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Sun protection practices in India: Preliminary findings from a nationally representative sample

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ABSTRACT

Sun safety research has mainly been conducted in the West, whereas little is known about sun protection practices in India. Using a survey design with a representative sample, we aimed to understand the frequency of sun protection practices in India. We also examined associations between demographic covariates and sun safe behaviours. We surveyed a representative sample ($N = 1560$) from the Indian population in November 2022. The study variables included sun safe behaviours, sunburn experience, demographic information, and skin tone. We employed descriptive and regression analyses to examine the prevalence of behaviours and their associations. To mitigate potential sampling biases, we applied poststratification weights in the analyses. More than half of the participants (64.2%) routinely performed at least one sun safe behaviour, with only 4.9% of the sample reporting no engagement with sun safe behaviours in the last 12 months. Physical protection (e.g., long sleeves, shade/umbrella) were more common than sunscreen use. Regression analysis showed that higher subjective social status, being younger, and living in one of the Eastern Indian states were the strongest predictors of sun protection practices. Our findings fill an important knowledge gap in global sun safe research, highlighting the urgent need for public sun safety education. Scalable and targeted interventions are needed to promote sun safety awareness and practices among people.

1. Introduction

Avoiding ultraviolet radiation is an effective way to prevent skin cancer. However, most sun protection research and interventions have been conducted in the West, with little focus on countries with populations of darker skin, such as India.

While pigmented groups are more resistant to ultraviolet radiation compared with people with lighter skin (Tadokoro et al., 2003), emerging evidence suggests that sun safe behaviours should be performed by everyone. For example, DNA damage induced by ultraviolet radiation has been observed in all types of skin colour (Tadokoro et al., 2003), and skin disorders, such as skin cancer, have a poorer prognosis among people of colour (Gloster and Neal, 2006). Thus, sun safe behaviours, such as sunscreen use and wearing clothing that protects from the sun, have been recommended for people of colour (Cestari and Buster, 2017).

India is the world's most populated country with a tropical climate, but sun safe practices among the public in India are largely unknown. Notably, the skin colour variation among Indians is remarkably larger compared with other populations (Del Bino and Bernerd, 2013; Iliescu et al., 2018). This distinction in colour variation suggests that Indians with fairer skin may be overlooked even though they are vulnerable to sun damage. While national epidemiological information on skin damage and skin cancer in India is limited, existing cancer registry data indicate regional differences in the incidence of skin cancer (Labani et al., 2021). Specifically, residents in the Northern, Northeastern, and Eastern states have reported higher incidences of skin cancer compared with other regions (Labani et al., 2021). Nonetheless, little is known about the prevalence of sun exposure and sun safe behaviours among nonclinical, public populations in India.

The purpose of this study was to investigate sun safe practices and sunburn experience in a nationally representative sample from India. We primarily examined how frequently Indians adopt sun safe behaviours recommended in the literature (Cestari and Buster, 2017), and what background variables are related to these sun protection practices. Previous studies in the Indian context and relevant research from other countries informed the inclusion of the study variables. While demographic variables have been found to be associated with sun safe

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Table 1
Unweighted descriptive results of demographic and sun safe behavioural variables in the general Indian population.

Variable	Frequency (%)
Mean age (range), years	39.25 (20–79)
Sex	
Woman	696 (44.6)
Man	864 (55.4)
Region	
Northern	411 (26.3)
Northeastern	65 (4.2)
Eastern	401 (25.7)
Western	256 (16.4)
Southern	427 (27.4)
Highest education level	
No formal education	19 (1.2)
Primary school	33 (2.1)
Secondary high school	243 (15.6)
Graduate	771 (49.4)
Postgraduate	494 (31.7)
Annual household income	
Less than 30,000 INR	274 (17.6)
30,000 to 99,999 INR	253 (16.2)
1,00,000 to 2,99,000 INR	402 (25.8)
3,00,000 to 9,99,000 INR	367 (23.5)
10,00,000 to 15,99,000 INR	136 (8.7)
16,00,000 to 29,99,000 INR	87 (5.6)
30,00,000 INR or more	41 (2.6)
Religion	
Hindu	1262 (80.9)
Muslim	170 (10.9)
Sikh	26 (1.7)
Christian	62 (4.0)
Jain	16 (1.0)
Buddhist	6 (0.4)
Other	18 (1.2)
Caste	
General Category (GC)	984 (63.1)
Other Backward Classes (OBC)	387 (24.8)
Scheduled Castes (SC)/Tribes (ST)	189 (12.1)
Sun safe behaviours (past year), mean	
Sunscreen use	2.99
Wearing a long sleeve shirt	3.25
Wearing a hat	2.84
Using shade/umbrella	3.03
Sunburn experience	2.23

behaviours (Buller et al., 2011; Holman et al., 2018), we also considered variables specific to the Indian context. The sun protection practices and beliefs of Indians could be influenced by religious and cultural traditions. For example, sun worship is an integral part of Hindu ritual tradition even in contemporary India. The ritual of making oblations to the sun with water in the morning, afternoon, and evening is a common practice among Hindus. During one such ritual, Brahmin men (i.e., upper caste among Hindus) face the sun and chant the Gayatri mantra (a highly revered sacred hymn to sun) wearing only a *dhoti* (a traditional lower garment) that exposes their upper body to the sun. Similarly, the caste system, a complex hierarchical social structure tied to concepts of purity and social status, is an integral aspect of the Hindu religion in India and is also prevalent among Abrahamic religious communities living in the Indian subcontinent. Thus, we included contextualised factors such as religion and caste given the scarcity of sun protection studies among Indians. Furthermore, regional differences of incidence of Indians' skin cancer have been observed (Labani et al., 2021). Thus, we included age, sex, region, education, income, religion, caste, and subjective social status as demographic variables. As a country with diverse skin pigmentation, previous studies conducted in India have also noted the association between skin tone and social status; in particular, lighter skin tones confer an elevated social status (Iliescu et al., 2018; Mishra et al., 2017). As people with sun-sensitive skin conditions tend to engage in more sun safe behaviours (Buller et al., 2011), we also included self-rated skin tone. Our findings fill an important knowledge gap in global health and can be used to inform Indian public sun safety education and policy making.

2. Methods

2.1. Participants and procedure

Recruitment of participants was facilitated by Rakuten Insight, drawing on their India-based research panel consisting of 1.6 million participants. Using a non-random stratified quota sampling method, the sample was constructed to be representative of the adult Indian population regarding sex, age, and region (based on the 2011 national census). A total of 3624 research panel members were approached to participate in the study, with 1560 qualifying for inclusion in the study. The rest of the panel members (n = 2064; 57.0%) either refused to participate or were disqualified for inclusion in the study due to quota fulfilment for a particular stratum. Participation was incentivised with points that respondents could redeem as vouchers for various sites and companies available in India. Table 1 summarises the demographic characteristics of the sample. Data were collected between 16 and 25 November 2022. The research was reviewed and approved by Indian Institute of Technology Delhi Ethics Committee (REF: 2021/P087).

2.2. Measures

The survey was conducted in English. The specific items are provided in the Supplementary Materials (Table S5).

2.2.1. Sun safe behaviours and sunburn

Five items were adopted from a previous sun safety study (Glanz et al., 2008), with four sun safe behaviours (i.e., sunscreen use, wearing a long sleeve shirt, wearing a hat, and using shade/umbrella) and one item about sunburn experience.

Sun safe behaviours were measured on a 5-point Likert scale (from 1 [*never*] to 5 [*always*]). To encapsulate seasonal variations across a year, the sun protection practices in the past 12 months were assessed. With an agnostic view on the contribution of each sun safe behaviour, a composite score based on the four behaviours was calculated using the method of Horst (1936) (see the Supplementary Materials: Table S2); higher scores indicate greater engagement with sun safe behaviours.

Sunburn experience in the past 12 months was measured on a 5-point Likert scale (from 1 [*never*] to 5 [*more than 6 times*]).

2.2.2. Skin tone

The Monk Skin Tone Scale (MST) was used to measure the participants' skin tone on a 10-color spectrum from dark to light (Monk, 2019). Higher scores reflect lighter skin tones.

2.2.3. Demographic covariates

As summarised in Table 1, the demographic covariates include age, sex, region (for categorisation, see the Supplementary Materials: Table S4), education, income, religion, caste, subjective social status (Adler et al., 1994).

2.3. Analytic plan

Multiple regression was mainly used to examine the relationships between sun safe behaviours and covariates. Specifically, the composite score generated from the four behaviours was used as the dependent variable, whereas skin tone and demographic covariates served as predictors. Box–Cox regression (Box and Cox, 1964) was further performed as a sensitivity test. Moreover, to match the demographic distributions in the Indian national census, poststratification weights were used in the analyses to mitigate potential sampling biases for age, sex, and region (see Table S1). The t-test, the chi-square (χ^2) test, and the Mann-Whitney U test were used for univariate comparisons. Only three missing data

Table 2
Multiple linear regression of the relationship between sun safe behaviours and covariates in the general Indian population.

Parameter	Unweighted				Poststratification weighted			
	B	SE	β	*p*	B	SE	β	*p*
Age	−0.12	0.02	−0.20	<0.001	−0.11	0.02	−0.19	<0.001
Sex	−1.18	0.41	−0.07	0.004	−1.38	0.40	−0.08	0.001
Region: North	2.16	0.55	0.11	<0.001	2.31	0.55	0.13	<0.001
Region: Northeast	1.22	1.05	0.03	0.246	3.12	1.10	0.07	0.005
Region: East	3.66	0.56	0.19	<0.001	3.63	0.62	0.18	<0.001
Region: West	1.59	0.64	0.07	0.013	1.93	0.70	0.08	0.006
Education	1.02	0.52	0.05	0.052	1.30	0.53	0.06	0.014
Income	0.56	0.15	0.10	<0.001	0.54	0.15	0.10	<0.001
Religion	−0.06	0.51	0.00	0.908	0.25	0.52	0.01	0.623
Caste: General Category (GC)	−0.99	0.64	−0.06	0.122	−0.39	0.65	−0.02	0.545
Caste: Other Backward Classes (OBC)	−0.08	0.71	0.00	0.912	0.59	0.72	0.03	0.408
Subjective social status	0.99	0.11	0.22	<0.001	0.95	0.11	0.22	<0.001
Skin tone	0.55	0.13	0.11	<0.001	0.49	0.13	0.10	<0.001
R^2	18.3%				16.0%			

Note. B = unstandardised coefficient. β = standardised coefficient. Sex: Man = 1, Woman = 0. Education: Post-secondary level = 1, secondary and below = 0. Religion: Hindu = 1, others = 0.

points were detected in the sun safe behaviours variable; listwise deletion was applied. A significance level of 95% was adopted for all statistical tests. Analyses were conducted with SPSS Statistics 28 and Stata 15.1.

3. Results

3.1. Description of sun safe behaviours

There were only 77 (4.9%) participants who had never performed any sun safe behaviours in the past year, dominated by men, $\chi^2_{(1)} = 5.93$, p =.015. Comparing across specific behaviours (i.e., non-never answers), wearing a long-sleeved shirt (87.4%) and using shade/umbrella (85.3%) were adopted more than sunscreen use (78.5%) and wearing a hat (78.2%). More than half of the participants (64.2%) routinely performed (i.e., *often* or *always*) at least one sun safe behaviour. Notably, 65.7% of participants reported a sunburn experience in the previous year.

Due to the folk costume culture in India, we examined sex differences based on the use of sun-protective clothing; there was a near-significant discrepancy ($t_{1555} = -1.76$, p =.079; Mann–Whitney $U = 283050.50$, p =.055). This finding suggests a potential sex effect in adopting clothing as a sun protection strategy. In other words, women were more likely to use sun-protective clothing than men, although the statistical significance is slightly lower than our criterion.

3.2. Variables associated with sun safe behaviours

As shown in Table 2, several parameters were significant predictors of the composite score of sun safe behaviours. More sun safe behaviours were related to a younger age, being female, a higher education levels, a higher income, a higher perceived social status, as well as lighter skin tone. Comparing all regions, living in the Northern, Eastern, and Western regions was associated with more sun safe behaviours.

These predictors remained significant when poststratification weights were considered. The Box–Cox regression results as well resulted in the same significance levels (see the Supplementary Materials: Table S3).

4. Discussion

Sun protection practices are commonly adopted by the Indian public, with 64.2% of the surveyed participants routinely performing at least one sun safe behaviour. This high percentage may be associated with the high education level (i.e., over 80% of the participants had received a graduate or postgraduate education) of our sample. A concerning finding is that 65.7% of the participants in our survey had been sunburnt, which is almost double the figure from a US national study (34.4%) (Buller et al., 2011).

Consistent with previous findings (Buller et al., 2011), sun protection practices are related to several demographic factors. Being older, male, less educated, as well as having a low income, and a low subjective social status, were inversely associated with sun safe behaviours.

Physical sun protection (e.g., clothing) was adopted to a greater extent than sunscreen use, consistent with previous findings from the US (Buller et al., 2011). Recent research suggests that multiple sun safe behaviours outperform shade seeking alone (Ou-Yang et al., 2017). This could potentially explain the high prevalence and co-occurrence of sun safe behaviours and sunburn experience in our results. Moreover, Indian women seemed to adopt sun-protective clothing to a greater extent, which was found to be a sun protection strategy more commonly used by men in the US (Holman et al., 2018). A future intervention could consider this potential sex difference in developing sun safety programmes.

We noted regional differences in both sun safe behaviours and sunburn experience. Partly consistent with previous registry data (Labani et al., 2021), participants living in Eastern and Northern India showed a higher risk for self-reported sunburn. More sunburn experiences in the lower strata of the Indian caste system may indicate insufficient sun safety recourses and knowledge.

The association between skin tone and sun safe behaviours is worth noting. Colourism, the caste system, and economic status have historically been interwoven in India (Ayyar and Khandare, 2013). Lower castes were often exposed to outdoor labour: they formed the working classes of Indian society and were poor, relegated to menial tasks, and lacking education. Higher castes, on the other hand, possessed a higher income and more education and thus could avoid working outdoors. This division of labour subsequently led to the linking of caste and colourism, assigning lighter skin tones to the higher castes and darker skin tones to the lower castes (Mishra et al., 2017). With the advent of European colonisation in India, notions of white supremacy reinforced the connection between lighter skin tone and higher social status among Indians (Jablonski, 2012). Interestingly, we found that, although religion and caste affiliations showed little correlation with sun safe behaviours, subjective social status, income, skin tone, and education – variables that are closely related to social status – remained significant in the model. One possible reason for these nonsignificant relationships is emerging and competing beliefs and lifestyles in contemporary India that are overcoming traditional ideas, such as religion and caste. However, in-depth research is needed to unpack these intricate connections.

Although our findings using a self-reported methodology require further triangulation (e.g., dermatological inspection), our preliminary

results highlight the urgency for preventive work in India. Based on the elevated sunburn prevalence, we urge Indian health authorities and health practitioners to establish stronger sun safety preventive programmes. Serious academic and practical attention are needed. Future studies could probe and map sun protection awareness and practices in local contexts. Given that the vulnerable cohort is featured among lower social classes/castes, wider and scalable population-based sun safety interventions are warranted (Geller et al., 2018). Our study also calls for more future sun safety studies that consider the colourism perspective.

CRediT authorship contribution statement

Xiang Zhao: Conceptualization, Formal analysis, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Yashpal Jogdand:** Data curation, Investigation, Methodology, Project administration, Resources, Writing – review & editing. **Preeti Sharma:** Investigation, Writing – review & editing. **Sammyh Khan:** Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102420.

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