

# More Skin, More Sun, More Tan, More Melanoma

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Although personal melanoma risk factors are well established, the contribution of socioeconomic factors, including clothing styles, social norms, medical paradigms, perceptions of tanned skin, economic trends, and travel patterns, to melanoma incidence has not been fully explored. We analyzed artwork, advertisements, fashion trends, and data regarding leisure-time activities to estimate historical changes in UV skin exposure. We used data from national cancer registries to compare melanoma incidence rates with estimated skin exposure and found that they rose in parallel. Although firm conclusions about melanoma causation cannot be made in an analysis such as this, we provide a cross-disciplinary, historical framework in which to consider public health and educational measures that may ultimately help reverse melanoma incidence trends. (*Am J Public Health*. 2014;104:e92–e99. doi:10.2105/AJPH.2014.302185)

Despite advances in its detection and treatment, melanoma remains the primary cause of mortality from skin disease in the Western world.<sup>1,2</sup> Improvements in the early detection of melanoma and changes in reporting practices contributed, in part, to the increase in melanoma incidence in recent decades; however, these factors alone cannot entirely account for the steady rise in tumor incidence and mortality observed during the 20th century. Several personal risk factors for developing melanoma are well established, including family history, multiple moles, fair skin, blue eyes, red hair, and freckles.<sup>3</sup> Environmental exposures, chiefly from UV radiation, including outdoor sunburns and indoor tanning exposure, also have been associated with increased melanoma risk.<sup>4,5</sup> On a population level, the contribution of changing socioeconomic factors is an intriguing variable that has not yet been fully explored, particularly the evolution of clothing styles, social norms, economic trends, available leisure time, and medical paradigms regarding UV radiation. We explore the historical relation between these factors and US melanoma incidence in the 20th century. Our goal is to illustrate how changes in fashion, perceptions of tanned skin, and socioeconomic factors have led to increased UV exposure and likely contributed to the escalation of melanoma in 20th-century America.

We have divided the 20th century into 4 periods, each illustrating historical forces contributing to increases in societal exposure to UV radiation. To assess fashion and clothing trends, we reviewed artwork, consumer advertisements, and sources describing Sears department store clothing catalogs.<sup>6–9</sup> We also studied historical events and publicly available data regarding Americans' leisure time and participation in outdoor activities. In an effort to illustrate the association between changing clothing styles, skin exposure to UV radiation, and the increasing melanoma incidence, we estimated skin exposure with the "rule of nines," a standardized system traditionally used to assess percentage of body surface affected by burns.<sup>10</sup> We then examined the relation between skin exposure and melanoma incidence. Although they may not capture all regional, geographic, and individual subpopulation variations in UV exposure and cancer incidence rates, we used data from the Connecticut Tumor Registry,<sup>11,12</sup> the oldest available US cancer registry, from its inception in 1935 to the present and the Surveillance Epidemiology and End Results (SEER) national cancer database, which incorporates population-level data from 9 to 17 different regions in the United States, depending on the time period analyzed.<sup>11,13,14</sup> Because the average age at diagnosis of melanoma during these decades is

50 to 60 years and early-life UV exposure is known to contribute to subsequent melanoma development, we used a postexposure lag time of 50 to 60 years in our analysis. We also explored additional societal factors that (1) led to the dramatic shift in perception of tanned skin from unattractive to desirable, (2) compelled the public to continue tanning despite evidence of the carcinogenic effects of UV exposure, and (3) sustained the indoor tanning fad of the late 20th century.

## TURN OF THE CENTURY

In the pre-1900s to 1910, a stigma was associated with tanned skin because it was commonly seen among working-class individuals. Clothing trends, socioeconomic factors, and artwork of this time promoted porcelain pale skin. Later in this period, however, new medical paradigms indicated the efficacy of sunlight in the treatment of disease, introducing the notion of the healthy tan.

### The Era of Porcelain Beauty

For centuries, the lower class mainly worked outdoors as manual laborers in farms and fields, whereas the upper class remained indoors. In addition, generally negative attitudes toward darker races increased the desirability of fair skin, which was associated with physical and social wellness.<sup>15</sup> As a result, sun avoidance was promoted in the United States through the use of parasols and thick layers of clothing that generally covered the entire body.<sup>16</sup> Swimsuits and sportswear also covered substantial parts of the skin (Supplemental Figures 1A–1D, available as a supplement to the online version of this article at <http://www.ajph.org>). Men's and women's swimwear exposed an estimated 23% and 18% of the total skin surface area, respectively, whereas sportswear revealed an estimated 9% of the skin surface in both sexes. Artwork of the mid to late 19th century captured these clothing

practices, exemplified by Edouard Manet's *The Beach at Boulogne* (Supplemental Figure 5, available as a supplement to the online version of this article at <http://www.ajph.org>), which depicts fully clothed men and women walking with parasols by the beach.

Given the desirability of pale skin, topical sun protectants, composed of white petrolatum or almond oil combined with a heavy powder made up of magnesium, zinc oxide, or bismuth, were often used to avoid sunburn and freckling.<sup>16</sup> Skin bleaching preparations were a popular modality to further whiten the skin. Advertisements for these formulations could be found in newspapers such as the *Los Angeles Times* in the early 1900s and boasted the ability to permanently remove any signs of a tan or freckling and to make the skin white.<sup>17,18</sup> Even photographs were altered during this time, both to lighten skin tone and to increase the difficulty of assigning racial categories to individuals and groups.<sup>15</sup>

Further contributing to a culture of pale skin in late 19th-century America were social and economic factors that promoted indoor activities. The Industrial Revolution reinforced the importance of work and shifted large segments of the workforce from outdoor to indoor settings. Between 1850 and 1900, the number of Americans employed indoors in manufacturing and mining increased 4- to 6-fold.<sup>19</sup> National census and Senate labor reports documented an average of approximately 62 work hours per week in 1880.<sup>20,21</sup> An estimated 1.8 hours per day were available for leisure activity for the typical US male worker during this same period.<sup>22</sup> This societal emphasis on the importance of work was illustrated by reformers of the late 19th century, who repeatedly stressed the notion that work was more important than play and warned the public about social dangers that could result from idle time.<sup>23</sup>

### Changing Science and the Healthy Tan

At the turn of the 20th century, the emergence of a new medical paradigm focusing on sunlight as a treatment modality for many diseases ignited a shift in sun exposure attitudes. The roots of the movement can be traced to Downes and Blunt, who found that direct sunlight inhibited the growth of microorganisms, and T. A. Palm, who showed that lack of sunlight was a chief cause of rickets in the

1890s.<sup>24</sup> In 1903, Niels Finsen was awarded the Nobel Prize for the treatment of lupus vulgaris (i.e., cutaneous tuberculosis) with UV radiation,<sup>25</sup> and Robert Koch won a Nobel Prize for his work in the late 19th century proving that sunlight killed the tubercle bacillus.<sup>26</sup> Excitement over this new treatment modality grew, and the first heliotherapy (i.e., sunlight therapy) clinic for the treatment of tuberculosis was opened in 1903.<sup>27</sup> The use of sunbathing was further explored to treat other conditions such as anemia, Hodgkin's disease, chronic renal failure, syphilis, and septic wounds.<sup>28</sup>

Eventually, this perceived benefit of sun exposure encouraged the idea of the healthy tan as exemplified by a 1910 annotation in *The Lancet* that affirmed, "The face browned by the sun is regarded as an index of health."<sup>16,29</sup>

### EARLY 20TH CENTURY

From 1910 to the late 1930s, several factors promoted the social acceptance of tanned skin. These factors included sustained advocacy from the medical community, the advent of indoor devices emitting UV radiation, increasingly revealing fashion trends, changes in work hours, and the construction of outdoor leisure and sporting facilities. Interestingly, this period also saw the emergence of clinical observations suggesting a potentially causative role of UV radiation in skin cancer.

#### Medicine Embraces UV Radiation

UV phototherapy was one of the major treatment modalities embraced by physicians in the early 20th century.<sup>28</sup> The dermatologist William Goeckerman demonstrated the use of coal tar with UV radiation for the treatment of psoriasis in 1925.<sup>30</sup> Prominent medical leaders, including Herman Bundesen, the president of the Chicago Board of Health, stressed the importance of sunlight in healthy development, advising mothers in a 1938 issue of *Ladies Home Journal*:

No deficiencies that develop in children are of greater significance than those caused by lack of sunlight . . . When it shines on a child it helps his bones and teeth to form properly [and] promotes the quality and circulation of his blood . . . The sunbath is just as important as the water bath.<sup>31(pp148-51)</sup>

To maximize the health benefits of sunlight, special lamps were developed to enable

consistent and controlled delivery of UV radiation in hospital wards. Treatment with UV lamps was described as having the ability to decrease blood pressure, increase appetite, and promote a feeling of freshness and well-being.<sup>32</sup> To provide UV therapy outside the hospital setting, companies such as General Electric, Campbell, and Alpine developed home sunlamps that were marketed as providing an invigorating therapeutic effect "good for the whole family,"<sup>33</sup> especially during the winter months.

#### Early Evidence for the Dangers of UV Exposure

Despite the strong endorsement of UV radiation for promoting good health, initial warnings from within the dermatology community began to appear. Chronic sun exposure had been implicated as an etiological agent in skin cancer as early as 1894, but these initial claims went largely ignored.<sup>16</sup> In an early epidemiological study, the French dermatologist William Dubreuilh wrote that grape pickers in Bordeaux, France, had skin cancers occurring more commonly on sun-exposed areas,<sup>34</sup> and in 1920, the American dermatologist James McCoy observed that a disproportionately higher percentage of skin cancers occurred on the face, neck, and hands.<sup>35</sup> By 1933, the term *sunlight cancer* was first coined,<sup>36</sup> and prolonged sun exposure was associated with the development of wrinkled and atrophied skin associated with horny growths (i.e., cutaneous horns) often seen in farmers and sailors.<sup>37,38</sup>

These early clinical observations linking UV exposure to skin cancer received little attention from the general medical community, lay press, and public. This may have occurred because the mechanism underlying UV-induced carcinogenesis was poorly understood. It was also widely held that sunlight caused skin cancer only in susceptible individuals, such as patients with xeroderma pigmentosum, but not in the general population.<sup>16</sup> Indeed, the American dermatologist James Nevins Hyde, who suggested the carcinogenic properties of UV radiation and referred to sunlight as "actinic rays,"<sup>39</sup> wrote, "So far as can be determined at the present time, the majority of all human beings are wholly incapable of developing the symptoms of cancer."<sup>39</sup>

### The Growth of Outdoor Leisure Time

During the same period, the availability and use of leisure time changed in the United States. A typical workweek for an American male decreased from 62 hours in 1880 to 42.5 hours by 1940.<sup>40</sup> Paid vacation became commonplace in the 1920s, further reinforcing the value of time away from work and encouraging leisurely pursuits.<sup>23</sup>

Cultural and social movements promoted outdoor activities, such as time spent in parks and beaches. This trend began in the late 1800s, as evidenced by the opening of Coney Island in 1897, and it grew steadily in popularity from 1910 to the 1930s. In fact, during its first full year of operation in 1930, 1.5 million visitors journeyed to the suburban New York Jones Beach State Park.<sup>41</sup> Sports such as tennis and baseball also were enjoyed by increasingly greater numbers of people, and the construction of thousands of athletic fields, tennis courts, baseball diamonds, and swimming pools made outdoor athletics a common element of the American social experience.<sup>42</sup>

### The Culture of the Healthy Tan

The historical, socioeconomic, and medical changes outlined earlier appear to have paved the way for the tan to become a fashion statement by the 1920s. With the Industrial Revolution shifting many lower- and middle-class workers indoors, tanned skin emerged as a symbol of travel, leisure, and wealth.<sup>43</sup> This was exemplified by the upper-class characters in F. Scott Fitzgerald's novel *The Beautiful and Damned*, set in 1913 to 1914, who talked at length about achieving a tan.<sup>44</sup> In a 1929 issue of *Vogue* magazine, Coco Chanel endorsed the tanning fad after returning from the French Riviera with bronzed skin, affirming that "the 1929 girl must be tanned" and "a golden tan is the index of chic."<sup>43</sup>

The 1920s and 1930s also witnessed a dramatic change in clothing and swimwear from fully covered, layered styles to more revealing fashions. During this period, swimsuit skin exposure increased from an estimated 18% to 47% in women and from an estimated 23% to 47% in men (Supplemental Figures 2A and 2B, available as a supplement to the online version of this article at <http://www.ajph.org>).<sup>6</sup> Sportswear of the 1920s experienced similar changes,

increasing skin exposure from 9% in both sexes to 14% in men and 27% in women (Supplemental Figures 2C and 2D, available as a supplement to the online version of this article at <http://www.ajph.org>). In addition, as early as 1914 to 1918, children's clothing also began to reveal more skin. Boys wore shorts and socks that fell below the knee, whereas girls wore dresses and socks, both exposing skin from midknee to midcalf.<sup>6</sup>

### MID-20TH CENTURY

The 1940s to 1970s were characterized by increased travel, greater availability of outdoor activities, and a popular culture that endorsed even more tanning and revealing clothing styles than in previous decades. Coinciding with the tanning trend, however, were mounting laboratory data indicating a direct role of UV radiation in the development of skin tumors in animals and epidemiological studies associating skin cancer with UV exposure.

### Growing Knowledge of the Dangers of UV Radiation

By the 1940s, the pathological mechanism of UV-induced carcinogenesis was better elucidated, first by the British physician George Marshall Findlay and later by the Argentinian researcher Angel Roffo, who produced cutaneous tumors in animal models by subjecting them to chronic UV irradiation.<sup>45</sup> Later in this period, reports in nondermatology medical journals, articles in the lay press, and television segments focusing on the association between tanning, sunburn, and skin cancer became more widespread and resulted in increased public awareness of the dangers of UV exposure.<sup>45</sup> Similarly, melanoma interest grew notably in the scientific literature, as evidenced by the more than 4000 articles containing the word *melanoma* referenced in the PubMed database of the US National Library of Medicine, an enormous increase from the 30 articles referenced prior to 1930. This represented a 133-fold increase in melanoma publications compared with a 21-fold general increase in total articles cited in PubMed.

Concurrent with heightened knowledge about the dangers of UV radiation, the consumer products industries had increased interest in developing novel sunscreen preparations. In

the 1940s to 1960s, dermatologists commonly recommended 2% to 5% para-aminobenzoic acid-containing topical preparations, which were believed to remain in the stratum corneum and provide UV-B radiation protection for several hours.<sup>46</sup> Later in the 1970s, the first water-resistant sunscreens were developed.<sup>46</sup> Similarly, the cosmetic industry began adding sunscreen to makeup products.<sup>46</sup> Whether sunscreen was used primarily as a way to avoid sunburn and increase time outdoors rather than prevent skin cancer during this time, however, remains uncertain.

### The Rise of Revealing Fashions

Despite growing warnings, tanned skin remained popular. Actresses, such as Ursula Andress (the first Bond girl), and fashion magazines endorsed tanning because it supported the prevailing notion of sexy, young, healthy, and wealthy women.<sup>47</sup> Likewise, clothing and swimwear styles also became more revealing. The T-shirt became an acceptable outer garment in 1942, allowing arms to be exposed on a daily basis.<sup>23</sup> During World War II, the US government instituted fabric rations for clothing manufacturers in an effort to conserve wool and silk, which were needed to make uniforms and parachutes.<sup>48</sup> In 1943, an order was issued stating that the fabric used in women's swimwear needed to be reduced by 10%; this resulted in the elimination of the midsection and the introduction of the 2-piece bathing suit.<sup>48</sup> Later, in 1946, skin exposure in swimsuits became even more pronounced when French designer Louis Reard invented the bikini, which was widely adopted in the United States by the 1960s. This new swimsuit design increased women's skin exposure from 47% to 80% (Supplemental Figure 3A, available as a supplement to the online version of this article at <http://www.ajph.org>). Men's swimsuit skin exposure increased from 47% to 89% as the swim tank top was eliminated in favor of a bare chest (Supplemental Figure 3B, available as a supplement to the online version of this article at <http://www.ajph.org>). Sportswear skin exposure also increased from 27% to 38% in women and from 14% to 38% in men (Supplemental Figures 3C and 3D, available as a supplement to the online version of this article at <http://www.ajph.org>).<sup>8</sup>

Together with increasingly revealing fashions, women's magazines continued to portray tanning as chic, and cosmetic companies developed and marketed various tanning oil preparations.<sup>46</sup> If deeply tanned skin could not be achieved by these means, the first commercial self-tanning product, the "Man-tan," became available in the 1950s.<sup>46</sup>

### American Affluence Promotes Travel and Sport

Besides changes in fashion, the 1940s to 1970s saw increased travel and expanded participation in organized sports. The reduced cost and increased speed of airplanes resulted in a surge of air travel in the post-World War II era. By the 1950s, the number of Americans traveling by airplane per year was in the millions, compared with tens or hundreds of thousands in the prewar years.<sup>49</sup> During this time, automobile travel also doubled and tourism boomed. Travel to national parks and monuments became popular, and boating and camping gear sales rose dramatically.<sup>50</sup> Amusement parks were common travel destinations. Disneyland in California opened in 1954 and recorded its 10-millionth visitor in just 3 years.<sup>50</sup>

An increase in American affluence also enabled families to dedicate more time and money to organized sports. All-American team sports such as football, baseball, and basketball rose in popularity as a means to promote the "American way of life" during the Cold War.<sup>51</sup> It was also during this time that the notion of sports participation as an important factor for the healthy development of children arose as evidenced by the expanding Young Men's Christian Association movement and the development of physical education in public schools.<sup>52</sup>

### The Rise of Melanoma

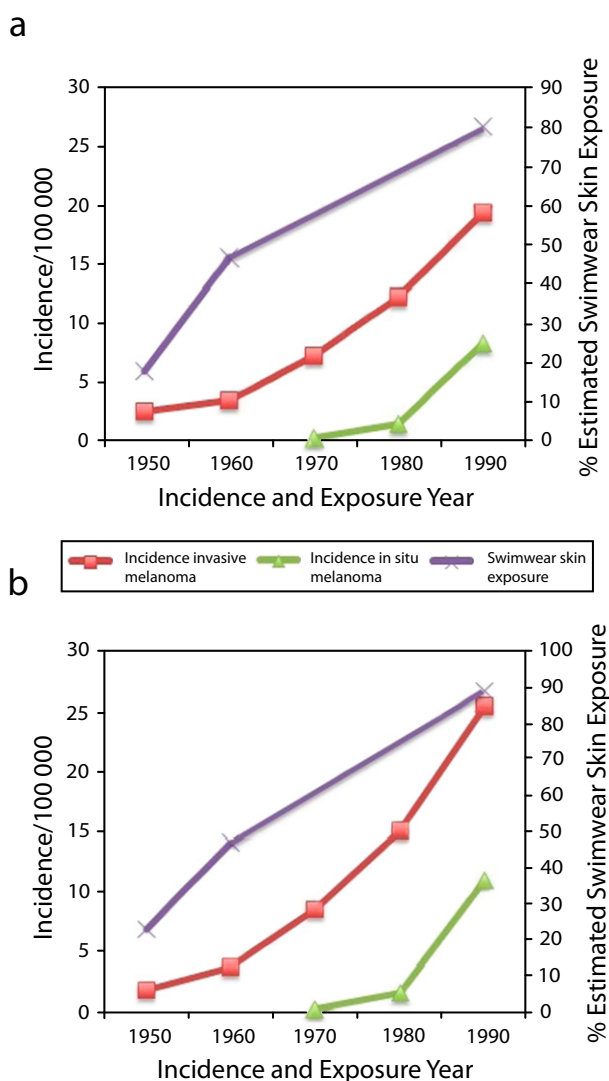
Although it is now well established that UV exposure is linked to melanoma, it was not until the creation of cancer databases that changes in UV exposure could be compared with melanoma incidence rates. The Connecticut Tumor Registry, which started keeping records in 1935, reported the age-adjusted melanoma incidence in both men and women as approximately 3.0 per 100 000 in 1950 (Figure 1).<sup>11</sup> By the late 1970s, the melanoma incidence rate

had risen 3-fold in men and 2.5-fold in women to 9.2 and 7.6 per 100 000, respectively (Figure 1).<sup>11</sup>

From the 1930s to the 1960s, the "all site" age-standardized cancer incidence in men and women increased by 69% and 18%, respectively, whereas melanoma incidence increased by more than 300% in men and 400% in women.<sup>12</sup> This increase in melanoma incidence occurred in parallel with changes in fashion, travel, and leisure that resulted in increased skin and UV exposure.

### LATE 20TH CENTURY

The tanning trend that began in the 1920s sustained its allure and celebrity promotion into the late 20th century. Despite mounting evidence that UV exposure was linked to the development of skin cancer, tanned skin remained highly desirable. The public continued to wear revealing swimwear and sportswear, enjoy travel to warm destinations, and spend increased time outdoors. The late 20th



Note. Swimwear skin exposure is based on a review of bathing suit styles as seen in Sears catalogs. A postexposure lag time of 50–60 years was chosen because this reflects the average age at melanoma diagnosis in different decades as described in the Connecticut Tumor Registry and the Surveillance, Epidemiology, and End Results (SEER) national cancer registries. Source: Geller et al.<sup>11</sup>

**FIGURE 1—Age-adjusted melanoma incidence rates with estimated swimwear skin exposure calculated with the rules of nines in (a) women and (b) men.**

century was also marked by the birth of the indoor tanning center, which quickly became popular, especially among young adults.

### Revealing Fashions Retain Their Popularity

Although not showing the dramatic changes seen in previous decades, clothing and swimwear in the late 20th century continued to be styled with a template of maximum skin exposure. The bikini, with the emergence of strapless tops and low-rise bottoms, was associated with an estimated 92% skin exposure (Supplemental Figure 4A, available as a supplement to the online version of this article at <http://www.ajph.org>); men's swimwear exposure remained steady at 89% (Supplemental Figure 3B). Women's sportswear exposure rose from 38% to 53%, and men's sportswear exposure increased from 38% to 44% (Supplemental Figures 4B and 4C, available as a supplement to the online version of this article at <http://www.ajph.org>).<sup>9</sup>

These fashion changes can be seen in several late-20th-century images, exemplified by Pam Turnbull's "Mom Walking With Babe," which depicts children and adults on the beach wearing typical swimsuits of the time (Supplemental Figure 6, available as a supplement to the online version of this article at <http://www.ajph.org>).

### The Growth of Sun Tourism and Sport

Consistent with revealing clothing and swimwear, travel to warm locations has been the predominant pattern of US tourism in the last few decades.<sup>53</sup> Of the top 10 US travel destinations, 6 were to sunny destinations including Orlando and Miami in Florida and Las Vegas in Nevada.<sup>54</sup> For example, Miami-Dade County's tourism data indicated an increase in visitors to the region from 8.8 million in 1994 to 10.4 million in 2003.<sup>55</sup> Outdoor sports and recreation maintained their popularity, as supported by data from the National Sporting Goods Association, which showed that the most popular leisure activities in the United States between 1992 and 1998 included walking, swimming, fishing, and golf.<sup>56</sup>

### The Surge of Indoor Tanning

Compared with previous decades, outdoor UV exposure rose more slowly, but indoor

tanning exposure surged. In 1978, the first US indoor tanning center opened in Arkansas.<sup>57</sup> In 1981, approximately 10 new tanning centers opened each week; by 1988, there were more than 18 000 tanning centers in the United States.<sup>58</sup>

Young adults, particularly White female adolescents of higher socioeconomic status,<sup>59</sup> have the highest rate of indoor tanning center use, providing this population with an additional source of UV radiation besides outdoor exposure. According to an American Academy of Dermatology survey, indoor tanning and sunlamp use in those younger than 25 years increased 3-fold, from 2% of individuals in 1986 to 6% in 1996.<sup>60</sup> The International Agency for Research on Cancer designated tanning devices that emit artificial UV radiation as carcinogenic to humans,<sup>61</sup> making indoor tanning a significant public health concern. Indoor tanning has been linked to basal cell carcinoma, cutaneous squamous cell carcinoma, and melanoma.<sup>4,5,62</sup> Importantly, the harmful effects of indoor tanning on melanoma risk have been shown to occur independently of outdoor UV exposure.<sup>63</sup>

### Melanoma Incidence Continues to Rise

During the last 2 decades of the 20th century, melanoma incidence continued to rise at accelerated rates. Connecticut Tumor Registry data indicate that by the late 1980s, the age-adjusted melanoma incidence was 13.7 and 10.9 per 100 000 in men and women, respectively (Figure 1).<sup>11</sup> From the 1960s to the 1990s, the "all site" age-standardized cancer incidence in men and women increased by approximately 30%, whereas melanoma incidence increased by 244% in men and 167% in women.<sup>13</sup> SEER data also showed an increase in melanoma incidence rates from 8.7 to 22.8 cases per 100 000 White patients from 1975 to 2000.<sup>13,14</sup> Despite this rising incidence, tanned skin remained desirable. A 1996 survey of 1000 US adults by the American Academy of Dermatology showed that 56% of respondents believed that people looked healthier with tanned skin, and 25% reported that they intentionally tanned.<sup>60</sup> Although no comparative surveys exist, this sentiment of tanned skin as healthy and attractive in the late 20th century stands in stark contrast to the negative social context of tanned skin that defined the early 1900s.

Although tanned skin remained highly desirable, people had a growing interest in sunscreen and sun protection in the late 20th century. In the 1980s, Coppertone developed the first sunscreen that provided protection against both UV-A and UV-B radiation and pioneered a sport, sweat-proof formulation.<sup>46</sup> Sunscreen became increasingly incorporated into daily-use cosmetic products, and routine sunscreen application became more widely adopted by the general public.<sup>46</sup>

### EPILOGUE

Melanoma incidence is continuing to rise in the 21st century. Between 2000 and 2009, incidence rose from 22.8 to 28.9 cases per 100 000 White patients.<sup>13,14</sup> Intriguingly, age-stratified SEER data show increasing melanoma rates of 3.6% per year among women aged 15 to 39 years (the population who most use indoor tanning centers) compared with 2% per year in men in the same age group.<sup>13,14</sup> Tanning, particularly at a young age, confers increased melanoma risk<sup>64</sup>; however, beliefs and practices related to tanning have proven challenging to modify. Today, indoor tanning remains a significant public health burden. Annually, nearly 28 million people tan indoors in the United States.<sup>65</sup> Measures to decrease the accessibility of indoor tanning in the United States are already under way. For example, in July 2010, a national 10% tax on indoor tanning was instituted in hopes of deterring use.<sup>66</sup> Individual states also have taken legislative action against indoor tanning. In October 2011, California became the first state to ban indoor tanning for minors, followed by multiple other states.<sup>67</sup> The fashion world, too, has become involved, as seen in the prohibition of tanning in models in the 2012 Fashion Weeks in London, England, and New York, New York.<sup>68</sup>

Indoor tanning is only one of several factors contributing to rising melanoma rates. Outdoor UV exposure and sun safety practices are examples of other modifiable melanoma risk factors. Educational programs may affect UV protection attitudes and skin cancer prevention. In Australia, public health and educational campaigns that were launched in the 1980s have resulted in promising shifts in attitudes and behaviors regarding UV exposure and the

attractiveness of tanned skin.<sup>69</sup> Compared with national survey data from 2003 to 2004, Australian adolescents and adults in 2010 to 2011 had a decreased desire to suntan and were less likely to perceive tanned skin as attractive and healthy.<sup>70</sup> Suggestive yet weak and indirect evidence indicates that public health and educational initiatives may affect melanoma incidence trends. A study from Queensland, Australia, examining melanoma incidence rates in different age groups found a statistically significant decline in rates from 1982 to 2008 in individuals younger than 60 years (those who would have been in their 30s or younger at the launch of Australian sun safety programs).<sup>71</sup> When incidence rates as a function of body site were examined, decreasing melanoma rates were noted among younger people on the trunk, upper limbs, and shoulders. These anatomical sites are subject to intermittent UV exposure and can potentially be shielded from the sun with protective clothing.<sup>71</sup> Nevertheless, the relation between Australian public health programs and declining melanoma incidence cannot be viewed as a direct, causative association. Even though legislative interventions requiring sun protection among schoolchildren and outdoor workers have been in place for at least 10 years, other shifting socioeconomic trends, such as decreased time spent outdoors,<sup>72</sup> attributable in part to the encroachment of the workweek into the weekend and a shift from outdoor to indoor play among children, also may have contributed to the observed decline in melanoma incidence. Other factors, such as the more recent banning of indoor tanning centers,<sup>73</sup> the development of more fashionable sun protective clothing,<sup>74</sup> and media and celebrity endorsement of sun protection,<sup>75</sup> provide hope for continuing declines in melanoma incidence rates in Australia. These observations underscore the number and diversity of population variables that may affect melanoma incidence.

In the United States, besides legislative measures limiting indoor tanning among minors, the importance of proper UV safety practices must be relayed to the public. Recently, an Australian randomized trial found a statistically significant decrease in primary melanoma incidence in daily sunscreen users compared with control subjects.<sup>76</sup> There has

been a general increase in the use of sunscreen, sunglasses, and barrier clothing from the years 2000 to 2010 in the United States, but sunburn rates remain high, with 50.1% of all adults and 65.6% of White individuals between ages 18 and 29 years reporting at least 1 sunburn in the past year.<sup>64</sup> These statistics confirm a continued need for further public health and educational efforts promoting increased UV protection as a means of primary skin cancer prevention. Although celebrities in the early 20th century advocated the desirability of tanned skin, celebrities, together with the popular media, are now taking an increasing role in public health measures that endorse UV safety and promote melanoma awareness.<sup>77</sup> Increasing these efforts may help to reshape public opinion and beauty ideals, increase UV protection, and potentially decrease melanoma incidence.

## CONCLUSIONS

Attitudes and behaviors shape exposures. We have used a multidisciplinary approach including socioeconomic factors, such as more revealing fashion styles, social norms encouraging the desirability of tanned skin, medical paradigms first promoting the benefits of but then warning against the dangers of UV radiation, and increased outdoor recreational activities, to elucidate the evolution of behaviors maximizing UV exposure. Although causation cannot be made in an analysis such as this one, we have provided a historical framework for the changing attitudes promoting increased UV exposure and the rising incidence of melanoma throughout the past century. Although changes in UV exposure may have occurred at different rates in different subpopulations, the overall effect encompassed a broad cultural change that diffused across the entire US population over time. The desire to be tan, which has its roots in the medical profession, retains its popularity today despite evidence linking UV exposure to skin cancer. How public health measures will positively affect long-term melanoma incidence rates remains to be seen.

More broadly, the approach used in this analysis (i.e., studying the attitudes and behaviors that drive public health issues) also could be applied to areas such as tobacco cessation,

alcohol use, and obesity. Identifying the roles of cultural and historical forces (including gender and social class differences) that contribute to the growth and persistence of public health problems may help target interventions to affect disease epidemiology in a positive fashion. ■

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## Contributors

C. Chang and E. C. Murzaku were co-lead authors. All authors analyzed and interpreted data and contributed to critical revision of the article for important intellectual content. C. Chang, N. R. Abbasi, P. D. Davis, M. Berwick, and D. Polsky conceptualized and designed the study. C. Chang, E. C. Murzaku, L. Penn, N. R. Abbasi, and P. D. Davis acquired data. C. Chang, E. C. Murzaku, and L. Penn drafted the article. C. Chang, E. C. Murzaku, L. Penn, M. Berwick, and D. Polsky completed the statistical analysis. D. Polsky supervised the project.

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## Human Participant Protection

Institutional review board approval was not needed for this study because it did not involve human participants.

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