available from: URL: http://wonder.cdc.gov/cancer-v2011.html
15. Watson M, Johnson CJ, Chen VW, et al. Melanoma surveillance in the United States: overview of methods. J Am Acad Dermatol. 2011; 65(5 Suppl 1):S6–S16. [PubMed: 22018069]
16. Surveillance, Epidemiology, and End Results (SEER) Program. [Accessed February 3, 2016] SEER*Stat database: incidence - SEER 18 regs research data, surveillance research program, surveillance systems branch, released April 2014, based on the November 2013 submission. Available from: URL: www.seer.cancer.gov
17. United States Cancer Statistics. [Accessed March 9, 2015] WONDER online databases: mortality. Available from: URL: http://wonder.cdc.gov/
18. Arias E. United States life tables, 2011. Natl Vital Stat Rep. 2015; 64:1–63.
19. Mariotto AB, Yabroff KR, Shao Y, Feuer EJ, Brown ML. Projections of the cost of cancer care in the United States: 2010–2020. J Natl Cancer Inst. 2011; 103(2):117–128. [PubMed: 21228314]

20. Bureau of Labor Statistics. [Accessed March 25, 2016] Consumer price index category medical care. Available from: URL: http://data.bls.gov/
21. Sonnenberg FA, Beck JR. Markov models in medical decision making: a practical guide. Med Decis Making. 1993; 13(4):322–338. [PubMed: 8246705]
22. AIM at Melanoma Foundation. [Accessed August 22, 2016] Tanning legislation in 2015. Available from: URL: http://www.aimatmelanoma.org/en/aim-for-a-cure/legislative-accomplishments-in-melanoma/2015-indoor-tanning.html
23. Guy GP, Berkowitz Z, Jones SE, et al. State indoor tanning laws and adolescent indoor tanning. Am J Public Health. 2014; 104(4):e69–e74.
24. Erdmann F, Lortet-Tieulent J, Schuz J, et al. International trends in the incidence of malignant melanoma 1953–2008–are recent generations at higher or lower risk? Int J Cancer. 2013; 132(2): 385–400. [PubMed: 22532371]
25. U. S. Preventive Services Task Force. [Accessed March 9, 2015] Recommendations for primary care practice. Available from: URL: http://www.uspreventiveservicestaskforce.org/BrowseRec/Index
26. Maciosek MV, Coffield AB, Flottemesch TJ, Edwards NM, Solberg LI. Greater use of preventive services in U.S. health care could save lives at little or no cost. Health Aff (Millwood). 2010; 29(9):1656–1660. [PubMed: 20820022]
27. Ekwueme DU, Uzunangelov VJ, Hoerger TJ, et al. Impact of the national breast and cervical cancer early detection program on cervical cancer mortality among uninsured low-income women in the U.S., 1991–2007. Am J Prev Med. 2014; 47(3):300–308. [PubMed: 25015564]
28. Culley CA, Mayer JA, Eckhardt L, et al. Compliance with federal and state legislation by indoor tanning facilities in San Diego. J Am Acad Dermatol. 2001; 44(1):53–60. [PubMed: 11148477]
29. Fleischer AB Jr, Lee WJ, Adams DP, Zanolli MD. Tanning facility compliance with state and federal regulations in North Carolina: a poor performance. J Am Acad Dermatol. 1993; 28(2 Pt 1): 212–217. [PubMed: 8432917]
30. Forster JL, Lazovich D, Hickle A, Sorensen G, Demierre MF. Compliance with restrictions on sale of indoor tanning sessions to youth in Minnesota and Massachusetts. J Am Acad Dermatol. 2006; 55(6):962–967. [PubMed: 17097392]
31. Steele RJ, Gnauck R, Hrcka R, et al. Methods and economic considerations: group 1 report. ESGE/UEGF colorectal cancer–public awareness campaign. The public/professional interface workshop: Oslo, Norway, June 20–22, 2003. Fulfillment corporate. Endoscopy. 2004; 36(4):349–353. [PubMed: 15057689]
32. Wright JC, Weinstein MC. Gains in life expectancy from medical interventions–standardizing data on outcomes. N Engl J Med. 1998; 339(6):380–386. [PubMed: 9691106]

CAPSULE SUMMARY

- Reducing indoor tanning can reduce melanoma incidence, mortality, and treatment costs.
- Prohibiting indoor tanning among minors can prevent 61,839 melanoma cases among youth. The benefits of reducing indoor tanning increase as its prevalence is further reduced.
- These findings underscore the importance of efforts to reduce indoor tanning.

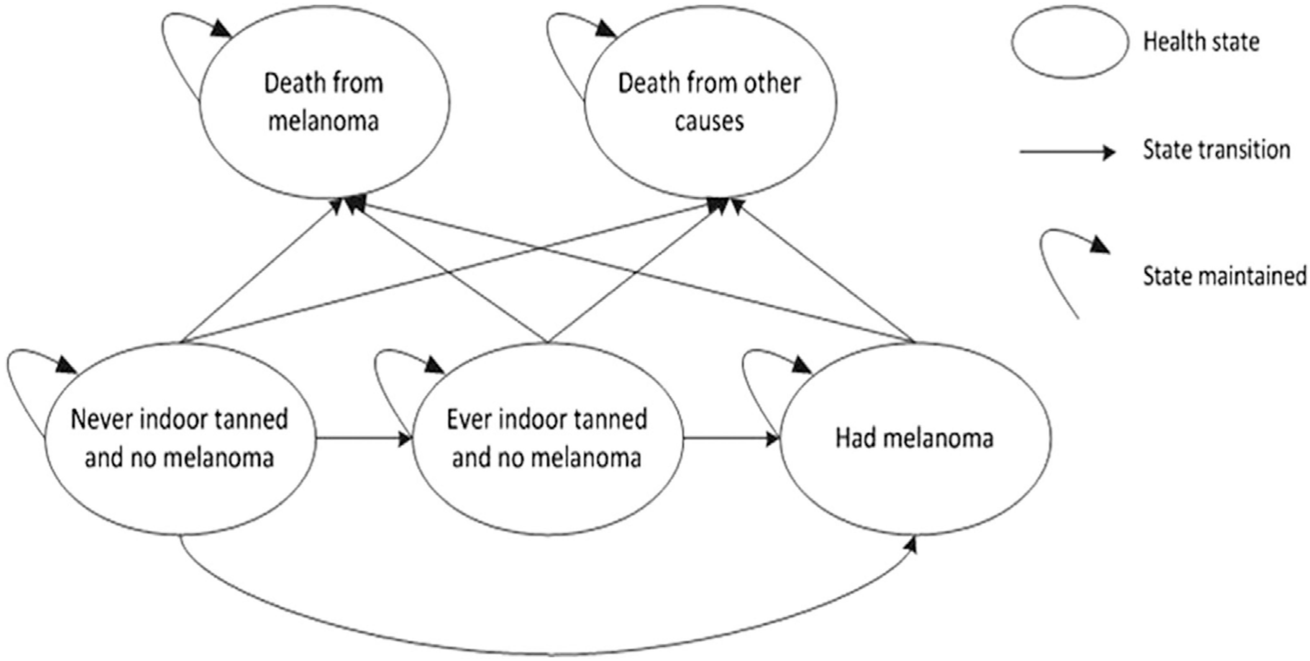

Fig 1.
One-step state transition diagram of the Markov model used to estimate the potential health benefits and melanoma treatment cost-savings of reducing indoor tanning. Circles represent the 5 health states of the model. Straight arrows represent transitions between health states. Circle arrows represent stay in the current health state. Transitions from “never indoor tanned and no melanoma” and “ever indoor tanned and no melanoma” directly to “death from melanoma” indicate individuals who were given a diagnosis and died from melanoma in the same 1-year period.

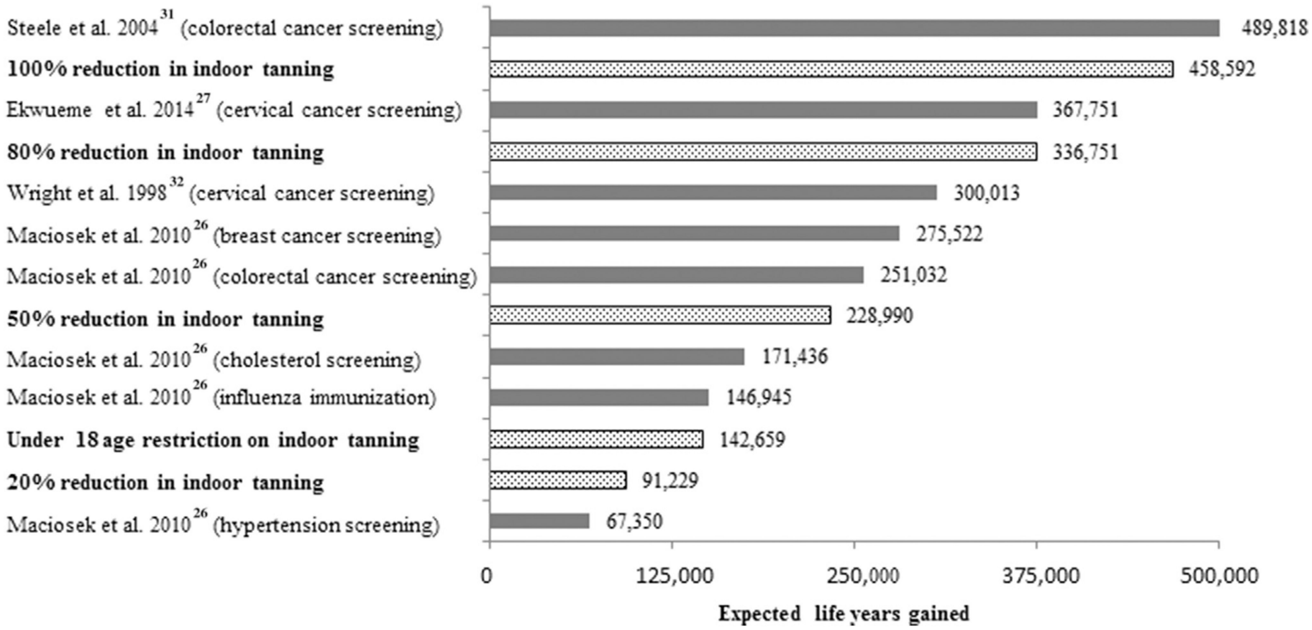

Fig 2.

Expected life years gained over the lifetime of the current cohort of 61.2 million individuals aged 14 years or younger in the United States by selected preventive health services. The black bars represent results from this study and the gray bars represent results from published literature.

Table I

Model parameters, estimates, and sources for base-case analyses, 1-way sensitivity analyses, and probabilistic sensitivity analyses

Parameters	Base-case value	Minimum	Maximum	Statistical distribution*	Sources
Current probability of ever indoor tanned ($P_{current}$[age])†					
Age					
15 y	8.8%	6.4%	12.2%	Beta distribution	2013 Youth Risk Behavior Survey[12]
16 y	12.8%	10.2%	16.0%		
17 y	15.2%	12.8%	17.8%		
18 y	19.0%	15.5%	23.0%		
≥77 y	35.7%	27.5%	44.0%		Wehner et al,[1] 2014
Relative risk of melanoma (ever vs never indoor tanned)					
First-time indoor tanning at age <35 y	1.59	1.36	1.85	Log-normal distribution	Boniol et al,[4,5] 2012
First-time indoor tanning at age ≥35 y	1.20	1.08	1.34		
Melanoma incidence rate (per 100,000 person) (current)‡					
Age					
15–19 y	1.2	1.1	1.2	Beta distribution	2007–2011 US Cancer Statistics[14]
≥85 y	83.3	82.2	84.4		
Melanoma relative survival					
1 y	96.8%	96.7%	96.9%	Log-normal distribution	1997–2008 Surveillance, Epidemiology, and End Results[16]
2 y	94.3%	94.1%	94.4%		
3 y	92.3%	92.1%	92.5%		
4 y	90.9%	90.6%	91.1%		
5 y	89.8%	89.5%	90.1%		
6 y	89.0%	88.7%	89.2%		
7 y	88.3%	88.0%	88.6%		
8 y	87.9%	87.6%	88.3%		
9 y	87.5%	87.2%	87.9%		
10 y	87.1%	86.7%	87.5%		
Melanoma mortality (per 100,000 person)‡					
Age					
15–19 y	0	0	0	Beta distribution	2007–2011 US Cancer Statistics[17]

Parameters	Base-case value	Minimum	Maximum	Statistical distribution*	Sources
≥85 y	22.6	22	23.1		
All-cause mortality	Age-specific	-	-	Not varied	2011 US life table[18]
Discount factor	3%	0%	5%	Uniform distribution	-
Melanoma treatment cost, $§					
Initial phase					
Age					
<65 y	7049	5287	8812		
≥65	5874	4406	7343		
Continuing phase					
All ages	1606	1204	2007	Gamma distribution	Mariotto et al,[19] 2011
Last year of life (death from melanoma)					
Age					
<65 y	100,200	75,150	125,250		
≥65 y	66,801	50,100	83,501		
Last year of life (death from other causes)					
All ages	447	335	559		

Rates were converted to annual probabilities in TreeAge Pro 2014 Suite, Version 2.2 using the formula: probability = 1 − $e^{(-\text{rate})}$. The minimum and the maximum for each parameter were used for 1-way sensitivity analyses.

* In the probabilistic sensitivity analysis, parameters a and b for beta distribution were derived from the mean and SD in TreeAge Pro 2014 Suite, Version 2.2 (TreeAge Software Inc, Williamstown, MA) using the formulas: a = $\text{mean}^2 \times (1 - \text{mean})/(\text{SD}^2)$; b = mean × (1 − mean)/(SD^2) − a. The parameters mu and sigma for log-normal distribution were derived from the mean and SD using the formulas: mu = (ln [minimum] + ln [maximum])/2; sigma = (ln [maximum] − ln [minimum])/3.92. The parameters alpha and lambda for gamma distribution were derived from the mean and SD using the formulas: alpha = $\text{mean}^2/\text{SD}^2$; lambda = mean/SD^2.

† The probability of ever indoor tanning between age 19–76 y increases with age and was imputed based the fitted exponential model:

$$P_{\text{current}}(\text{age}) = \frac{35.8 - 450.1 \times e^{(-0.2237 \times \text{age})} - 32.06 \times e^{(-0.06977 \times \text{age})}}{100}.$$

‡ Melanoma incidence rates and melanoma mortality were obtained in 5-y age intervals. Both rates increased with age. The smallest rate (15–19 y) and the largest rate (≥85 y) are presented.

§ All costs were adjusted to 2014 $US using the medical care component of the Consumer Price Index.[20]

Table II

Estimated health benefits and melanoma treatment cost-savings from reducing indoor tanning over the lifetime of the 61.2 million youth age 14 years or younger in the Unitesd States

	Absolute changes	Relative changes
Expected no. of melanoma cases averted		
Age ≤18 y restriction	61,839	4.9%
Reduction in indoor tanning		
20%	40,410	3.2%
50%	101,637	8.1%
80%	162,252	13.0%
100%	202,662	16.2%
Expected no. of melanoma death averted		
Age <18 y restriction	6735	4.7%
Reduction in indoor tanning		
20%	4286	3.0%
50%	11,633	8.1%
80%	18,368	12.7%
100%	23,266	16.1%
Expected life-years saved		
Age <18 y restriction	142,659	0.004%
Reduction in indoor tanning		
20%	91,229	0.002%
50%	228,990	0.006%
80%	366,751	0.009%
100%	458,592	0.012%
Expected melanoma treatment costs saved, $US, 2014		
Age <18 y restriction	$342,872,393	5.0%
Reduction in indoor tanning		
20%	$219,193,423	3.2%
50%	$547,983,556	8.0%
80%	$876,773,690	12.8%
100%	$1,095,967,113	16.0%

Based on the 2010 US census data, there are approximately 61.2 million individuals aged 0–14 y in the United States.