Sun Exposure Knowledge, Attitudes, Habits, and Practices among Medical Students: Impact and Analysis of an Educational Intervention

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Abstract

Background: Sunlight exposure is linked to nevi and skin cancers, with UV radiation identified as a key environmental carcinogen since the 1960s. Skin cancer rates have risen globally, with UV exposure as the main risk factor, and the WHO reports millions of cases annually. Behavioral changes could prevent 80% of cases, highlighting the need for public awareness and sun protection education, particularly among youth and young adults. Studies show varying levels of knowledge and practices worldwide, emphasizing the need for targeted health promotion programs to improve sun protection behaviors.

Objective: It aimed to evaluate the knowledge, attitudes, and practices related to sun exposure among medical students, as well as to assess the impact of an educational intervention on their understanding and behaviors regarding sun protection.

Methods: This study was conducted at CMH Lahore Medical College from October 2024 to January 2025. The design was exploratory with pre-post intervention, using a sample size of 110, and data collection included demographic information, sun exposure behaviors, attitudes, and knowledge, validated through reliability and validity tests.

Results: Of the 110 students enrolled, 106 completed both pre- and post-intervention assessments. Participants were primarily aged 17-20 years. A significant improvement was observed in sun exposure habits (p=0.050), while sun protection knowledge, overall practices (p=0.060), and attitudes (p=0.329) showed no significant change.

Conclusion: The results indicate a substantial need for the development and implementation of health promotion interventions targeting skin cancer prevention.

Keywords: *Medical students, sunlight, exposure, intervention, knowledge, habits.*

INTRODUCTION

Exposure to sunlight is a major risk factor for nevi and skin cancers, influenced by both personal and environmental factors. Since the 1960s, UV radiation has been recognized as a carcinogen, with research identifying associated DNA mutations and signaling disruptions [1]. The global incidence of melanoma and nonmelanoma skin cancers continues to rise, with UV exposure as the primary cause. Importantly, behavioral changes could prevent up to 80% of skin cancer cases [2].

Skin cancer—including melanoma, basal cell carcinoma, and squamous cell carcinoma—is among the most frequently diagnosed cancers worldwide, leading to rising healthcare costs and reduced quality of life [3, 4]. According to the WHO, 2-3 million non-melanoma and 132,000 melanoma cases occur annually, and in the U.S., 1 in 5 individuals is expected to develop skin cancer during their lifetime [5]. Prevention through sun avoidance and photoprotective practices is therefore critical, emphasizing the need for public education on UV risks and protective strategies [6-8].

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Youth are particularly vulnerable to UV exposure, receiving higher cumulative doses than adults, and thus early education is essential [9, 10]. Studies from Ecuador and Florida have shown the importance of awareness campaigns, with some parents holding misconceptions about tanning and sunscreen use [10].

Despite the effectiveness of school-based interventions [11], few studies focus on university students. Research from Spain and the U.S. highlights persistent risky behaviors despite good knowledge of sun exposure [12, 13]. In Turkey, students demonstrated satisfactory knowledge across socioeconomic backgrounds, yet struggled to adopt consistent protective habits [1].

An international study across 25 countries revealed that 57.2% of university students preferred sunbathing, with only 48.1% using sun protection—behaviors influenced by age, gender, financial status, and skin tone [8]. In the UK, students continued unsafe practices despite awareness, influenced by peers, family, and media [14].

In South Asia, an Indian study showed lower awareness of sun protection compared to Western populations [15]. Similarly, in Pakistan, studies revealed gaps between awareness and proper sunscreen use, even among regular users [16]. While Pakistani medical students are aware of UV risks, adherence to sun-safe practices remains low [5].

Given the key role of medical students as future health educators, this study aimed to assess their knowledge, attitudes, and behaviors regarding sun exposure and evaluate the impact of a brief educational intervention at CMH Lahore.

MATERIALS AND METHODS

The project was designed as an exploratory Quasi-experimental study conducted at CMH Lahore Medical College from October 2024 to January 2025. The ethical approval from CMH Lahore Medical College & Institute of Dentistry was duly taken (Case #.65/ERC/CMH/LMC). The inclusion criteria for participants comprised medical and dental students, while the exclusion criteria eliminated non-medical students, individuals who declined to provide consent, and those with a diagnosed skin disorder. A total of 150 participants who met the inclusion criteria were selected for the study. To ensure objectivity, a simple random sampling method was utilized, based on the students' roll numbers generated through a computer program. Sample size was determined using the Yamane formula (1) [17] for finite populations:

(1) $$n = \frac{N}{1+N(e^2)}$$

Where:

- *n* = sample size
- N = population size = 150
- *e* = margin of error = 0.05 (5%)

Substituting the values:

$$n = \frac{150}{1 + 150(0.05^2)} = \frac{150}{1 + 0.375} = \frac{150}{1.375} \approx 109.1$$

The final sample size was rounded up to 110 participants.

The study participants completed a questionnaire following the provision of written informed consent, which was included alongside the questionnaire. The study participants completed a questionnaire after providing written informed consent, which was attached alongside the survey. Data were collected in two phases using a self-administered questionnaire: baseline data were collected on the same day before giving the intervention, and post-intervention data were collected after the completion of the two-week intervention. The intervention lasted two weeks and included a 60-minute educational video covering topics such as sunlight exposure, associated risk factors, and sun protection methods. Additionally, written materials—including PDF files and infographic posters displayed in classrooms—were provided. During the two weeks, students were encouraged to review these materials. At the end of the two weeks, the same questionnaire was re-administered to evaluate changes in knowledge, attitudes, and practices.

We used a 41-item structured questionnaire adapted, with permission, from the CHACES (Comprehensive Health and Activity-related sun-Care Evaluation Scale) questionnaire described by Blázquez-Sánchez *et al.* [11]. Items were grouped into the following categories: 1) Consent form, 2) Demographic information, and 3) Requested details (segmented into four key areas: knowledge, attitudes, habits, and practices, concerning sun exposure). These categories are structured to explore the following aspects:

a. Consent form (1 item).
b. Demographic information (7 items: Gender, Age, Marital Status, Country of Birth, Place of residence, Year of medical education, and Discipline).
c. Skin tone (1 item): shade of unexposed skin (4 response options).
d. Fitzpatrick skin classification (1 item with 6 response choices).
e. Understanding of sun exposure (Knowledge) (10 items): Ten core principles linked to sun exposure and skin cancer are evaluated through true or false responses.
f. Sun exposure attitudes (10 items): Attitude is described as a lasting positive or negative sentiment. Views on sun exposure and protection are investigated across three aspects: health, cosmetic significance, and enjoyment/leisure. Participants provide feedback using a 5-point Likert-type scale.
g. Sun exposure habits (5 items): Sun exposure habits are evaluated in two contexts: leisure activities like sunbathing at the beach or pool, and outdoor sports or recreation. The questionnaire asks about the frequency and duration of sun exposure per day and per year (using 4 response options), as well as the number of days per year of sun exposure at work (4 response options). Sunburn occurrence within the past year (1 item, with 2 response options): Sunburn is defined as experiencing redness and discomfort following sun exposure.
h. Sun protection practices (6 items): The questionnaire assesses adherence to six sun protection practices recommended by the World Health Organization, including seeking shade, wearing sunglasses, hats or caps, long sleeves or pants, avoiding peak sunlight hours (11:00 to 17:00), and using high-SPF (Sun Protection Factor (SPF) of 30 or above) sunscreen. Likert-type scales with 5 response options are utilized. Additionally, respondents are asked to indicate the sun protection factor (SPF) of the sunscreen they typically use (5 categories).

Test-retest absolute agreement for the adapted instrument exceeded 60% [11]. Internal-consistency reliability (Cronbach's α) ranged 0.45-0.80 across domains, except for knowledge (α = 0.335) [11]. The full questionnaire (item wording, coding keys, scoring instructions) is provided as Supplementary File **S1** to enable independent verification and re-calculation.

The data collected was analyzed using SPSS software (version 29.0), which involved descriptive analysis to gather means, frequencies, and standard deviations, providing insight into the demographic characteristics of the participants. Frequencies and percentages were calculated for categorical variables. For comparing paired categorical variables (*e.g.*, knowledge and habits before and after intervention), McNemar's test was used. For quantitative variables such as practice and attitude scores, paired t-tests were applied. The normality assumption was assessed prior to analysis using the Shapiro-Wilk test, and both variables met the assumption of normality, justifying the use of paired t-tests for comparison. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 110 students were recruited using randomly generated roll numbers. In the pre-education phase, all 110 provided verbal consent and participated. However, only 106 students completed the post-education phase. To ensure consistency in paired analysis, the four students who did not complete the post-intervention questionnaire were also excluded from the pre-intervention data, resulting in a final analysis sample of 106 participants.

Participants were primarily aged 17-20 years. All were single, and the distribution between the MBBS and BDS disciplines remained consistent. Demographic characteristics are presented in Table **1**.

Table 1: Summary of participants' demographics.

Variable	Groups	Frequency (%)
Age	17-20 years	78 (73.6)
	20-23 years	28 (26.4)
Gender	Males	31 (29.2)
	Females	75 (70.8)
Relationship status	Single	106 (100)
	Married	0 (0)
Discipline	MBBS	51 (48.1)
	BDS	55 (51.9)
Year of education	1st Year	55 (51.9)
	2nd Year	51 (48.1)

The majority of participants had intermediate skin color and fell into Fitzpatrick skin types II and III. There were minimal changes in the distribution of skin color and Fitzpatrick skin types over the study period (**Table 2**).

Table 2: Skin color and phenotype (Fitzpatrick).

Variable	Groups	Frequency (%)
Skin color	Very pale	3 (2.8)
	Pale	34 (32.1)
	Intermediate	68 (64.2)
	Dark	1 (0.9)
Fitzpatrick skin type	Ivory/Pale (type I)	9 (8.5)
	Fair/White (type II)	40 (37.7)
	Light Brown (type III)	32 (30.2)
	Moderate Brown (type IV)	25 (23.6)
	Dark Brown (type V)	0 (0)
	Dark Brown to Black (type VI)	0 (0)

Knowledge about sun exposure remained largely unchanged between phases. The only area approaching significance was an increase in correct responses on the need for extreme sun protection when the UV index exceeds 3, but it was not significant (p=0.505) (**Table 3**).

Table 3: Knowledge concerning sun exposure.

Questions	Pre-phase (n=106) correct responses) n (%)	Post-phase (n=106) (correct responses) n (%)	p-value
Using UV-A tanning cabins before age 30 increases the risk of melanoma (True)	87 (82.1%)	86 (81.1%)	0.305
UV radiation causes your skin to age more quickly (True)	98 (92.5%)	94 (88.7%)	0.670
Being in the shade means we are not at risk of the effects of (solar) radiation (False)	63 (59.4%)	61 (57.5%)	0.765
Using sunscreens is the most appropriate way to protect yourself from the sun and prevent skin cancer (True)	20 (18.9%)	19 (17.9%)	0.305
Once the skin is tanned, it is not necessary to use sunscreen (False)	88 (83.0%)	79 (74.5%)	0.728
Babies under 1 year old should not be directly exposed to the Sun (True)	80 (75.5%)	79 (74.5%)	0.845
It is necessary to use extreme sun protection measures when The UV index is above 3 (True)	92 (86.8%)	96 (90.6%)	0.505
Dark clothing protects from the Sun more than light clothing (True)	20 (18.9%)	32 (30.2%)	0.984
It is recommended to get at At least one hour of sun exposure per day (to ensure adequate vitamin D levels (False)	23 (21.7%)	13 (12.3%)	0.898
Children should use sunscreens with an SPF of 30 or higher (True)	68 (64.2%)	79 (74.5%)	0.435

* p-value significant at p<0.050, ** p-value significant at p <0.010
McNemar's test analysis of matched pre-post responses showed an insignificant change in knowledge

Paired t-test analysis showed no significant differences in sun exposure practices (p=0.060) or attitudes (p=0.329) between phases, indicating the intervention had no substantial impact (**Table 4**).

Table 4: Practices and attitudes towards sun exposure; pre-post mean comparison.

Variables	Groups	Mean (S.D.)	Mean difference (S.D.)	T	df	p-value
Sunlight Exposure Practices	pre-phase	2.9485	0.2095	1.896	105	0.060
	post-phase	2.7390				
Sunlight exposure Attitudes	pre-phase	2.7406	0.051	0.980	105	0.320
	post-phase	2.6896				

Paired t-test analysis of mean scores for pre-post education phases showed insignificant differences in Sun Exposure Practices and Attitudes

Table **5** shows no significant changes in most sun exposure habits between phases, except for a significant change (p=0.050) in hours spent on outdoor sports or leisure activities, suggesting a possible behavioral shift post-intervention.

Table 5: Habits concerning sun exposure; pre-post comparison.

Questions	Categories	Pre-phase (n=106) n (%)	Post-phase (n=106) n (%)	p-value
How many days a year do you expose yourself to the sun (sunbathing) while engaging in outdoor activities?	Under 5 days or 6-30 days	40 (37.7)	62 (58.5)	0.445
	31-90 days or >90 days	66 (62.3)	44 (41.5)	
Sunbathing (hours per day)	None or 1-2 hrs	88 (83.1)	92 (86.8)	0.998
	3-4 hrs, 5-6 hrs, >6 hrs	18 (16.9)	14 (13.2)	
Sports or leisure activities outdoors (days per year)	Under 5 or 6-30 days	76 (71.7)	80 (75.5)	0.721
	31-90 or >90 days	30 (28.3)	26 (24.5)	
Sports or leisure activities outdoors (hours per day)	None or 1-2 hrs	94 (88.7)	84 (79.2)	0.050*
	3-4 hrs, 5-6 hrs, >6 hrs	12 (11.3	22 (20.8)	
I've experienced sunburns previously	Yes	44 (41.5)	32 (30.2)	0.779
	No	66 (58.5)	74 (69.8)	

* p-value significant at p≤0.05

McNemar's test analysis of matched pre-post responses showed only one significant difference in sun exposure habits

DISCUSSION

The research identified key factors in health data collection and health promotion, particularly regarding sun exposure knowledge, attitudes, and behaviors. While participant distribution remained generally consistent across the pre- and post-intervention phases, there were minor variations in age and gender representation. Younger participants showed greater engagement by more actively completing the questionnaires and participating in the intervention activities. Similarly, female participants were more responsive and consistent in their participation compared to males, who showed comparatively lower interest.

Men exhibited lower awareness of sun care, used fewer protection methods, and reported more frequent sunburns, indicating a need for targeted health promotion. In contrast, women had better knowledge and used more protective measures, but valued tanning more, suggesting attitudinal barriers. Patel *et al.* [18] found similar trends, with 42% of females *versus* 28% of males reporting they sunburn easily without sunscreen. Women also reported greater use of sun protection methods like sunscreen, shade-seeking, and umbrellas [18].

The study found that younger participants engaged more than older ones, highlighting the need for targeted health campaigns that address knowledge gaps and attitudes in young adults. Older students reported lower sun exposure and used fewer protection methods, highlighting the importance of promoting sun protection knowledge, as sunscreen use can reduce actinic keratoses in aging skin.

Sun care advice was often based on self-assessed skin type, which may lead to misinterpretation of risk. A study found similar results, with young adults self-reporting sun protection behaviors [19]. Another study noted differing attitudes toward skin cancer risk based on skin color, with some recognizing a higher risk for lighter skin, while others saw no difference [20].

The only statistically significant pre-post change was in hours spent on outdoor sports or leisure activities (p = 0.050), which may reflect increased awareness of sun exposure risks and a behavioral shift toward safer sun practices, rather than a decline in overall physical activity. Similar studies have shown modest, but not always significant, improvements with tailored sun safety counseling [21]. No major behavioral changes were observed in sun exposure habits, sunbathing, or past sunburns. Health initiatives should emphasize the use of sunscreen in conjunction with shade-seeking and sun avoidance. A related study found high knowledge but low risk perception, with greater regret linked to skin cancer than sunburn, and continued preference for tanned skin [22].

The data on sun exposure knowledge showed no statistically significant differences between pre- and post-phase groups. However, trends suggest possible improvements in awareness of dark clothing protection, sun exposure risks for babies under one year, the necessity of extreme protection when the UV index is above 3, and SPF 30+ sunscreen use for children. A study found that parents who received counseling improved sun protection strategies for newborns, though the clinical significance was unclear [21].

Previous studies have found that shade-seeking behaviors tend to score lowest among sun protection habits, particularly in younger populations. For example, Arizona's sun-safety program was effective in improving UV protection behaviors among students [22, 23]. While

some literature also discusses the role of parental influence in earlier age groups [24], the focus of our study remains on independent behaviors in young adults.

Declines in knowledge about UV radiation's role in skin aging, sunscreen efficacy, and vitamin D needs were observed, but not statistically significant. In Palm Beach, only half of the students regularly sought shade, whereas 64.5% of males in another study reported that they would increase their use of sunscreen to prevent aging [24, 25].

Paired t-test analysis showed slight decreases in sun exposure practices (mean difference: 0.2095) and attitudes (mean difference: 0.0510), but neither change was statistically significant, suggesting the intervention had minimal impact.

This should explore the significance of the results of the work, present a reproducible procedure, and emphasize the importance of the article in the light of recent developments in the field. Extensive citations and discussion of published literature should be avoided.

LIMITATIONS

This was a single-center study without a control group, which limits the ability to draw causal inferences. Future research should consider incorporating a control group to strengthen the internal validity of the findings. Additionally, reliance on self-reported data may have introduced recall and social desirability bias, potentially affecting the accuracy of reported behaviors. The short follow-up period may also have been insufficient to capture lasting behavioral changes; thus, longer-term studies with repeated assessments are recommended to better evaluate sustained impact.

While the intervention was intentionally brief and primarily educational in nature, participation was tracked through roll numbers and completion of pre- and post-intervention questionnaires. However, we acknowledge that the passive format may have limited participant engagement and behavioral change. Future studies should explore more interactive, personalized, and sustained interventions to improve effectiveness.

Despite these limitations, the study offers valuable insights and identifies key areas for improving sun safety interventions.

CONCLUSION

The research highlights the need for continuous health promotion interventions to address skin cancer prevention. Children, adolescents, and adults remain at risk due to inadequate knowledge and behaviors regarding sun exposure. While formal counseling and tailored educational tools can positively influence attitudes, modifying sun exposure behaviors remains challenging. The media plays a crucial role in spreading sun safety awareness, and regular skin checks are essential for early melanoma detection. Personalized counseling is beneficial but varies in effectiveness based on socioeconomic factors. Long-term monitoring and global studies are necessary to assess evolving trends and develop effective interventions for sustained behavior change.

ETHICS APPROVAL

The ethical approval from CMH Lahore Medical College & Institute of Dentistry was duly taken (Case #.65/ERC/CMH/ LMC). The study procedures were in line with the institutional ethical standards for human experiments and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all study participants prior to their inclusion in the study.

AVAILABILITY OF DATA

Data files may be made available on request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

IM: Conceptualization, study design, literature review, manuscript drafting, Statistical analysis, and overall coordination of the project.
SMI: Study design, methodology development, data collection supervision, and critical revision of the manuscript.
FI: Statistical analysis, interpretation of results, visualization of findings, and manuscript editing.
OURK: Drafting assistance and final review of the manuscript.
All authors have read and approved the manuscript.

SUPPLEMENTARY MATERIAL

Supplementary material is available on the journal's website.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the authors limitedly used ChatGPT (GPT-4, OpenAI) to get language suggestions and do minor proofreading in some parts of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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