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Sharon L. Manne, PhD *Editors*

Shedding Light on Indoor Tanning

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Foreword

It is now clear that the use of tanning beds is associated with increased risk for squamous cell carcinoma, basal cell carcinoma and melanoma. In fact, in 2009, the World Health Organization categorized tanning beds as carcinogenic to humans [1]. Several countries worldwide have either banned the sale of tanning beds, or restrict access to tanning beds by minors; many states in the US have also limited access to minors. However, despite the known risk of exposure to tanning beds and the intense public education effort on the side-effects of tanning by many organizations in the US, tanning beds remain widely used, especially by young women.

Tanning beds are currently classified by the US Food and Drug Administration (FDA) as Class I medical devices with 510(k) exemption. This is the classification for devices that pose minimal potential harm, and are exempted from premarket notification to demonstrate their safety and efficacy. Aside from tanning beds, tongue depressors, bedpans, and elastic bandages are examples of Class I medical devices. Because of the public health concerns associated with tanning bed exposure, as evidenced by multiple peer reviewed publications, many professional medical organizations, including the American Cancer Society, American Academy of Dermatology, National Council on Skin Cancer Prevention, and others, have strongly urged the FDA to reevaluate the above classification. As a result, on March 25, 2010, the FDA conducted a public hearing on this issue. Topics presented included the effects of ultraviolet radiation (UV) exposure such as DNA damage and immune suppression, the observation that UVA output from tanning beds could be as high as four times noon sunlight in Washington, DC, the risk of skin cancer development and its economic burden, the vitamin D controversy, tanning as an addictive behavior, and the compliance of tanning bed operators to state and federal guidelines [2]. At the time of this writing, the final action of the FDA has not yet been released.

Drs. Heckman and Manne are to be congratulated for editing a book in which the relevant topics on indoor tanning are addressed in an evidenced-based manner by recognized leaders. Topics covered include the history and prevalence of tanning, health behavior theories on motivations for tanning, tanning addiction, the physiology of tanning, health effects of UV exposure (e.g., skin cancer development, vitamin D

production), and intervention and regulatory efforts to minimize indoor tanning; the book concludes with discussion on sunless tanning as well as sunbed use outside of the US.

The timely publication of this book nicely fulfills the need of a single volume, up-to-date source of information on indoor tanning, a topic that has significant public health consequences. This book should be on the shelf of dermatologists who counsel patients daily on the side-effects of UV, policy makers who address the public health impact of indoor tanning, photobiologists and other scientists who investigate the cutaneous effects of UV radiation, and social scientists who study tanning motivations and design interventions to reduce engagement in the behavior.

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Contents

Chapter 1
Introduction

Carolyn J. Heckman and Sharon L. Manne

Abstract Since the industrialization of the Western workforce, tanned skin has been perceived increasingly as attractive and fashionable for naturally light-skinned individuals. However, in addition to causing tanning, photo-aging, and other health effects, ultraviolet radiation (UV) is a well-known carcinogen. Despite increased awareness of UV risks, tanning has become widespread. While millions of individuals tan indoors each day, relatively little is known about this phenomenon. This book attempts to fill that gap by providing an overview of the phenomenon of indoor tanning, reasons for its popularity, its risks, and the public health context surrounding the behavior. We have invited some of the preeminent experts in the field to summarize the existing scientific literature for each of the chapters, which are described below. This book provides a unique and essential overview of the most significant current issues related to indoor tanning for scientists, educators, students, clinicians, and the general public interested in dermatology, aesthetic trends, skin care, and skin cancer.

Keywords Indoor tanning • Introduction • History of tanning • Prevalence of indoor tanning • Correlates of indoor tanning • Motivations for indoor tanning • How UV tans skin • Skin cancer • Tanning dependence • Vitamin D • Interventions to reduce indoor tanning • Regulation of indoor tanning • Sunless tanning • International issues in indoor tanning • Melanoma • Ultraviolet radiation (UV)

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A tanned appearance has not been viewed favorably at all times in history, and some cultures favor a paler skin tone. Chapter 2 of the book provides a valuable historical and cultural perspective of tanning and its popularity. Which skin colors are most attractive is a subjective perception that has changed over time and across cultures. Additionally, the social meaning attributed to skin colors is mutable. This chapter outlines a fascinating history of tanning behavior and related attitudes and highlights the influential the role of fashion and advertising.

Is indoor tanning only a phenomenon of young, Caucasian women and girls, or is it more widespread? The current prevalence of indoor tanning and the demographic correlates predictive of who tans indoors, such as age, race, and gender, are described in Chap. 3. Prevalence rates of indoor tanning vary depending on the country and population under study as well as the time-frame being assessed. For example, the prevalence of indoor tanning in the past year among adults was highest in Europe, followed by the USA, and was much lower in Australia. Overall, indoor tanners are more likely than non-tanners to be female, adolescents or young adults, Caucasian, and to have low to moderate skin sensitivity to ultraviolet radiation (UV). Other correlates of indoor tanning include associating with other indoor tanners, as well as use of alcohol, cigarettes, and other substances.

Knowledge of the link between UV radiation exposure and skin cancer is widespread in the USA and several other Western countries. However, there are significant psychosocial motivations to tan that sometimes outweigh an individual's concern for his or her health. Chapter 4 describes the major theories explaining why people may tan indoors. Appearance enhancement is the most commonly-cited reason given for intentional indoor tanning. Attractiveness and the appearance of youth and vitality are highly prized in American culture. Indoor tanning is perceived to be an efficient and convenient way to tan, particularly in climates that are not conducive to continuous sun-tanning throughout the year. In addition to appearance enhancement, some individuals tan for mood enhancement or for social reasons. These can be very compelling factors, making individual behavior change and implementation of public health campaigns challenging.

Although many individuals find a tanned appearance attractive, it is also a sign of skin damage. UV radiation activates pigmentation in skin cells, producing a tanned appearance. A tanned appearance is a sign of underlying DNA damage to skin cells. In fact, UV radiation is a well-established human carcinogen. In addition to the psychosocial context of the behavior, it is important to understand the biological effects of UV radiation on the skin. Chapter 5 addresses how tanning and burning occur and how this varies by individual characteristics such as skin type and family heritage.

The major health risk of UV exposure is skin cancer, which is the most common cancer in the USA, with over a million new cases diagnosed yearly. Perhaps because tanning is commonly perceived as a cosmetic adolescent fad, its association with fatal skin cancer is not taken as seriously as it could be. Melanoma is the most lethal form of skin cancer, but non-melanomas can cause significant morbidity and even mortality as well. It is generally accepted that UV exposure is the most significant modifiable risk factor in the prevention of melanoma, and UV radiation has also

been definitively demonstrated to cause non-melanoma skin cancers. In addition to increased risk for melanoma and non-melanoma skin cancers, UV radiation causes photo-aging (the visible signs of aging such as wrinkles and age spots) and can have negative effects on the immune system. Chapter 6 describes the health effects of UV radiation and indoor tanning.

There are also several current controversies that are addressed in the book including tanning addiction and myths perpetuated by the tanning industry. Appearance enhancement is the most commonly-cited reason given for intentional indoor tanning. An additional reason for frequent tanning, particularly indoor tanning, may be tanning dependence or addiction, colloquially referred to as "tanorexia". Chapter 7 describes the accumulating evidence, both observational and experimental, regarding the phenomenon of tanning dependence. Behavioral studies of adolescents and young adults have reported addictive tendencies among indoor tanners including higher rates of other substance use and anticipated difficulty quitting indoor tanning. Several studies have also found greater symptoms of other psychiatric disorders such as anxiety and mood problems among indoor tanners and tanning dependent individuals. Methods for defining and identifying tanning dependence are being refined, and a potential biological mechanism involving endogenous opioids has been proposed. The cutting-edge clinical experiments that have been conducted related to tanning dependence and its mechanisms are fascinating, even demonstrating altered brain activity during UV exposure. This topic is an excellent example of translational research linking basic and behavioral science.

Chapter 8 discusses some of the myths about tanning perpetuated by the tanning industry. One of the main reasons offered in defense of tanning by the tanning industry is the health benefit of vitamin D (e.g., bone health, colon cancer prevention), which is produced by the skin after UV exposure. No published studies have examined vitamin D levels in frequent tanners or tanning dependent individuals. While some level of vitamin D is undoubtedly beneficial for health, it is readily available as an oral supplement, and the high prevalence of vitamin D deficiency and claimed health benefits of high vitamin D levels are unproven. This is currently a very hot topic. The chapter also discusses the myths that indoor tanning is safer than sunbathing, that there is such a thing as a beneficial "base tan," and that commercial indoor tanning can be used as an alternative to medically-supervised phototherapy for skin conditions.

With the growing popularity of indoor tanning and its related consequences, a number of researchers have been attempting to develop and test interventions to reduce this behavior. Chapter 9 summarizes the research examining psychosocial interventions to reduce indoor tanning, particularly interventions that target appearance-related concerns. The literature is small but growing, and more rigorous intervention research is needed. This chapter outlines issues that should be addressed in future research on indoor tanning. For example, how can we combat the strong societal pressure, particularly among women, for appearance-enhancement by any means possible, regardless of the potential risks?

In addition to psychosocial interventions, policy interventions are also discussed. Chapter 10 describes the state and federal policies surrounding the regulation,

enforcement, and taxation of the indoor tanning industry. Why are there more tanning salons in major American cities than McDonald's or Starbucks? Are there similarities between the tanning and tobacco industries with regard to marketing and regulation issues? Policy level interventions have been some of the most successful strategies for lowering smoking rates. This chapter describes the restrictions on indoor tanning primarily in the USA, some of which have occurred very recently and will likely further evolve in the future. These are restrictions related to age, parental consent, UV radiation levels, warning labels, taxation, and operator education. Unfortunately, these regulations have not had their intended impact due to insufficient compliance and enforcement. Successful tobacco regulation is used as a model to suggest strategies to reduce indoor tanning, particularly among our vulnerable youth.

Despite the book's primary focus on indoor UV tanning, Chap. 11 provides valuable information about chemical sunless tanning. What is sunless tanning and how does it work? Who sunless tans, and how does sunless tanning relate to UV tanning behavior? Sunless tanning is a safe alternative to UV tanning that can achieve the desired appearance-enhancement effects in an efficient and cost-effective manner. Sunless tanning has become quite popular in the USA in the last few years, and there are many varieties of sunless tanning products available. Chapter 11 will also address what interventions have been explored to alter sunless tanning behavior and what additional research is needed.

While the emphasis of this book and much of the existing research is on indoor tanning practices in the USA, Chap. 12 describes the prevalence, correlates, and regulation of indoor tanning in Europe, Canada, Australia, and other countries. The similarities and differences among the countries are fascinating and warrant additional research. Indoor tanning is truly a global issue.

In summary, indoor tanning is an all-too common behavior that is associated with multiple adverse effects, including skin cancer. Like tobacco, indoor tanning has been marketed to adolescents and young adults, putting this vulnerable population at increased risk for high levels of long-term UV exposure. Appearance enhancement is the primary motivation for indoor tanning, but there are several other potential reasons for the behavior, including regulation and enhancement of mood as well as tanning dependence. Recent regulations and interventions have been shown to have some effect on reducing indoor tanning rates, but there is considerable need for further research and education as well public health and policy efforts. The concluding chapter, Chap. 13, summarizes future directions for research, policy, and intervention.

Shedding Light on Indoor Tanning is a unique, up-to-date, and comprehensive book that we hope readers will find as interesting, informative, and useful as we do.

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Chapter 2
History and Culture of Tanning in the United States

Yvonne Hunt, Erik Augustson, Lila Rutten, Richard Moser, and Amy Yaroch

Abstract This chapter traces changes in the perception of tanning and tanning behavior primarily within the United States (U.S.) from the later part of the nineteenth century to the early part of the twenty-first century. Originally seen as a hallmark of the working class/disadvantaged groups and associated with disease and ill health, societal perceptions of the tan evolved over time to reflect the opposite: wealth, health and beauty. These core beliefs regarding the value of tanning and ultraviolet (UV) radiation exposure have proven extremely difficult to modify despite substantial efforts by the public health community to do so. In an attempt to understand why millions of Americans continue to engage in high-risk, intentional UV exposure such as use of indoor tanning facilities, the beliefs and behaviors related to tanning are considered within the context of the historical medical and societal factors, especially the role of fashion and advertising, which helped to shape current opinion.

Keywords Advertising • History of tanning • Indoor tanning • Melanoma • Skin cancer • Sun bed • Sun exposure • Sun protection • Sun safety • Sunbathing • Sunburn • Sunlamp • Sunscreen • Tanning • Tanning bed • Ultraviolet radiation

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Abbreviations

FDA	Food and Drug Administration
SPF	Sun Protection Factor
U.S.	United States
UV	Ultraviolet radiation
UVA	Ultraviolet A radiation
UVB	Ultraviolet B radiation
UVC	Ultraviolet C radiation

2.1 The Great American Tan

Ultraviolet (UV) radiation has deleterious effects on human health. Chronic UV exposure can result in permanent structural damage to the skin, including wrinkling, discoloration, and loss of elasticity. More importantly, UV radiation causes DNA damage, which can lead to the development of skin cancers [1–3].

Despite decades of public health efforts to communicate the importance of protection from UV radiation, millions of Americans continue to deliberately engage in behaviors that increase their UV exposure. As a result, the past 30 years have seen alarming upward trends in the incidence of skin cancers, including malignant melanoma, which is associated with poor survival rates [4–9]. A substantial body of published survey data suggests that most Americans are at least somewhat aware of the risks of excessive UV exposure [10–13]. Yet, cultural standards of attractiveness continue to place a high value on tanned skin at the expense of health and safety.

Why are so many Americans willing to risk their lives for a tan? In answer to this question, there is much to be learned by examining the historical and cultural context that has shaped the social construction of attitudes, beliefs, and behaviors around tanning. This information provides a framework for our understanding of current challenges related to skin cancer prevention. The image of a tan as healthy, attractive, and fashionable has proven difficult to reverse, and a well established tanning culture persists in the face of the known medical risks of skin cancer and photodamage. Public health professionals continue to be challenged by the need to address important questions about how to change the cultural norms around tanning in the U.S. In this chapter, we will begin with a discussion of some of the meanings associated with skin color and then consider how medical, social and economic factors have changed over time and what their impact on America's stance toward tanning has been.

2.2 Skin Deep

Skin color arises from a protein in the skin called melanin, which confers different shades of pigmentation when present in varying amounts [14, 15]. Melanin acts as a natural "sunscreen" by blocking the penetration of UV radiation through the skin.

Amounts of pigmentation differ around the world, with various populations demonstrating a wide range of tones from fair to dark, but most falling somewhere in between (i.e., brown) [16]. Geographical differences in skin pigmentation are hypothesized to be evolutionary adaptations to the UV light intensity in a particular population's native habitat [15]. Heavily pigmented populations are typically encountered in environments characterized by intense UV exposure, whereas fair-skinned populations are found in higher latitudes where the amount of solar radiation is less. In light-skinned humans, tanning is a natural response to the injurious effects of UV radiation [17]. The characteristic darkening of the skin (i.e., tanning) arises from the stimulation of melanin production in the outer layer of the skin, or epidermis. Far from being an indication of health, a tan is a sign that too much UV exposure has occurred, resulting in damage to the skin.

While the biological function of skin color is fairly straightforward (see Chap. 5 by Lessin and colleagues), the rest of the story certainly is not. Skin color is much more than just a phenotype; it frequently forms the basis for socially constructed definitions of beauty, health, and social status. The allure of tanned skin is unique to Western cultures, and particularly Caucasians. Accordingly, the focus of this chapter will be on tanning in whites and white cultures. However, the practice of cosmetically altering the appearance of one's skin to meet cultural standards of attractiveness is, sadly, endemic in modern societies around the world. For evidence of this, we need look no further than the multibillion dollar industry that has grown up around cosmetic skin-bleaching in many Asian nations [18].

2.3 Beyond the Pale

The cosmetic appeal of the tan is a relatively recent development. For most of history, pale skin has reigned as the archetype of aesthetic beauty in light-complexioned populations [19]. Examples drawn from a variety of literary sources, proverbs, and scriptures provide evidence of many cultures placing an idealized value on white-skinned beauty. Japanese culture has considered white skin an essential characteristic of feminine beauty since antiquity. An ancient Japanese proverb says that "white skin makes up for seven defects"; that is, a woman's light skin is believed to mask undesirable physical features or "uglinesses" [14, 20]. The famous Chinese poetess, Li Ching Chao, wrote about skin so white that it shines through her red veil. In the Bible, King David's fair complexion is emphasized [19]. Renaissance art, which sought to create the most beautiful representation of the human form, portrayed its human figures with light skin and a rosy hue. References to fair-skinned beauties appear in classical works of literature by Homer, Dante, and Goethe. European court poets waxed reverently about necks that were "white as alabaster" or bosoms as "white as snow" [21]. In the early nineteenth century Brothers Grimm fairy tale "Snow White," the beautiful princess is described as having "skin white as snow, lips red as blood, and hair black as ebony" [22]. So great is Snow White's beauty that it incites the jealous and murderous wrath of her wicked stepmother.

Historically, pallor has also served as a physical representation of social class [23]. White face powders have been used for centuries by the upper classes in Europe and Asia to create the appearance of preternaturally white skin. Parasols have long been used by Chinese emperors, European courtiers, and Spanish royalty to maintain pale complexions, and over time have become a universal symbol of privilege and high social status [21]. A tanned appearance, on the other hand, has traditionally been stigmatizing. Derogative references to suntan even appear in the Bible, including this verse from the Song of Solomon 1–6: *Do not stare at me because I am dark, because I am darkened by the sun. My mother's sons were angry with me and made me take care of the vineyards; my own vineyard I have neglected* [24].

The preoccupation with fair skin still prevails in many Asian and Hispanic societies, and within some ethnic minority populations in the U.S. The social significance of light skin can be seen in the language used to describe beauty in these cultures. *Bihaku*, which literally translates to "white beauty," is the term used to describe the porcelain pale complexion that sets the standard of beauty in Japan [18]. In Hindi, the word *gori*, which translates to "fair skinned," is synonymous with the word for beauty [20]. In Thailand, the term *tua dam*, or black body, is commonly used to insult a person of lower social status [25]. Within certain ethnic groups, nuanced skin color hierarchies are commonly established using words that refer to graduated shades of color, a phenomenon anthropologists call "colorism" [26]. In the colloquial slang of Harlem circa 1930, gradations in African-Americans' skin tone were parsed into "high yaller [yellow], yaller, high brown, vaseline brown, seal brown, low brown, dark brown" [27]. Similarly, in India, descriptive terms for variations in skin pigmentation include "fair," "wheatish," and "dusky." As shade lightens on the gradient, social capital increases within these cultures. Perched atop the gradient is "white," which has connotations of purity, cleanliness, and flawlessness. Over the past two decades, the relentless pursuit of a fair complexion has fueled the rapid growth of the skin lightening industry in many Asian markets. Skin-whitening products with names like "White Radiance," "White Perfect," and "Fair and Lovely" are aggressively marketed to men and women alike throughout Asia and the Pacific Islands [20, 28]. Black-market bleaching preparations frequently contain powerful and potentially dangerous bleaching agents (e.g., chromium, mercury, and arsenic), and can produce disfiguring results [25].

2.4 Before the Dawn

Attitudes around sun exposure have varied throughout history. Sun worship was practiced in many ancient civilizations, including the Aztecs, the Inca, the Egyptians, the Romans, and the Greeks. Sun gods were believed to be a source of life [23]. There is also evidence that both the ancient Greeks and Romans employed sunlight in the treatment of diseases. More than 2,000 years ago, the Greeks built a temple to Aesculapius, the god of medicine, on a mountainside facing the sun.

The temple was used for sunbathing and restoring of health [29]. Ancient Greek scientists, Hippocrates and Pythagoras, wrote about the healing powers of the sun. The Romans, too, engaged in sunbathing. Pliny wrote about the daily walks in the sun taken by his elderly friend Spurinna [29]. However, at other times and places in history, the sun was viewed as something to be avoided, even feared.

Before the 1900s, attitudes towards sun exposure in the U.S. bore little resemblance to the culture that has grown up around tanning today. The now-familiar concept of the tan as an index of health and beauty had not yet emerged. Instead, to the extent possible, people took great care to isolate themselves from the sun, through the use of protective clothing, gloves, and wide-brimmed hats [30]. Heavy drapes were standard in Victorian-era homes, providing a physical barrier to natural light. The parasol became a popular fashion accessory for wealthy women in the U.S. and Europe in the later part of the nineteenth century, a trend that is reflected in the art of that era – women with parasols appear regularly on the canvases of Monet, Renoir, and Manet [30].

Since the luxury of sun protection belonged primarily to the privileged upper classes, a pale complexion was a status symbol. Only unfortunate laborers and members of the working class, who had no choice but to "toil" outdoors, had a tanned appearance. For genteel women and men, any sign of sun exposure (i.e., freckles, tan) was considered a regrettable affliction that required corrective action. It was common to see advertisements in popular magazines for bleaching products or at-home preparations that promised to restore the skin to a white condition [29, 30]. A Pond's advertisement from 1912 warned women to "Beware the Kiss of the Sun…The summer girl has no charm as great as the appeal of a complexion as clear, transparent, and like an apple blossom in its delicate soft coloring" [31]. Of note however, many of these bleaching preparations contained toxic ingredients [32].

In the period around 1900, although the association of UV light with skin cancer had yet to be discovered, a host of other physical and mental disorders were attributed by the medical field to sun exposure. The assertion that sunlight had negative health effects was influenced by the European colonization of tropical regions in which large numbers of light-skinned Westerners moved to unfamiliar tropical settings where they often succumbed to mysterious diseases [33]. In the absence of a well-developed understanding of microbes and pathogens, climatic theories of tropical illness became prominent. Central to these theories was the belief that penetration of fair skin by the intense rays of the tropical sun led to deterioration of health. In 1905, the dangers of sunlight were chronicled in *The Effects of Tropical Light on White Men* [34]. In this volume, Dr. Chas Edward Woodruff explicitly suggested a link between electromagnetic radiation and the harmful effects of the sun. He implicated the sun's rays in the etiology of "tropical neurasthenia," a nebulous diagnosis defined by symptoms such as restlessness, irritability, fatigue, memory loss, insomnia, headaches, diarrhea, ulcers, heart palpitations, alcoholism, insanity, and suicide [34]. Subsequently, Dr. Woodruff commented specifically about the U.S. being too sunny to sustain the health of its fair-skinned inhabitants, declaring "The American girl is a bundle of nerves. She is a victim of too much light" [34]. A few years later, Dr. Percy Brown of Harvard Medical School echoed these

concerns in a *New York Times* interview when he suggested that chronic exposure to the sun's rays was at the root of "Americanitis," a condition he described as being characterized by "irritability and extreme activity" [35].

Despite these dire warnings, a paradigm shift was beginning to take place in the U.S. and Europe. In the years to follow, a variety of social forces would combine to drown out the lingering "heliophobic" voices of the past and usher in a new era of "sun worship," one that would alter the American relationship with the tan for much of the next century. It would be several decades before warnings about sun exposure were heard again.

2.5 Into the Light

The industrialization of the American workforce set the stage for a gradual reversal of socially constructed attitudes and beliefs towards tanning. In the period roughly between 1880 and 1920, America underwent massive demographic changes as increasing numbers of people left the countryside and moved into urban environments to work in factories [36]. Urban populations swelled even larger under a steady influx of immigrants from Northern Europe [37]. By 1920, for the first time in history, more Americans lived in cities than outside of them, and a new working class lifestyle was born. Pallor, for so long a status symbol, now came to be associated with those who worked in the factories and inhabited the working class slums. Factory work required long hours spent indoors, away from sunlight, with neither the time nor the means for outdoor leisure pursuits. Moreover, the congested parts of the cities were heavily polluted with coal smoke, and thus individuals living in cities received limited amounts of sunlight. The topic of "sunlight starvation" was popular among physicians and scientists at the time, who concluded that the lack of sunlight threatened the health of urban populations [23, 33, 38]. Common medical wisdom held that "Pale, dull, and perverse children get so as a result of dark, gloomy schoolhouses and tenement rooms" [39]. So-called "diseases of darkness" were endemic in the slums; these included tuberculosis and rickets, as well as diseases of "moral depravity," such as alcoholism, depression, and suicide [23, 33]. Indeed, the pallor of tuberculosis was an increasingly common feature of the working class, who lived together in crowded, often unsanitary conditions. Pale skin ceased to be perceived as the picture of health and social status. Instead, it was the color of the feeble, sunlight-starved, lower class. This new association of pale skin with illness and depravity is reflected in the popular fiction of the period; an appearance of "extraordinary pallor" is a defining physical trait of the vampire in Bram Stoker's *Dracula* [33]. In modern American cinema, unnaturally white skin continues to be used as a visual tool for distinguishing villains, as seen in movies like the *Da Vinci Code* and *The Matrix Reloaded* [40].

Against this backdrop of America's changing demographics, the tan shifted markedly from something to be avoided to a physical representation of upward mobility. America's high society groups regularly summered at popular resorts like

Newport Beach and Atlantic City to escape the heat, grime, and congestion of the cities. A "sun-kissed face and bronzed body" symbolized a lifestyle of affluence, recreation, and vacations to the seashore. Recreational swimming gained popularity, and as it did, bathing suits became more streamlined and functional – and more revealing, to the detriment of sun protection [30]. Men and women alike took up new hobbies like golf, tennis, and bicycle riding [41]. New clothing styles emerged to support this life of leisure. Active wear and sporty styles that promoted freedom of movement and exposed more skin replaced the modest, cumbersome garments of the previous century [29].

2.6 No Tan, No Cure

Along a similar timeframe to these changes in American society, medical beliefs regarding UV exposure were also changing due to a number of scientific and medical advancements. The rise of diseases common in urban settings such as tuberculosis and rickets focused an increasing amount of attention on issues of health and hygiene, including the role of sunlight deprivation as a contributing factor. Simultaneously, scientists and physicians in Europe were beginning to understand more about the physical properties of sunlight and its possible role in the treatment of disease.

German scientist Johann Ritter laid the groundwork for the "sun cure" a century earlier, when he discovered UV light in 1801 [42]. Using silver chloride, a colorless crystal which turns black when exposed to light, Ritter demonstrated that solar rays exist beyond the spectrum of visible light, and are capable of producing photochemical effects [43]. At the time, the physiological effects of UV radiation on the human body were not well understood. It would be more than 100 years before the link between UV radiation and skin cancer was made, and even longer before scientists would describe the action spectrum (i.e., wavelengths) of UV radiation capable of inducing sunburn [43]. Another major discovery was made in 1877, by English chemists Thomas Blunt and Arthur Downes, who first identified the bactericidal and fungicidal properties of UV light [30]. Importantly, they demonstrated that the germicidal properties of sunlight were not related to heat, as previously believed, but rather to wavelength, with the shortest wavelengths (i.e., UV) having the greatest effect. In 1882, German scientist Robert Koch discovered that tuberculosis is caused by a bacterium (i.e., tubercle bacilli) and subsequently demonstrated that exposure to direct sunlight killed the bacterium [44].

Perhaps the greatest advance in light therapy was made by Danish physician Niels Finsen, who in 1897 pioneered the technology for the creation of an artificial sunlamp to treat tuberculosis, making it possible for the first time in history to produce "sunlight" on demand (see Fig. 2.1) [23]. Finsen's work is all the more remarkable given that artificial light itself was still a new field. Only a short time before, in 1879, Thomas Edison had invented the incandescent light bulb; and x-rays were first described by Röntgen in 1895 [43]. Finsen's device consisted of a powerful

Fig. 2.1 Circa 1897: Nurses administer artificial light therapy with Finsen's carbon arc lamp at the Finsen Medical Light Institute. Printed with permission from the University of Copenhagen Medical Museum

carbon arc that produced UV radiation, a convex quartz lens to concentrate the radiation on diseased areas of skin, and a water chamber for cooling [45]. Finsen demonstrated that treatment with his Finsen lamp could cure the cutaneous form of tuberculosis, and was awarded the Nobel Prize for this work in 1903 [46]. The Finsen lamp was a predecessor to the first commercially available sunlamps, which would go on to populate homes and businesses all over America. However, Finsen did not live to witness the ensuing commercial popularity of sunlamps – he died in 1904, the year after he received the Nobel Prize.

The pioneering work of Finsen, Koch, Blunt, and Downes ushered in a new era of medical therapy, involving exposure to UV light, either by natural (heliotherapy) or artificial (phototherapy) means. In the pre-antibiotic era, the sanitarium became the preferred treatment for tuberculosis [47]. These were hospitals located in favorable climates where doctors could exploit the bactericidal properties of sunlight by exposing patients with tuberculosis to a daily regimen of rest, fresh air, and maximal sun exposure [48]. The first sanitarium in the U.S. was founded in 1885 by American physician Edward Trudeau in Saranac Lake, New York [49]. It was situated in the Adirondack mountains, thought to be an ideal climate for maximal exposure to fresh air and sunshine. Patients of the Adirondack Cottage Sanitarium reclined on its porches in specially designed lounge chairs, now famously known as Adirondack