Received: 31 January 2023 | Accepted: 12 July 2023

DOI: 10.1111/jdv.19421

JEADV JOURNAL OF THE EUROPEAN ACADEMY OF DERMATOLOGY & VENEREOLOGY

ORIGINAL ARTICLE

Sun exposure behaviours as a compromise to paradoxical injunctions: Insight from a worldwide survey

Thierry Passeron[1,2] | Henry W. Lim[3] | Chee Leok Goh[4] | Hee Young Kang[5] | Fatimata Ly[6] | Akimichi Morita[7] | Jorge Ocampo-Candiani[8] | Susana Puig[9] | Sergio Schalka[10] | Wei Liu[11] | Anne-Laure Demessant-Flavigny[12] | Caroline Le Floc'h[12] | Delphine Kerob[12] | Brigitte Dreno[13] | Jean Krutmann[14,15]

[1]Department of Dermatology, Côte d'Azur University, Nice University Hospital Center, Nice, France

[2]INSERM U1065, C3M, Côte d'Azur University, Nice, France

[3]Department of Dermatology, Henry Ford Health, Detroit, Michigan, USA

[4]National Skin Centre, Singapore City, Singapore

[5]Department of Dermatology, Ajou University School of Medicine, Suwon, South Korea

[6]Department of Dermatology, Cheikh Anta Diop Dakar University, EPS Institute of Social Hygiene, Dakar, Senegal

[7]Department of Geriatric and Environmental Dermatology, Nagoya City University Graduate School of Medical Sciences, Nagoya, Japan

[8]Universidad Autonoma de Nuevo León, Facultad de Medicina, University Hospital "Dr. Jose E. González", Monterrey, Mexico

[9]Dermatology Department, Hospital Clinic de Barcelona, Barcelona University, Barcelona, Spain

[10]Medcin Skin Research Center and Biochemistry Department, Chemistry Institute of Sao Paulo University, Sao Paulo, Brazil

[11]Department of Dermatology, The General Hospital of Air Force PLA, Beijing, China

[12]La Roche-Posay International, Levallois-Perret, France

[13]Nantes University, Univ Angers, INSERM, Immunology and New Concepts in ImmunoTherapy, INCIT, UMR 1302, Nantes, France

[14]IUF Leibniz Research Institute for Environmental Medicine, Duesseldorf, Germany

[15]Medical Faculty, Heinrich-Heine-University, Duesseldorf, Germany

Correspondence
Thierry Passeron, Department of Dermatology. Archet 2 Hospital, CHU Nice, 151, route St Antoine de Ginestière, Nice 06200, France.
Email: passeron@unice.fr

Funding information
La Roche-Posay

Abstract

Background: Behavioural interventions can improve attitudes towards sun protection but the impact remains inconsistent worldwide.

Objective: To assess awareness of and attitudes towards the multiple facets of sun exposure and suggest ways to improve prevention from overexposure to the sun in all geographical zones and multiple skin types.

Methods: Online survey was conducted from 28 September to 18 October 2021. Study population was selected from the Ipsos online Panel (3,540,000 panellists), aged ≥18 years, from 17 countries around the five continents. Demographics, sun-exposure habits and practices, understanding of risks and information on phototypes were documented and analysed using descriptive statistics.

Results: Eighty-eight per cent of participants knew that sunlight can cause skin health problems (90% phototypes I-II, 82% phototypes V-VI, >90% in American and European countries, 72% in Asia and 85% in Africa). Eighty-five per cent used some form of protection against sunlight, predominantly: Seeking shade (77%), avoiding the midday sun (66%), facial application of sunscreen (60%) and wearing protective clothing (44%). The perception of sunlight itself is positive ('it gives energy' for 82%; 'tanned skin looks attractive' for 72%), although less in Asian countries and among individuals with dark skin phototypes. Eighty-three per cent reported having experienced sunburn, mainly in Australia, Canada, USA, Germany, France and Russia,

and among individuals with dark skin phototypes. Only 12% systematically/often used all types of protection during exposure to the sun and 23% believed it is safe to go out in the sun with no protection when their skin is already tanned. From 13% (skin phototype I) to 26% (phototype VI) reported not using any form of protection against the sun. Knowledge and habits were significantly superior among people who are accustomed to seeing a dermatologist for a complete skin exam.
Conclusions: Dermatologists could play a crucial role in relaying novel prevention messages, more finely tailored to specific risks, populations and areas of the world.

INTRODUCTION

The skin is the largest organ of the human body and the main protective interface against the outside environment.[1] The vital roles and benefits of sunlight have been well documented[2] including vitamin D synthesis and benefits on the mood. The sunlight spectrum covers a wide range of electromagnetic radiation wavelengths.[3] UVB rays (295–320 nm) primarily penetrate the epidermis while UVA rays (320–400 nm) also reach the dermis.[4] The detrimental effects of UV rays are both acute (erythema, sunburn, photo-immunosuppression and photo-allergy), and chronic (including skin cancers, melasma, post-inflammation hyperpigmentation and photoageing).[5] More recently, visible light (400 nm [violet] to 700 nm [red]) and IR radiation (700 nm to 1 millimetre) were identified as contributing factors to photoageing of the skin and skin damage.[5–9] Visible light is involved in worsening pigmentary disorders, such as melasma.[5,10] Expert consensus and guidelines on photoprotection recommend to include all skin tones with a tailored photoprotection approach.[11–13]

Attitudes towards protection from sunlight and the quest for a tan have evolved over the course of human history[14] and are both closely linked to cultural, sociodemographic and health-related aspects.[15–17] The first campaigns of protection against excessive exposure to sunlight were launched in reaction to the alarmingly sharp rise in the number of skin cancers in the 1970s,[14] mainly in Northern America, Europe and Australia. Current day sun protection encompasses a wide range of measures, including wearing protective clothing and sunglasses, seeking shade, avoiding the sun when the UV index is at its peak and applying sunscreen.[18]

Most public health awareness campaigns typically focus on improving knowledge of sun exposure, protection against the sun and skin cancers. In Australia, where skin cancer is a major public health concern, the SunSmart prevention program succeeded in improving sun protection behaviour over the 30 years from 1987.[19] Several studies have also shown that sun protective behaviours have improved; thanks to guidance from primary care general practitioners,[20] through counselling by dermatologists,[21] and via appearance-based interventions.[22,23] There is however nothing to suggest that the incidence of sunburn in children or adults has sustainably decreased as a result of these interventions.[24] Moreover, awareness of skin cancers was shown to be only moderately correlated with sun protection behaviour.[17]

Overall, although behavioural interventions have been seen to improve attitudes towards sun protection, the impact remains inconsistent. One reason may be that recent warnings have delivered somewhat simplified messages, focusing essentially on the protection of lighter skin tones, the adverse effects of UVB rays alone and the prevention of skin cancers.[25] Campaigns of protection against the adverse effects of sunlight need to maintain the balance between cultural, geographical and health-related aspects.

To this end, this survey sought to gain clearer insight into the awareness and attitudes towards the multiple facets of sun exposure and to help eventually refine and tune prevention actions towards sun overexposure across the world and across different skin types.

MATERIALS AND METHODS

The survey was conducted online from 28 September to 18 October 2021. The study population, selected from the Ipsos online Panel (3,540,000 panellists in 17 countries), included men and women aged 18 years and older from 17 countries around the five continents: United States of America (US), Brazil, Mexico, Argentina, Canada, Germany, France, Spain, Italy, United Kingdom, Russia, South Africa, Egypt, China, Japan, Indonesia and Australia.

Eligibility required that all participants had not recently taken part in a similar survey. A preliminary sample population was compiled using the automatic selection process of the Ipsos software (eMethodology). This was adjusted, giving the final sample population that fit the quotas based on sex, age, employment status and regions of the individual countries. The final sample sizes made allowances for country-specific variations in response rates.

A total of 17,001 individuals were surveyed and samples of 1000 individuals per country fit the quotas defined above. Questionnaires covered demographics, personal medical history, sun-exposure habits and practices, including habits of protection with sunscreen, and knowledge and understanding of risks. Information on phototypes was documented using the Fitzpatrick classification together with a description of the colour of the skin and colour picture representations. Questionnaires were translated into the appropriate languages for each country and proofread by a native speaker.

Data were analysed using descriptive statistics, including frequency tables, means, standard deviations and 95%

confidence intervals. Two-sided chi-square tests with a 0.05 significance level were used to compare subgroups. The Cosi software (M.L.I., France, 1994) was used for all analyses.

RESULTS

Description of the population

The average age of the survey population was 44.5 years (SD:16.3), with 49% men (Table S1). Worldwide, skin phototypes II-III were the most widely represented (61%). Types II (33%) and III (28%) were predominant in European countries (Figure 1). This distribution was consistent across Europe, except in the United Kingdom where the lightest phototypes prevailed (Type I: 20%, $p < 0.001$, Type II: 41%, $p < 0.001$ and Type III: 25%, $p = 0.04$). Respondents in the United States, Canada, Australia, Argentina and Egypt had a similar profile to that of Europeans, with the lightest phototypes in the United States, Canada and Australia. In Asian countries, phototype III and IV were more numerous compared to worldwide, although there were notable disparities between the different Asian countries surveyed. In certain countries, there was a more equal distribution of light and dark phototypes: South Africa and Brazil (Figure 1). In contrast, in Mexico, there was a majority of phototype III (31%, $p = 0.04$), and greater proportions of phototypes IV (24%, $p < 0.001$) and V (9%, $p = 0.02$) (Figure 1).

Sixteen per cent of the overall population reported seeing a dermatologist at least once a year to check for moles (Table S1). This figure was higher among men (17%, $p = 0.05$), 25–34-year-old respondents (18%, $p < 0.001$), and those with a phototype I (25%, $p < 0.001$).

Knowledge of sun-related damage

Most respondents were aware that sunlight can cause skin health problems (88%) and accelerates skin ageing (81%) (Table 1). Awareness of sun-related skin health problems was more widespread among individuals with phototypes II (91%, $p < 0.001$ vs. phototypes V-VI: 84%–75%, $p < 0.001$) (Table S2). It was also more widespread in American and European countries (>90%, except in Russia). Awareness of sun-related skin health problems remained high in Asian and African countries, despite the lowest reported awareness figures (Figure 2).

In line with these findings, 79% of the survey population believed they were at risk to develop later one of these following damages: skin photoageing (57%), hyperpigmentation (52%), new moles (48%) and skin cancer (44%) (Table 1). Individuals of phototype III felt more at risk of skin photoageing (59%, $p = 0.001$) and hyperpigmentation (54%, $p = 0.001$)

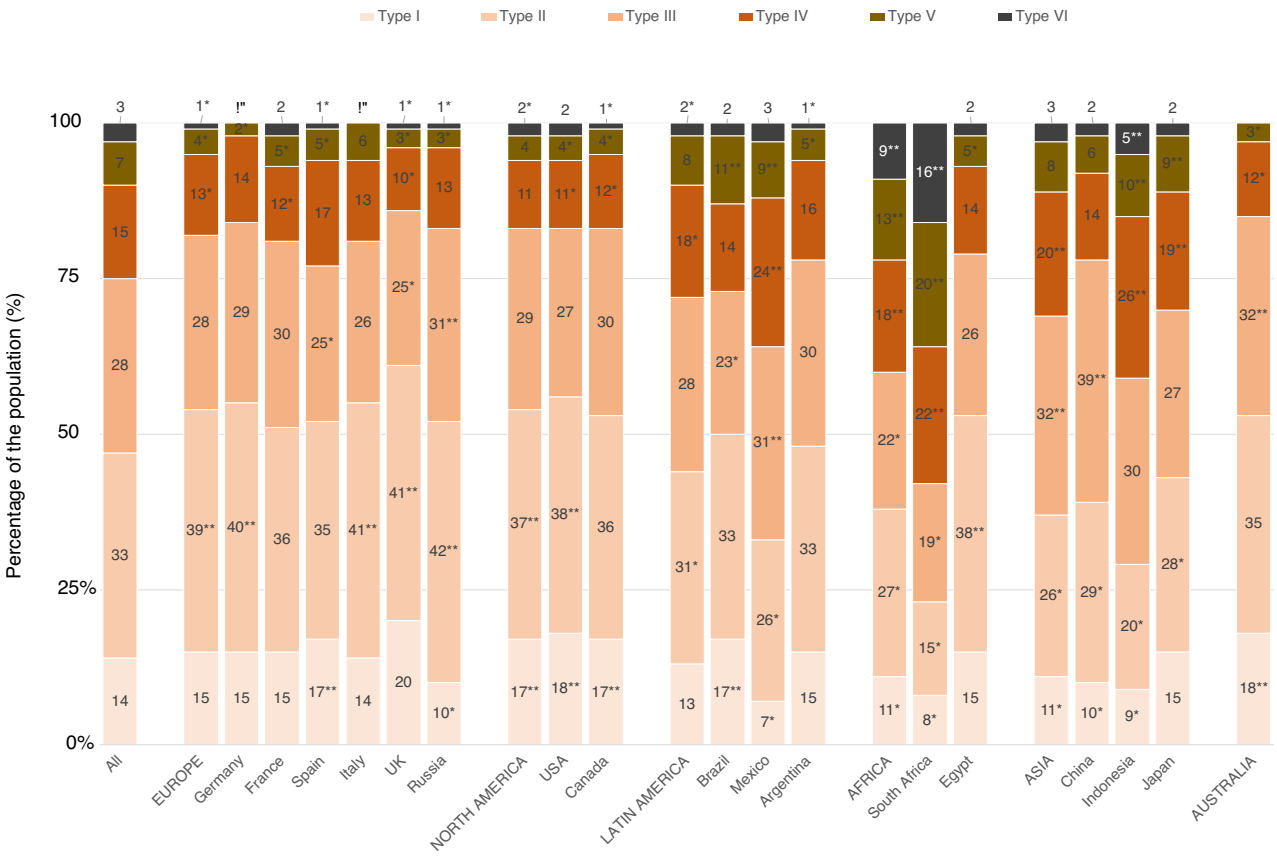

FIGURE 1 Distribution of phototypes in the population of the individual countries. Numbers are expressed as a percentage of the population. */** values were significantly lower/higher ($p < 0.05$) compared to the overall population (All).

TABLE 1 Attitudes towards exposure to the sun and measures of protection.

Items of the questionnaire	All, No. (%) (*N* = 17,001)
Attitudes towards exposure to the sun	
Would you say that …	
Exposure to the sun can cause skin health problems	
Yes	15,075 (88)
No	1603 (10)
Do not know	323 (2)
Exposure to the sun accelerates skin ageing	
Yes	13,952 (81)
No	2151 (13)
Do not know	898 (6)
Regarding your sun exposure habits, do you feel at risk to develop later these following damages? (ST "yes")	
Skin cancer	7585 (44)
Skin photoageing	9703 (57)
Hyperpigmentation	8952 (52)
Sun sensitivity	6457 (38)
Eye damages	7443 (44)
New moles	8197 (48)
Perception of sunlight	
Would you say that … (ST 'yes')	
The sun gives you energy	13,883 (82)
A tanned skin looks attractive	12,315 (72)
You cannot imagine coming back from holidays without being tanned	8386 (49)
I seek to tan with a sun protection	10,138 (59)
Attitudes towards sun protection	
When you are exposed to the sun, do you (Systematically or Often)?	
Wear a hat/cap	9379 (55)
Wear a long-sleeved shirt/protective clothing	7578 (44)
Put sunscreen on your face	10,358 (60)
Put sunscreen on your hands, neck, decollete and ears	9002 (52)
Put sunscreen on your arms, legs and chest	9558 (55)
Wear sunglasses with a UV filter	9564 (56)
Try to stay in the shade	13,198 (77)
Avoid sun exposure between noon and 4:00 pm	11,219 (66)
All of the above, systematically or often	2144 (12)
In general, would you say that you protect yourself from the sun?	
No, not really	2479 (15)
Yes, all year round, whatever the season	3928 (23)
Yes, but only on hot and sunny days, whether you are on holiday or not	7439 (44)
Yes, but only when you are on holiday (beach, skiing, etc.)	3155 (18)
Experience of sunburn	14,156 (83)
It is safe to go out in the sun without protection if you are already tanned	
Yes	3736 (23)
No	12,536 (73)
Do not know	729 (4)
Sunscreen with a very high Sun Protection Factor (SPF) of 50+ is dedicated to people who are particularly at risk	
Yes	9777 (58)
No	5919 (34)
Do not know	1305 (8)
Do you regret not having better protected yourself from the sun in the past (ST 'yes')	9801 (57)

Abbreviation: ST, subtotal.

whereas those of phototype I felt more at risk of new moles (55%, $p < 0.001$) and skin cancer (52%, $p < 0.001$). Asian respondents were more likely to feel at risk of developing skin photoageing (71% vs. 57% worldwide, $p < 0.001$) or hyperpigmentation (70% vs. 52% worldwide, $p < 0.001$) (Table S3).

Perception of sunlight

Most respondents (82%) agreed that 'the sun gives you energy', with inter-country variations (69% in South Africa [$p < 0.001$] to 92% in Indonesia [$p < 0.001$] [Table S3]). For 72% of respondents, 'A tanned skin looks attractive' (Table 1). The cosmetic benefit of a tan varied significantly from one country to another and the scores in Europe were among the highest reported (Table S3).

Interestingly, 49% of the overall population 'cannot imagine coming back from holidays without being tanned' (Table 1). This feature showed strong inter-country variations, reaching 67% in Russia ($p < 0.001$) in contrast to 26% in Japan ($p < 0.001$) (Table S3). It was also lower among individuals with a phototype I-II (42%, $p < 0.001$–47%, $p = 0.001$ vs. phototypes III-IV 54%, $p < 0.001$–52%, $p < 0.001$; Table S2).

Attitudes towards sun protection

The majority of respondents reported protecting themselves from the sun (85%, Table 1). The most frequent sun-protective measures were trying to stay in the shade (77%; systematically/often) avoiding exposure between noon and 4:00 pm (66%; systematically/often) and applying sunscreen on the face (60%; systematically/often) (Table 1). Overall, only 12% systematically/often used all types of protection during exposure to the sun (Table 1). This figure was the lowest in Japan (3%, $p < 0.001$) and it was significantly higher in Australia (20%, $p < 0.001$) (Table S3).

Importantly, 23% believed it is safe to go out in the sun with no protection when their skin is already tanned, and 58% answered 'yes' to the statement that sunscreen with a very high Sun Protection Factor (SPF) of 50+ is dedicated to people with a particularly high risk (Table 1). Besides, a small proportion of survey participants (15%) reported not using any form of protection against the sun (Table 1). This figure varied from

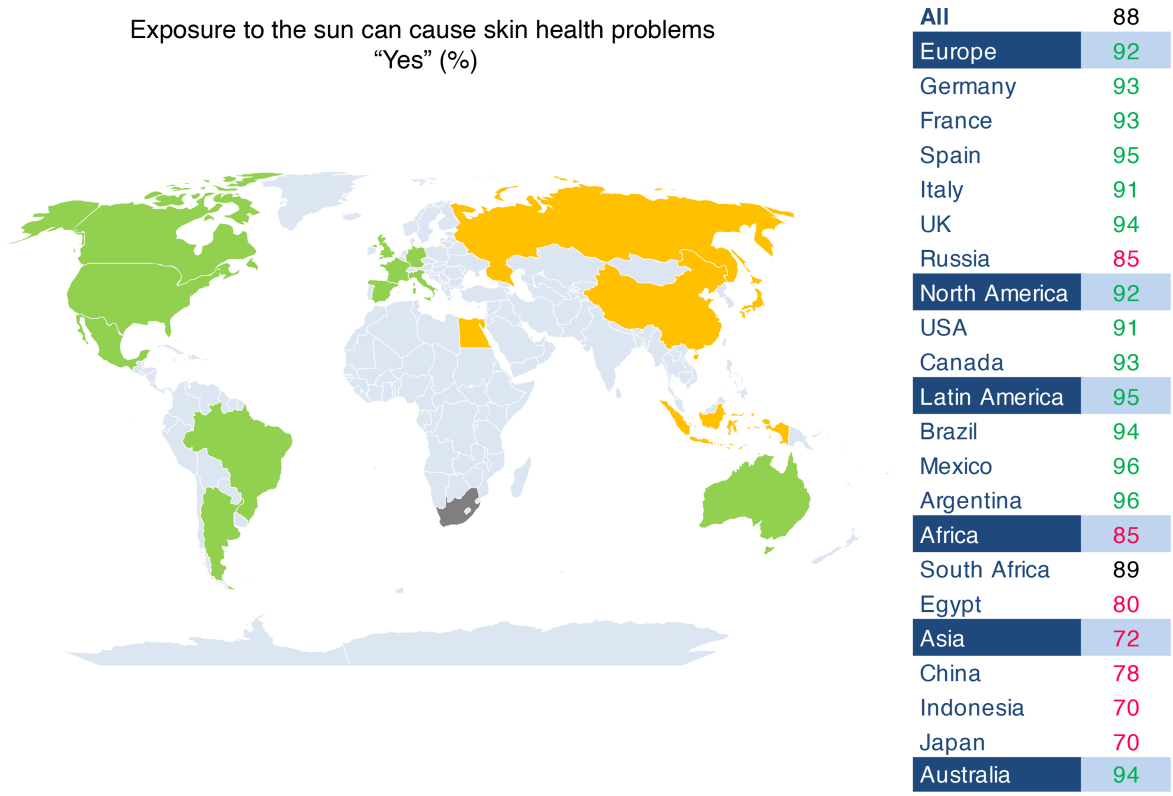

FIGURE 2 Geographical representation of data regarding awareness of the risk associated with exposure to sunlight. Percentage of respondents answering "yes" to the question: 'Would you say that exposure to the sun can cause skin health problems?' All figures are significantly different ($p < 0.05$) from the average of 17 countries (88%), except South Africa (89%). UK, United Kingdom; USA, United States of America.

13% ($p = 0.001$) in individuals with skin phototype I to 26% ($p < 0.001$) of those with phototype VI (Table S2) and was particularly notable in certain countries: 33% in Japan ($p < 0.001$), 30% in Russia ($p < 0.001$), 20% in the United States ($p < 0.001$) and 19% in Canada ($p < 0.001$) (Table S3).

Among the respondents who reported using sunscreen even rarely ($n = 13{,}434$, 78%, Table 2), those with light skin phototypes favoured sunscreens with a high/very high SPF (69% phototype I, and 68% phototype II), whereas individuals with phototypes V and VI were more likely to use a low/medium SPF (33% phototype V, and 39% phototype VI). While the majority (74%) applied sunscreen once-a-day (44%) or twice a day (30%), only 15% reported sunscreen application habits of once every 2 h. Among sunscreen users, when skin is getting tanned, 44% applied sunscreen in a different way: 19% indicated applying less often, 18% declared using a lower protection and 7% declared not using sunscreen anymore.

Interestingly, 83% of respondents declared having experienced sunburn (Table 1), including a notable proportion of individuals with the darkest skin phototypes (IV: 77%, $p < 0.001$, V: 67%, $p < 0.001$, and VI: 54%, $p < 0.001$, Table S2). Episodes of sunburn were reported significantly more frequently in Australia (95%, $p < 0.001$), Canada and Germany (93%, $p < 0.001$), France (91%, $p < 0.001$) and in Russia and the United States (90%, $p < 0.001$) compared to the overall population (83%) (Table S3). Dark spots were more frequent in Japan (77%, $p < 0.001$), South Africa (74%, $p < 0.001$), China and Egypt (71%, $p < 0.001$) and Brazil (61%, $p < 0.001$), compared to the worldwide average (52%) (Table S2). However, 57% of all respondents regretted not having protected themselves better from the sun in the past (Table 1; Table S3).

Knowledge of sunlight radiation

Although 75% of the study population knew something about at least one aspect of sunlight, there were many misunderstandings: 70% were unable to distinguish between UVA and UVB, and approximately half either misunderstood or did not know the definitions of visible light (52%) and IR light (49%). The concepts of UV protection and Sun Protection Factor index were also poorly understood (Table 3).

Regarding visible light and UVA, only 12% and 6% of the population, respectively, understood the roles of these two types of radiation in hyperpigmentation (Table 3).

Attitudes and knowledge among individuals visiting a dermatologist regularly

There was a significantly better knowledge and habits among people who had a complete skin exam by a dermatologist at

TABLE 2 Attitude towards sunscreen use.

Items of the questionnaire	All, No. (%) (*N* = 13,434)
When you are exposed to the sun, how often do you apply your sunscreen?	
Once a day	5829 (44)
Twice a day	4036 (30)
Every 2 h	2101 (15)
More often (systematically after bathing/after sweating)	1468 (11)
When your skin is tanned, do you keep applying your sunscreen?	
Same frequency and same protection factor	7586 (56)
Same frequency but with a lower protection factor	2406 (18)
Less often	2546 (19)
I no longer apply sunscreen	896 (7)
What is the level of UVB protection of the sunscreen you are using most often?	
Low SPF	496 (4)
Medium SPF	3028 (22)
High SPF	5331 (40)
Very high SPF	3420 (25)
I do not know	1159 (9)

Note: Baseline: 14,343 respondents who declared using sunscreen even rarely.
Abbreviations: SFP, Sun protection factor; UV, Ultraviolet.

TABLE 3 Understanding of sunlight and associated risks (from a 13-question questionnaire).

Items of the questionnaire	All, No. (%)[c] (*N* = 17,001)
How well, if at all, do you feel you understand each of the following terms?	
Answers: 'Not well' and 'Do not know'	
Differences between UVB and UVA	11,913 (70)
Level of SPF index/category	9168 (54)
UV protection	11,467 (68)
Long UVA protection	9954 (59)
Visible light	8735 (52)
Infrared	8384 (49)
From your understanding, which rays of the sun are responsible for the following effects?[a]	
Incorrect answers[b]	
Skin photoageing	8044 (48)
Hyperpigmentation	14,978 (88)
Allergic reactions to the sun	16,113 (95)
Keratinocyte carcinoma	12,811 (76)
Melanoma cancers	11,743 (69)
Actinic keratosis	14,187 (84)
Worsening of certain forms of dermatosis	12,598 (74)
Vitamin D synthesis	15,898 (93)
Sunburn	16,074 (94)
Tanning	11,398 (67)
Skin dryness	12,449 (73)
Improvement of some skin disease	16,158 (95)
Only incorrect answers or I do not know	3910 (23)
At least one correct answer	13,091 (77)
Number of correct answers, mean [SD]	2.7 [2.2]

Abbreviations: PA, UVA Protection level; SD, standard deviation; SFP, sun protection factor; UV (A or B), Ultraviolet (A or B).
[a]Possible answers were: UVA, UVB, Both UVA and UVB, Visible light, Infrared and I do not know.
[b]Percentages and number of 'Incorrect answers' include the percentage and number of answers 'I do not know'.
[c]No. (%), unless otherwise specified.

least once a year. Those individuals had a better knowledge of sun-related skin damage, namely skin ageing (86% vs. 81% of the overall population, $p < 0.001$), and skin health problems (91% vs. 88% of the overall population, $p < 0.001$). They were more likely than the overall population (90% vs. 79%, $p < 0.001$) to feel at risk for at least one form of photodamage. They also reported more frequent sun-protective measures: 30% systematically/often used all types of protection during exposure to the sun (vs. 12% of the overall population, $p < 0.001$) and 92% reported sunscreen application at least for one zone, even rarely (vs. 78% of the overall population, $p < 0.001$).This population also had a better understanding of the different types of radiation in sunlight: 88% reported understanding at least one element (vs. 75% of the overall population, $p < 0.001$), but still 48% of them do not know the difference between UVA and UVB (vs. 70% of the overall population, $p < 0.001$).

DISCUSSION

Attitudes towards exposure to sunlight and sun protection were studied in a large population of 17,001 adults throughout 17 countries. While these topics are frequently explored in Caucasian and fair-skinned populations,[26] they remain rarely explored in population of darker skin phototypes,[11] notably from Asian[15] or African countries.[27]

Most survey participants, including individuals with dark skin phototypes, had at least some knowledge of UV-related risks for health and skin photoageing. Photoageing was considered to be the greatest risk, ahead of skin cancer, related to exposure to the sun. Overall, and compared to the populations of both North and South America, and Europe, African and Asian populations were less likely to be aware of sun-related skin health risks. Although the positive perception of sunlight itself ('it gives energy'), and the belief in the aesthetic benefit of tanning were common in the study population, there were a number of reservations in Asian countries for cultural reasons,[15] and among individuals with dark skin phototypes who had no reason to seek a tan.

Overall, a minority of respondents choose concomitant protection measures, which would provide a cumulative protective effect. Most respondents reported using some measure of protection against sunlight. The importance of sun avoidance (seeking shade and avoiding the midday sun) was well understood, as was facial application of sunscreen, although sunscreen was overall underuse. A previous study[26] showed that sunscreen was the first-line option for most respondents. However, almost 50% of the total population of that study were residents of nine countries in Northern and Eastern Europe.[26] Nevertheless, the absolute proportions of respondents reporting facial application of sunscreen were comparable (57% vs. 60% in this study). Moreover, in contrast to the international recommendations, protective clothing was the least frequently used form of protection in both studies.[18] Our findings also suggest regular complete skin exam by dermatologists or general practitioners is not yet a widespread practice.

Although people understand they have to protect themselves from the sun, a notable proportion of individuals reported having experienced sunburn. Our findings reveal areas of the world where episodes of sunburn are more frequent (Australia, Canada, United States, Germany, France and Russia). These areas correspond to lighter skin tones on average, and historical and cultural trends in favour of tanning.[14] However sunburns were also reported in individuals with dark skin phototypes. Although this observation is likely against common sense, it is acknowledged that dark skin can also experience sunburns.[27] Dark spots were more frequently reported in other areas of the world (Japan, South Africa, China, Egypt and Brazil), likely because of a combination of a geographical latitude with high ambient solar radiation and skin phototypes which tend to be higher than the worldwide average.[28] Therefore, these populations may be more widely exposed to UVA and visible-light-related damage. Interestingly, although the overall average knowledge of visible-light-related skin damage was low, some areas of the world, notably China and South Africa, had a distinctive, significantly greater awareness of this specific risk factor.

These different geographical observations highlight the discrepancies between the level of awareness of the risks of sunlight-related skin damage and sun-protection strategies, and how both are related to different factors, including geographical latitude, skin tone and sociocultural aesthetics with regard to skin colour.[15] Interestingly, a parallel can be drawn between these observations and the most recent data on the epidemiology of skin cancers. Although the highest incident rates of skin cancers were reported in Australia, Western and Northern Europe, and North America,[29–31] several reports have highlighted an increasing incidence in East Asia, Sub-Saharan African countries and Tropical Latin America.[31–34] Additionally, incident rates of skin cancers are expected to rise by 50% over the next 20 years, in Australia, Western and Northern Europe and North America.[29]

In summary, although the population of this study was aware of the main sunlight-related health risks, the most appropriate measures of prevention against acute and chronic consequences on skin health were underused. This is consistent with the findings of other international surveys suggesting that widespread dissemination of messages of prevention do improve the level of knowledge of the average lay person but do not necessarily improve sun protection behaviour.[17,24,26]

Our survey participants had limited knowledge of the different types of radiation that make up sunlight and their effects on the skin. The majority do not have a good understanding of other harmful radiation than UVB, that is, UVA, neither were aware of protection means against UVA.

In the same way, the majority reserves the use of SFP 50+ sunscreen protection to individuals particularly at risk. Although limited, this knowledge is likely based on the recommendations that an adequate UVB protection is provided by SFP 50+ for light skins and SFP 30+ for dark skin.[12] But our data highlight the misunderstanding of the SFP index together with the knowledge gap that UVA are other harmful radiations for all skin types.[12,35] Interestingly, although the overall average knowledge of visible-light-related skin damage was low, some areas of the world, notably China and South Africa, had a distinctive, significantly greater awareness of this specific risk factor.

While most interviewees had at least some knowledge of common sunlight-related skin reactions such as tanning and sunburn, they demonstrated a limited understanding of sunlight-related diseases and the specific causes, and of the associated medical terms.

Interestingly, individuals seeing regularly a dermatologist have been seen to have a greater level of understanding and more effective sun protection habits than the overall population. However, a number of misconceptions came to light more frequently among this population. The prevailing misconceptions suggest that at-risk populations tend to ignore their individual risks amid the psychological benefits of intentional tanning.

These observations not only point to the limits of cognitive capacity to drive preventive behaviour but also the crucial educational role of dermatologists, together with general practitionners.[20]

The present online survey does have some limitations. The findings may be affected by the inherent bias of declarative surveys, including cognitive and memory bias. Moreover, a social desirability bias (whereby interviewees select expected answers, in this case relating to sun protection) cannot be excluded.

It is worth noting that the final sample populations were not representative in terms of phototype as this criterion was not included in the quota sampling method. However, the very large number of survey respondents allows to draw conclusion on various skin phototypes. Additionally, the sampling bias due to the required access to Internet may have selected the most educated people to respond. In particular, the sample populations of China (mainland), Indonesia, Mexico, Argentina, Brazil, South Africa and in Egypt were more urban, more educated and/or more affluent than the general population of the individual countries. Therefore, we

could expect the actual knowledge on sunlight and sunlight-related damage and protection behaviours to be less favourable than shown in this study.

In conclusion, the survey population do not make optimal use of all the means at their disposal to protect themselves from the sun. Additionally, the notable differences worldwide in terms of awareness of the risks and the need for protection measures suggest that prevention campaigns should include messages that are more finely tailored to specific risks, populations and areas of the world: (1) cumulative protection measures and adequate reapplication of sunscreen contribute to the prevention of acute and chronic effects of sunlight and to maintaining skin health. (2) UVA, together with UVB, promotes skin cancers and skin photoageing; (3) darker skin tones, develop specific UVA- and visible light-related photoageing and hyperpigmentation. Beside population-based prevention campaigns, dermatologists could be a very useful relay of these novel messages tailored to the populations of the individual countries. It would be important to understand the best ways and medias to deliver these education messages.

ACKNOWLEDGEMENTS

A medical writing assistance was provided by Ipsos France and Potentiel d'action (France).

FUNDING INFORMATION

The survey was funded by La Roche Posay.

CONFLICT OF INTEREST STATEMENT

Dr Passeron reports personal fees from La Roche Posay during the conduct of the study; personal fees from L'Oréal, personal fees from SVR, personal fees from Symrise, personal fees from Isis Pharma, personal fees from Bioderma, personal fees from Beiersdorf, personal fees from ISDIN, personal fees from Pierre Fabre and personal fees from Hyphen, outside the submitted work. **Dr. Lim** is an investigator for Incyte, L'Oreal, Pfizer and PCORI, has served as a consultant for La Roche-Posay, ISDIN, Pierre Fabre, Ferndale and Beiersdorf and has been a speaker on general educational session for La Roche-Posay, Pierre Fabre and Bioderma. **Dr. Goh** reports other support from La Roche Posay during the conduct of the study. **Dr. Kang** reports personal fees from L'Oréal during the conduct of the study. **Dr. Ly** has nothing to disclose. **Dr. Morita** reports personal fees from L'Oréal during the conduct of the study. **Dr. Ocampo-Candiani** reports personal fees from La Roche Posay during the conduct of the study and personal fees from Pierre Fabre outside the submitted work. **Dr. Puig** reports personal fees from La Roche Posay, during the conduct of the study; grants, personal fees and non-financial support from Almirall, personal fees from Amgen, personal fees and non-financial support from Avene, personal fees and non-financial support from BMS, grants and personal fees from Cantabria, grants, personal fees and non-financial support from ISDIN, grants from MSD, non-financial support from Lilly, non-financial support from AbbVie, personal fees and non-financial support from Pierre Fabre, grants, personal fees and non-financial support from La Roche Posay, personal fees from Pfizer, personal fees and non-financial support from Sanofi, grants, personal fees and non-financial support from Sunpharma, grants and personal fees from Roche, outside the submitted work. **Dr. Schalka** has served as an investigator for NAOS/Bioderma, Johnson& Johnson, Mantecorp Skincare Brasil and FQM Brasil. He has also served as a consultant for Pierre Fabre, ISDIN, FQM Brasil, Mantecorp Skincare Brasil, Vichy, La Roche Posay and NAOS/Bioderma, and has participated as a speaker in an educational session for Pierre Fabre, La Roche-Posay, Eucerin and NAOS/Bioderma. **Dr. Wei** reports personal fees from La Roche Posay during the conduct of the study. **A.-L. Demessant-Flavigny, C. Le Floc'h, D. Kerob** are employees of La Roche Posay. **Dr. Dreno** reports personal fees from La Roche Posay International during the conduct of the study. **Dr. Krutmann** reports personal fees from La Roche Posay during the conduct of the study; grants and personal fees from Amway, grants and personal fees from Beiersdorf, grants and personal fees from Bitop, grants and personal fees from Blue Lagoon, grants and personal fees from Estee Lauder, grants and personal fees from Evonik, grants and personal fees from Galderma, grants and personal fees from Henkel, grants and personal fees from Horphag, grants and personal fees from ISDIN, grants and personal fees from Kiessling, grants and personal fees from Lancaster-Coty, grants and personal fees from La Roche Posay, grants and personal fees from L'Oréal, grants and personal fees from Lycored, grants and personal fees from Mary Kay, grants and personal fees from Mibelle, grants and personal fees from Procter & Gamble, grants and personal fees from Repairogen, grants and personal fees from RepliCel, grants and personal fees from Skinceuticals, grants and personal fees from SkinMedica, an Allergan Company, grants and personal fees from Stada, grants and personal fees from Symrise, grants and personal fees from Unilever, grants and personal fees from Vichy, grants and personal fees from Walgreen-Boots-Alliance, outside the submitted work.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Ipsos is an independent Market Research Company. The survey has been carried out according to the ICC/ESOMAR code of conduct.

ORCID

Thierry Passeron https://orcid.org/0000-0002-0797-6570
Akimichi Morita https://orcid.org/0000-0001-8372-3754
Jorge Ocampo-Candiani https://orcid.org/0000-0002-0213-0031
Anne-Laure Demessant-Flavigny https://orcid.org/0000-0002-3854-8851
Brigitte Dreno https://orcid.org/0000-0001-5574-5825
Jean Krutmann https://orcid.org/0000-0001-8433-1517

REFERENCES

1. Woodby B, Penta K, Pecorelli A, Lila MA, Valacchi G. Skin health from the inside out. Annu Rev Food Sci Technol. 2020;11:235–54.
2. Passeron T, Krutmann J, Andersen ML, Katta R, Zouboulis CC. Clinical and biological impact of the exposome on the skin. J Eur Acad Dermatol Venereol. 2020;34(Suppl 4):4–25.
3. Rigel DS, Lim HW, Draelos ZD, Weber TM, Taylor SC. Photoprotection for all: current gaps and opportunities. J Am Acad Dermatol. 2022;86(3s):S18–S26.
4. Battie C, Jitsukawa S, Bernerd F, Del Bino S, Marionnet C, Verschoore M. New insights in photoaging, UVA induced damage and skin types. Exp Dermatol. 2014;23(Suppl 1):7–12.
5. Sklar LR, Almutawa F, Lim HW, Hamzavi I. Effects of ultraviolet radiation, visible light, and infrared radiation on erythema and pigmentation: a review. Photochem Photobiol Sci. 2013;12(1):54–64.
6. Addor FAS, Barcaui CB, Gomes EE, Lupi O, Marçon CR, Miot HA. Sunscreen lotions in the dermatological prescription: review of concepts and controversies. An Bras Dermatol. 2022;97(2):204–22.
7. Austin E, Geisler AN, Nguyen J, Kohli I, Hamzavi I, Lim HW, et al. Visible light. Part I: properties and cutaneous effects of visible light. J Am Acad Dermatol. 2021;84(5):1219–31.
8. Geisler AN, Austin E, Nguyen J, Hamzavi I, Jagdeo J, Lim HW. Visible light. Part II: photoprotection against visible and ultraviolet light. J Am Acad Dermatol. 2021;84(5):1233–44.
9. Krutmann J, Morita A, Chung JH. Sun exposure: what molecular photodermatology tells us about its good and bad sides. J Invest Dermatol. 2012;132(3 Pt 2):976–84.
10. Boukari F, Jourdan E, Fontas E, Montaudié H, Castela E, Lacour JP, et al. Prevention of melasma relapses with sunscreen combining protection against UV and short wavelengths of visible light: a prospective randomized comparative trial. J Am Acad Dermatol. 2015;72(1):189–190.e181.
11. Tsai J, Chien AL. Photoprotection for skin of color. Am J Clin Dermatol. 2022;23:195–205.
12. Passeron T, Lim HW, Goh CL, Kang HY, Ly F, Morita A, et al. Photoprotection according to skin phototype and dermatoses: practical recommendations from an expert panel. J Eur Acad Dermatol Venereol. 2021;35(7):1460–9.
13. Schalka S, Steiner D, Ravelli FN, Steiner T, Terena AC, Marçon CR, et al. Brazilian consensus on photoprotection. An Bras Dermatol. 2014;89(6 Suppl 1):1–74.
14. Randle HW. Suntanning: differences in perceptions throughout history. Mayo Clin Proc. 1997;72(5):461–6.
15. Chen HY, Robinson JK, Jablonski NG. A cross-cultural exploration on the psychological aspects of skin color aesthetics: implications for sun-related behavior. Transl Behav Med. 2020;10(1):234–43.
16. Arthur K, Belliard JC, Hardin SB, Knecht K, Chen CS, Montgomery S. Practices, attitudes, and beliefs associated with complementary and alternative medicine (CAM) use among cancer patients. Integr Cancer Ther. 2012;11(3):232–42.
17. Bränström R, Kasparian NA, Chang YM, Affleck P, Tibben A, Aspinwall LG, et al. Predictors of sun protection behaviors and severe sunburn in an international online study. Cancer Epidemiol Biomarkers Prev. 2010;19(9):2199–210.
18. World Health Organization. Radiation: Sun protection. 2003 [cited 2022 Mar 17]. Available from: https://www.who.int/news-room/questions-and-answers/item/radiation-sun-protection
19. Tabbakh T, Volkov A, Wakefield M, Dobbinson S. Implementation of the SunSmart program and population sun protection behaviour in Melbourne, Australia: results from cross-sectional summer surveys from 1987 to 2017. PLoS Med. 2019;16(10):e1002932.
20. Hedevik H, Guorgis G, Anderson CD, Falk M. Sustainable effect of individualised sun protection advice on sun protection behaviour: a 10-year follow-up of a randomised controlled study in primary care. BJGP Open. 2019;3(3):bjgpopen19X101653.
21. Mallett KA, Turrisi R, Billingsley E, Trager B, Ackerman S, Reavy R, et al. Evaluation of a brief dermatologist-delivered intervention vs usual care on sun protection behavior. JAMA Dermatol. 2018;154(9):1010–6.
22. Williams AL, Grogan S, Clark-Carter D, Buckley E. Appearance-based interventions to reduce ultraviolet exposure and/or increase sun protection intentions and behaviours: a systematic review and meta-analyses. Br J Health Psychol. 2013;18(1):182–217.
23. McWhirter JE, Hoffman-Goetz L. Systematic review of population-based studies on the impact of images on UV attitudes and behaviours. Health Promot Int. 2015;30(2):397–410.
24. Henrikson NB, Morrison CC, Blasi PR, Nguyen M, Shibuya KC, Patnode CD. Behavioral counseling for skin cancer prevention: evidence report and systematic review for the US preventive services task force. JAMA. 2018;319(11):1143–57.
25. Lucas RM, Neale RE, Madronich S, McKenzie RL. Are current guidelines for sun protection optimal for health? Exploring the evidence. Photochem Photobiol Sci. 2018;17(12):1956–63.
26. Seité S, Del Marmol V, Moyal D, Friedman AJ. Public primary and secondary skin cancer prevention, perceptions and knowledge: an international cross-sectional survey. J Eur Acad Dermatol Venereol. 2017;31(5):815–20.
27. Lucas RM, Norval M, Wright CY. Solar ultraviolet radiation in Africa: a systematic review and critical evaluation of the health risks and use of photoprotection. Photochem Photobiol Sci. 2016;15(1):10–23.
28. Krutmann J, Bouloc A, Sore G, Bernard BA, Passeron T. The skin aging exposome. J Dermatol Sci. 2017;85(3):152–61.
29. Arnold M, Singh D, Laversanne M, Vignat J, Vaccarella S, Meheus F, et al. Global burden of cutaneous melanoma in 2020 and projections to 2040. JAMA Dermatol. 2022;158:495–503.
30. International Agency for Resaerch on Cancer (IARC). Cancer Today – Data visualization tools for exploring the global cancer burden in 2020 (Globocan 2020). 2020 [cited 2022 Mar 18]. Available from: https://gco.iarc.fr/today/home
31. Zhang W, Zeng W, Jiang A, He Z, Shen X, Dong X, et al. Global, regional and national incidence, mortality and disability-adjusted life-years of skin cancers and trend analysis from 1990 to 2019: an analysis of the Global Burden of Disease Study 2019. Cancer Med. 2021;10(14):4905–22.
32. Urban K, Mehrmal S, Uppal P, Giesey RL, Delost GR. The global burden of skin cancer: a longitudinal analysis from the Global Burden of Disease Study, 1990–2017. JAAD Int. 2021;2:98–108.
33. Arnold M, de Vries E, Whiteman DC, Jemal A, Bray F, Parkin DM, et al. Global burden of cutaneous melanoma attributable to ultraviolet radiation in 2012. Int J Cancer. 2018;143(6):1305–14.
34. Wu Y, Wang Y, Wang L, Yin P, Lin Y, Zhou M. Burden of melanoma in China, 1990–2017: findings from the 2017 global burden of disease study. Int J Cancer. 2020;147(3):692–701.
35. Li H, Colantonio S, Dawson A, Lin X, Beecker J. Sunscreen application, safety, and sun protection: the evidence. J Cutan Med Surg. 2019;23(4):357–69.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Passeron T, Lim HW, Goh CL, Kang HY, Ly F, Morita A, et al. Sun exposure behaviours as a compromise to paradoxical injunctions: Insight from a worldwide survey. J Eur Acad Dermatol Venereol. 2023;37:2481–2489. https://doi.org/10.1111/jdv.19421