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REVIEW

Blindspot: how sun exposure guidelines have ignored the health of individuals with skin of color

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Abstract

This review examines the history of sun exposure guidelines and their implications for the health of people with skin of color. Medical authorities first encouraged limiting sun exposure in the 1930s. This guidance followed a decade of findings indicating that rickets and hypertensive heart disease were far more likely to afflict Black than White Americans and that ultraviolet radiation cured rickets and lowered blood pressure. In the late 1950s it emerged that South Asians suffered from high rates of coronary artery disease. Australia introduced the first national sun exposure guidelines in the 1980s, recommending that all residents drastically limit their sun exposure to address the epidemic of skin cancer among its White majority. In succeeding decades other White-majority countries introduced restrictive sun exposure policies. These directives assumed that sun exposure confers no benefits beyond catalyzing the production of Vitamin D and that the amount of Vitamin D readily available through diet is sufficient for good health. Evidence available at the time indicated that both assumptions were likely flawed. Differences in risk-benefit profiles of sun exposure by skin color were discussed within the public health community but were not communicated to the public. In the 2010s large studies reported that sun nexposure is associated with reduced risk of cardiometabolic disease in Northern Europe and among Black Americans. The UK and Australia have recently revised their guidelines to recognize that people of different skin colors have distinctive needs. Still, guidelines in the US and many other countries continue to take a 'one-size fits all' approach to sun exposure. By extending policies originally tailored to White needs to populations for whom sun/UV exposure has very different risks and benefits, this approach may have significant negative consequences for the health of people with skin of color.

Keywords Sun exposure · Skin of color · Blood pressure · Cardiovascular · Ultraviolet

1 Introduction

The era of sun exposure guidelines began in 1980 when countries with White majorities began recommending that all residents limit sun exposure to reduce skin cancer risk. Ultraviolet radiation (UVR) causes skin cancer in White people (people of European descent), but compelling evidence of its association with skin cancer in populations with dark skin is limited [1]. Epidemiological studies have found that added sun exposure is associated with reduced all-cause mortality in the Northern Europe and lower blood pressure (BP) and risk of stroke among White and Black Americans [2, 3]. There is increasing evidence that sun exposure has very different risk-benefit profiles for White people and people with skin of color (PSC). Australia and Britain recently revised their sun exposure guidelines, tailoring recommendations to skin tone. Given these developments, a historical review of sun exposure policies is warranted to determine the degree to which guidelines have taken account of the distinct health needs of diverse populations.

2 From wavelengths of light to UV causing skin cancer (1672–1946)

Sun exposure guidelines were a 20th century innovation, but the science of light's effect on skin began much earlier. Newton's 1672 prism experiments showed that white light decomposes into different colors, yet it was not until 1801 that Ritter reported the existence of a shorter wavelength,

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ultraviolet radiation (UVR), band [4, 5]. Both the damaging and the beneficial effects of sunlight together with population differences came into view shortly thereafter. In 1820 Home found that exposing White skin to sunlight caused a "scorching" effect that was blocked by covering the skin with a black cloth, though heat at the skin surface was the same. He found that the skin of a Black man did not "scorch" [6, 7]. Home hypothesized that a component of sunlight other than heat damaged skin and that darker pigmentation was protective. In 1822 Sniadecki found that sunlight could cure rickets. Following the first description of melanoma by Laennac in 1804 and basal cell carcinoma by Jacob in 1827, in 1887 von Smaedel proposed that dark skin protected against damage caused by UVR, which had recently been found to kill microbes. Unna reported that UVR exposure was associated with skin cancer in White populations in 1896 [7]. Soon after, it was determined that darker skin protects against skin cancer [8, 9]. "Melanin, the pigment of the skin," Paul remarked in 1918, "stands as a sentinel, guarding the underlying tissues from the baneful effects of sunlight." [10] Thus, by 1920 it was understood that sun exposure caused sun burn and suspected that it caused skin cancer in White people but appreciated that the risks were far lower for PSC.

In 1890 Palm reported that rickets increased in prevalence with latitude. It was more common in winter than summer and in northern regions compared to sunnier tropical areas like North Africa [11]. In the 1920s researchers also discovered that Black American children were at higher risk of rickets than Whites [12–16]. Hess reported that the majority of breast-fed, and nearly all bottle-fed, Black infants in New York City suffered from the condition [17]. One study estimated that 49.8% of White, but 87.6% of Black children in Memphis suffered from rickets [18]. Hess concluded that Black infants required more UVR exposure than White infants due to their skin's adaptation to tropical high solar radiation climates: [14, 17, 18]

> The carbon arc [UV] lamp has been found…to be a very effective therapeutic agent in the prevention and cure of rickets. …Such treatment would be of especial value for negro infants; for it is evident that if these babies – whose skin tends to filter out the essential rays of the sun – are to thrive in cities of the temperate zone, they must be provided with a greater abundance of effective light than white infants.

Thus, research from this period pointed to inadequate sun exposure as the principal sun-related risk faced by Black children and to the utility of supplemental UVR as a remedy.

Rickets can lead to lifelong disability, but it is generally not lethal. However, a health disparity leading to increased mortality was coming into view. In the 1920s state and insurance company data showed that Black Americans were at greater risk of hypertensive heart diseas than Whites, while evidence was slowly accumulating that added UVR exposure might address this disparity. In 1922 Dublin noted that "the greater prevalence of heart disease among colored people is notorious." [19] In the following years, studies demonstrated that Black Americans possessed higher blood pressure on average than Whites Americans and that hypertension was the primary cause of heart disease in Black people [20–22]. Research also began to suggest that UVR was beneficial for cardiovascular health. Finsen reported in 1901 that UVR dilated arteries [23], and beginning in 1907 studies began reporting that UVR lowered blood pressure [24–26]. These results hinted that the risk-benefit profile of UVR exposure for Black people was more favorable than for White people. In 1926 Roddis and Cooper found that blood pressures of US Navy officers were roughly 10 mmHG lower in the sub-tropical Caribbean than in temperate US territorial waters [27]. In 1929 Donnison reported that systolic blood pressure of Kenyans did not rise during adulthood, in contrast with higher latitude Westerners, who demonstrated the now familiar age-related increase [28]. In the century since Donnison published a few dozen "zero slope" populations have been identified, concentrated in equatorial regions [29].

In 1941 Williams proposed that high rates of hypertension among Black Americans might be due to a difference in climate between Africa and the US, based on healthy blood pressure levels in Africa and the rise of blood pressure with latitude [30]. William's thesis suggested that added sun exposure in temperate regions might have substantial benefits for Black people's cardiovascular health.

Thus, published research indicated that Blacks Americans were at lower risk of skin cancer and suffered disproportionately from conditions that could be addressed with UVR. This convergence of evidence could have led medical authorities to propose that sun exposure was a potentially safe and effective treatment for Vitamin D deficiency and hypertension in black Americans. Instead, in 1936 JAMA published an editorial recommending that *all* people limit their exposure to the sun [31].

> As far as is known, man actually requires only a relatively small amount of sunshine for the maintenance of normal health, and the greatest danger perhaps at the present time lies in too much exposure to sunlight rather than too little. Certainly, over-indulgence in solar radiation should be avoided because of known possible ill effects.

The unnamed authors do not explain how they came to their conclusions, but by 1936 Vitamin D had been chemically isolated and its structure determined. It could be synthesized in large quantities to fortify foods. With abundant Vitamin D in the food supply the JAMA editorial position follows naturally from two hypotheses: (1) dietary Vitamin D is sufficient, or nearly so, for good health and (2) sun exposure carries no benefits beyond Vitamin D production. Assumption (1) justifies ignoring skin tone in public policy, for any Vitamin D deficiency in dark skinned people can be made up by diet, while (2) entails that there is no need for an extensive risk-reward analysis of sun exposure, as there are no benefits beyond Vitamin D. Over the next 80 years, evidence would accumulate that both assumptions were seriously flawed.

The JAMA article focused on sunburn as the principal negative effect of sun exposure. At the time, there was a sentiment in the medical research community that the connection between sun exposure and skin cancer was not yet definitive [32]. Data was coming in rapidly, though. Dorn's 1944 report of strong statistical support for a north-south latitudinal gradient in skin cancer in the US and lower rates among Black compared to White populations strengthened the case [33]. Still, the recommendation to avoid the sun and the conclusion that UVR exposure caused skin cancer had not yet come together. With evidence that sun exposure had a potentially favorable risk-benefit profile for PSC, it was an open question in which direction public health would policy go.

3 White Australia to "Slip, Slap, Slop" (1946–1987)

Australia has played an outsized role in the history of sun exposure policies, driven by its location and demographics. It is nearly unique among countries in having both very high average UVR levels and a very light skinned majority population. This anomalous human ecology is a direct consequence of the "White Australia Policy," a series of laws enacted by the country's parliament beginning in 1901 that gave priority to immigrants from the British Isles and blocked immigration from China and the Pacific Islands. Skin cancer was prevalent, and its cause understood. As one commentator wrote in 1918, "the common occurrence of these cancerous and precancerous diseases of the skin in Australia is to be regarded as one of the penalties to be paid for inhabiting a country normally destined [in geographical location] to be occupied by a coloured race." [10] In the mid-1950's the Australian epidemiologist Lancaster established that blond and red hair and blue and green-gray eyes were risk factors for melanoma [34, 35]. Nineteen-seventy-five saw the introduction of the Fitzpatrick skin color scale, which would become the standard for classifying skin cancer risk [36]. Much of Australia's population fell into Fitzpatrick categories I or II, the highest risk. Though the White Australia Policy was completely eliminated by 1975, the country was still 89% White in 1976 [37]. Facing skin cancer rates that were the highest in the world and still rising, in 1980 the Australian state of Victoria introduced the world's first guidelines on sun exposure.

The new policies aimed to reduce sun exposure for all residents regardless of skin color, even native Australians who were biologically adapted to the climate and at very low risk. When exposure could not be avoided, guidelines encouraged residents to wear sufficient clothing to protect exposed skin and sunscreen of at least SPF 30, later raised to SPF 50 [38]. The campaign's tagline was "Slip, Slop and Slap," as people were urged to *slip* on clothes, *slop* on sunscreen and *slap* on a hat to protect the head and neck [38]. The policy rested on the same unstated assumptions as the JAMA editorial 44 years earlier: dietary vitamin D was sufficient to keep all Australians in good health and sun exposure conferred no benefits beyond Vitamin D. If either of these assumptions was incorrect, there could be negative consequences.

Scientific findings in the post-war years raised doubts about these assumptions. Dietary supplementation had reduced but not eliminated severe Vitamin D deficiency. US deaths from rickets declined from 122 in 1942 to four in 1961 [18], but rickets cases continued among Blacks and South Asians in the US and UK [39–41]. Consistent with earlier results, research indicated that the benefits of sunlight extended beyond vitamin D. Studies found that UVR exposure reduced blood pressure in people with hypertension for multiple days and relaxed blood vessels by inhibiting epinephrine-induced vasoconstriction [42, 43]. Because, Vitamin D is not known to affect the human adrenergic system, this finding pointed toward UVR acting through alternative pathways. Because Black people have greater stress-induced blood pressure responses than White individuals, mediated by adrenergic stimulation, the results hinted that UVR might be particularly effective in reducing vasoconstriction and so blood pressure in Black populations [44]. Studies around the time also indicated that South Asians in Singapore, South Africa and Trinadad were at greater risk of stroke and heart attack than White and East Asian people and that blood pressure was a leading predictor of stroke and heart attack risk [45, 46]. Thus, added sun exposure could potentially lower South Asian cardiovascular disease (CVD) risk. Given the low risk of skin cancer faced by PSC, these data suggested that added sun exposure might have a favorable risk-benefit profile not just for Black people but for South Asians as well.

In 1987 Australia established a nationwide public health program based on the policies pioneered in Victoria state. The national program also ignored skin color. Sounding a contrary note, that same year the British Royal College of Physicians correctly observed – citing Lancaster's findings – that sun exposure was a risk principally for light skinned White people. The British Physicians recommended limiting sun exposure for White residents, while exempting others from its guidelines [47]. Would coming national policies take into account the British Physicians' accurate assessment of sun exposures' varied risk-reward balance for diverse populations or follow the uniform Australian approach?

4 Australian policies spread (1988–2008)

In 1988 Australia introduced the Sun Smart program. In light of findings that excessive UVR exposure caused cataracts and cancers of the eye, Sun Smart maintained the core elements of its predecessor, "Slip, Slop and Slap," but also urged people to wear sunglasses when outside [48]. Over the following years countries with White majorities, including the US, the UK, Canada, Norway and European Union member states, all adopted Australian-style guidelines, even though their skin cancer rates and UVR levels were lower than Australia's. The gap between research recognizing that dark skin protects against skin cancer and public health communications urging everyone to protect themselves from the sun continued when the US introduced its guidelines.

In 1989 INTERSALT published the results of a study that measured blood pressures in 52 populations across the world. Data indicated the blood pressure rose with latitude [49]. Four populations of people with skin of color stood out as having extremely low blood pressures. All lived near the equator [29]. In 1997 Richard Cooper and colleagues published the results of a study of blood pressure in seven populations of West African ancestry. Hypertension rates rose with latitude from West Africa to the Caribbean to the United States [50]. These studies used standardized blood pressure measurement methods across regions. Collectively, their results suggested that blood pressure is lower in regions with higher UV levels and that low blood pressures and hypertension rates in equatorial regions are not a measurement artifact or the result of underdiagnosis.

In 1995 the CDC partnered with the American Academy of Dermatology (AAD) to develop a national program for skin cancer prevention. The program's executive summary notes that risk factors for skin cancer include being "light-complected", but this fact was not communicated to the public, which was encouraged to follow Australian-style guidelines regardless of skin color [51]. Later, the "National Skin Cancer Prevention Education Program" took a similar approach. Their documents observed that skin cancer risk factors include "light skin tone" and "sun sensitivity", but then the program set the same goals for reducing sun exposure for the entire population [52]. In 1998 the CDC launched its "Choose Your Cover" campaign to encouraged all adolescents and young adults, including African Americans, to adopt more negative attitudes towards sun exposure [53]. These recommendations form the basis of current CDC guidelines [54, 55]. These directives left the US public with the misleading impression that people with darker skin are at significant health risk from sun exposure, and that sun exposure risks outweigh its benefits regardless of skin color or local climate.

As public health agencies continued to recommend limiting sun exposure into the late 2000s, reports of conditions caused by insufficient sun persisted. A 2001 Canadian statement urged reducing sun exposure [56], a year before 104 cases of rickets occurred in the country, a rate of 2.9 per 100,000 [57]. A 2003 review of US and Canadian studies found that Black people are at higher risk of Vitamin D deficiency and that increased milk consumption only moderately increases serum vitamin D levels [58]. A review of US studies 1986–2003 identified 166 cases of rickets in children, 83% of them Black. The authors recommend an improved diet to treat and prevent the condition but make no mention of increased sun exposure [59]. In Australia women living at higher latitudes and possessing darker skin were found to be particularly at risk of Vitamin D deficiency [60, 61]. These findings raised doubts about whether dietary vitamin D was sufficient for good health in dark skinned people, a central pillar of medical sun exposure recommendations for 70 years.

Researchers began publicly questioning Australian-style guidelines in the mid 2000s. In 2005, Australia's leading public health organizations recommended that the country revise its recommendations. To achieve a balance between skin cancer risk and adequate vitamin D levels this group proposed that public health campaigns should: [60]

- Shift away from the idea that people have to protect themselves against the sun at all times.
- Note that there are benefits and harms associated with sun exposure and that a balance between the two needs to be achieved.
- Refrain from encouraging people to stay indoors and instead urge people to take appropriate measures when they are outside.

In 2006 researchers at the WHO also questioned whether their guidelines were too strict [62]. These proposals did not ask whether the recommendations adequately addressed the

needs of PSC, but they did engage with research in a way that existing guidelines had not. However, these proposals did not become public policy.

By 2008 Australia's skin cancer prevention program had been embraced by the WHO and public health institutions in White majority countries across the world, though some individuals and organizations were questioning the policies [63, 64]. Most research looking at the downsides of limiting UV was focused on Vitamin D.

5 All-cause mortality and Australia and Britain change course (2008 to present)

Since 2009 research has indicated that, if anything, sun exposure likely has greater benefits and smaller risks for PSC than previously believed. Over this period, the US, Europe and the UK have continued to report rickets cases, concentrated among Black and Asian children[65, 66]. The major change in our understanding of the PSC risk-benefit profile stems from studies that have linked sun exposure to positive cardiovascular outcomes. With research continuing to show elevated risk of cardiovascular disease in dark skinned compared to White populations these findings indicate that more sun exposure will likely improve overall health for Black and South Asian people, while reducing cardiovascular disease disparities.

This period saw the publication of the first large epidemiological studies linking sun exposure to long-term cardiovascular outcomes. Research in the UK and Scandinavia focused primarily on White residents showed decreased risk of venous thromboembolism, diabetes, CVD, heart attacks, hypertension, death from CVD and all-cause mortality in people with higher levels of sun/UV exposure [67–73]. These are all outcomes for which Black people and South Asians face elevated risk compared to White individuals. The Scandinavian findings also demonstrated the importance of skin color. The Swedish Women's Health Initiative found that the ability to tan was associated withelevated cardiovascular mortality [68]. Women whose skin burned painfully after acute exposure were half as likely to die of CVD as women who turned brown without any reddening. Similarly, women whose skin did not tan after chronic exposure were less than half as likely to die of CVD as women who turned dark brown. The conclusion suggested mirror image risks: darker skin, whether baseline or in tanning capacity, is protective against skin cancer but may be a risk factor for CVD.

The first large studies examining the association between sun/UV exposure and the health outcomes of Black and East Asian populations reported findings in this period. UVR exposure was associated with improved cardiovascular health. Stroke risk is lower for Black and White Americans in regions of the US Southeast with above median solar radiation [3]. The blood pressure of Black and White Americans also varies inversely with ambient UV and solar radiation, but Black people require a greater increment in UVR to achieve an equivalent blood pressure reduction [2, 74]. An 11-year retrospective cohort study of 12,916 vitiligo patients in Korea found that UVB treatment was associated with lower risk of stroke and myocardial infarction [75]. At the same time, risk of UVR exposure were confirmed to be low in PSC. A 2021 systematic review of the link between UVR exposure and melanoma in PSC found no association in 11 of the 13 high-quality studies examined [1]. These findings point toward substantial benefits of UVR exposure for PSC with low risk.

During this period, policies on the use of artificial UVR devices spread. Following the US Department of Health and Human Services' classification of artificially-generated UV radiation as a human carcinogen in 2002, the WHO classified indoor tanning devices as carcinogens in 2009 [76]. This label was applied to the use of these devices by people regardless of skin color. While tanning is associated with skin cancer in White people, no published studies link artificial UVR to skin cancer in PSC [77]. Thus, while research has linked the use of artificial UVRto improved bone cardiovascular health and no research links it to skin cancer in PSC, restrictive policies designed to protect the health of White populations have been recommended to everyone.

Sun exposure policies in the UK and Australia have recently moved away from the 1980's-style Australian paradigm to recognize the importance of skin color. In 2016 the British National Institute for Health and Care Excellence replaced its earlier one-size fits all recommendations with guidance that healthcare professionals offer personalized advice to patients based on their individual risk-benefit profiles as determined by skin tone, clothing coverage and time spent indoors [78]. In 2024 Australia announced new guidelines taking into account skin type, which accurately observe that UVR-caused skin cancer in dark skinned people is extremely rare and recommended that dark skin populations no longer engage in routine sun protection [79]. Striking a balance between the benefits and risks of sun exposure is challenging, but these developments show that it is possible to move toward less biased and more evidence-based guidelines.

6 Mechanisms of sun exposure and health disparities

Mechanistic studies also suggest that added sun/UV exposure is likely to be beneficial for the health of many PSC and for reducing cardiovascular disease disparities. Low nitric oxide bioavailability is a risk factor for cardiovascular disease [80]. A number of studies have found diminished NO-mediated vasodilation and increased endothelial dysfunction in people of African and East and South Asian ancestry in the US [81] and UK [82, 83], indicating reduced NO bioavailability. In 2014 Liu demonstrated that UVR lowers blood pressure through nitric oxide independently of vitamin D [84]. This result is consistent with clinical trials that have failed to find any effect of vitamin D supplementation on cardiovascular outcomes in the general population [85, 86], and the findings of mendelian randomization studies that genetic defects leading to low vitamin D production are not associated with CVD [87]. These studies support the hypothesis that sun/UV exposure may have significant benefits for the cardiovascular health of PSC in temperate regions by increasing nitric oxide bioavailability.

Because dietary nitrate is converted to NO, it is possible that diet contributes to differences in NO bioavailability and blood pressure. Some studies have suggested that typical US and UK diets are low to moderate in nitrate, while traditional African and South Asian diets often provide higher levels of the compound [88–90]. Therefore, diet may contribute to differences in NO bioavailability and blood pressure between people living in the US and UK compared to West Africa and South Asia. In contrast, evidence that dietary contrasts might add to inter-racial differences in blood pressure is uneven. Due to consuming a diet richer in vegetables South Asians in the United States have higher levels of dietary nitrates than White Americans [91]. Data on differences in nitrate consumption between Black and White Americans is weak and conflicting [92, 93]. Thus, it appears diet is unlikely to play a significant role in lower NO bioavailability in Black and South Asian individuals compared to White individuals living in the same region.

7 Conclusion

Sun exposure guidelines should protect all members of the population. Until recently, however, these recommendations have taken a 'one-size fits all' approach driven by perceptions of what is good for the health of White people. Doctors have long known that Black and South Asian people face a far lower risk of sunburn and UVR-induced skin cancer, and higher rates of rickets and cardiometabolic disease, than White populations. More recently, studies have found substantial cardiovascular benefits to sun exposure. These considerations suggest that a risk-benefit analysis would likely find that added sun exposure for people with skin of coloacross or above temperate regions, and in urban areas of equatorial regions, will improve cardiovascular health and not increase all-cause mortality. Moreover, while public health authorities have been aware that PSC are at lower risk of UVR-induced skin cancer, they have pointedly failed to communicate this risk difference to the public at-large. These omissions and oversights suggest that sun exposure policies have been guided by a widespread Eurocentric bias that coupled with a single-minded focus on skin cancer may do be doing more harm than good to the health of people with skin of color.

What recommendations on sun/UV exposure should be made to populations with skin of color? While developing fully informed guidelines will require more research on the benefits and risks of sun exposure across the skin color spectrum, a number of considerations suggest that guidance should encourage more sun/UV exposure rather than less. As regards individuals with dark skin – Fitzpatrick V or VI -- the fact that sun exposure carries cardiovascular benefits with minimal risk makes it similar to exercise, an activity that is encouraged. Historical data is also supportive. Black and South Asian people have traditionally had good cardiometabolic health and low skin cancer risk pursuing traditional lifestyles in native equatorial regions. Given that cardiovascular disease is the leading cause of death in the world with the greatest morbidity and mortality risk in these populations, it is highly plausible that encouraging dark skin people to achieve levels of sun exposure similar what was common in traditional rural life in native contexts will maximize healthy lifespans. However, research is needed to determine approximately how much sun exposure was common in traditional native contexts. But even without new studies, existing findings suggest that dark skinned people above equatorial regions or living non-traditional lives in native regions should seek out added sun/UV exposure through natural or artificial means. Artificially generated UV will likely be necessary at higher latitudes because equatorial levels of exposure cannot practically be achieved in these regions through natural means. This strategy brings to PSC what the Australian guidelines accomplished for White people: returning their sun exposure levels closer to what was common in their native regions.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors declare no competing interests.

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