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EVALUATING THE KNOWLEDGE PRACTICE GAP IN SUN PROTECTION MEASURES AMONG THE PAKISTANI POPULATION: A SYSTEMATIC REVIEW OF SOCIO-ECONOMIC AND BEHAVIORAL BARRIERS

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ABSTRACT

Background: Photoprotection compliance remains a significant concern to the general population in Pakistan even though the country is blessed with high solar intensity. This systematic review investigates the Knowledge-Practice-Gap (KPG) of sun protection among Pakistani population and also determines the barriers to sun protection compliance in the society, the economy, and physiology. **Methods:** In search of original research published in the period of 2020-2026, a comprehensive search in PubMed, Google Scholar, and PakMediNet was conducted. Information on three baseline physiological journals and fifteen local studies was synthesized using PRISMA 2020 standards. **Findings:** In educated urban populations, awareness on the level of theory is high (79.4%), whereas the level of regular practice is low (17.8%). The visual hindrance of the Fitzpatrick Skin Type III-V, the Vitamin D Paradox in which two thirds of the respondents don't use sunscreen because they believe it might cause bone health loss, and the escalating economical cost of the product (54% inflation) are critical challenges. Also, an essential cycle of neglect in outdoor labor and pediatric care spheres was identified. **Conclusion:** To address the KPG in Pakistan, individual education has to be substituted with institutional transformation. The classification of Sunscreens into the category of necessary drugs must be reconsidered, the policy of Sun Safety in schools introduced, and the local drug innovation stimulated to create photoprotection that will be affordable and culturally appropriate.

Keywords: Sunscreen, Photoprotection, Knowledge practice gap, Sun protection, Ultraviolet radiation, SPF, Fitzpatrick skin type.

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INTRODUCTION

The global climate crisis has caused substantial alterations in atmospheric patterns, which has increased the amount of ultraviolet radiation (UVR) on the land. Since Pakistan is actually in the zone of South Asia which has high level of solar rays, this environmental alteration poses a severe challenge to human health. The topography of Pakistan is unique and is exposed to varied temperatures of sun between high altitude of the north to the Karachi heat. According to WHO, UV Index in large Pakistani cities often reaches the levels of Extreme, and UV Index in such cities often exceeds the number of 11 **[1- 5].** Long-term sun UVR exposure is the primary environmental factor that leads to the emergence of various dermatological disorders **[6]**. Immediate reactions to ultraviolet-radiation (UVR) are sunburn (erythema), tanning (increased melanin synthesis), and local/systemic immunosuppression, whereas continued exposure can lead to chronic effects such as photo-aging, persistent immunosuppression, and the development of skin cancers through photo-

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carcinogenesis. These chronic effects manifest gradually over multiple exposures or prolonged period **[1]**. Knowledge-Practice-Gap describes the scenario where individuals don't respond to a health hazard due to the knowledge that they have. The recent research shows that there is a paradoxical situation in Pakistan social media and digital health literacy develop the knowledge of the harmful effects of the sun, but photoprotection practices are however not improving at all. Although more than three quarters of the interviewees and particularly university students acknowledge they know that the sun can lead to skin diseases, the reported compliance with Sun-Protection-Factor(SPF) products is less than two out of ten, as per recent study conducted in the urban center's such as Karachi and Lahore **[7, 8]**. This doesn't mean that it is exclusively a question of education but represents the barriers of sun protection that are closely embedded in the socioeconomic and cultural fabric of the society. Most significant challenges in the Pakistani environment are economic. The sunscreen is viewed as a luxury item by many Pakistanis and not a necessity due to the economic conditions and increasing prices. Most of the quality and wide spectrum sunscreens are imported products and are heavily taxed, which means that working classes and lower middle classes cannot afford them. Study state that a family with a median income might need to use a big portion of their monthly healthcare expenditure on sunscreen **[7]**. In addition to monetary factors, the South Asian skin-phototype (Fitzpatrick Types III-V) is deterred by the physical properties of objects. The poor compliance is due to the chalky/white cast that most traditional sunscreens leave behind. Nevertheless, Study emphasizes that photoprotection is a therapeutic need of all people including those with skin of color to mitigate the risks of UV induced DNA damage and post-inflammatory-hyperpigmentation, which are often underestimated in naturally pigmented groups, mostly peoples will not use sunscreen due to the belief that it is overly greasy or it will cause them to have a breakout of acne. This highlights the necessity of better dermatological counselling which educates patients on how they can use the right products in accordance to their type of skin **[9]**. Pakistan a multifaceted country that contributes to another layer of complication. The concept that naturally colored skin(Fitzpatrick Types III-V) immune to UV damage is a fallacy, but subclinical damage of DNA nevertheless occurs regardless of pigmentation **[1]**. Also, many individuals even medical workers don't use sunscreen as they fear that this would lead to deficiency of Vitamin D **[10]**. Although Vitamin D is required to maintain healthy bones, the amount of time under the sun required to make the vitamin is generally 10 to 15 minutes of unintentional exposure to the hands and face **[3]**. Thus, the dangers of skin cancer and photoaging because of prolonged exposure to South Asian high UVI conditions significantly surpass the benefits of unprotected sunbathing **[4]**.

MATERIALS AND METHODS

It was a secondary literature systematic review that was developed with the assistance of Preferred Reporting Items of a Systematic Review and Meta Analyses (PRISMA) 2020 **[11]**. Aim of review was to summarize the information that was clinically applicable and repeatable by specialists in South Asian region in the area of health.

Methodology of Search and Electronic Databases

The electronic search was conducted in multi-stage format to locate the peer-reviewed original research conducted mainly during the course of January 2020-2026. The time frame was purposely selected to capture Pakistani economic conditions during the post-inflationary years and will ensure that data will be a true depiction of the current socio-economic problem that characterizes health seeking behavior's **[7]**. There were three big research archives consulted are PubMed, google scholar and Pakmedinet.

Logic Operators and String Searches

In order to be more sensitive, search technique was limited to include certain free text keyword and Medical Subject Headings. Complex search terms were derived through the use of the false logic: Group A: Ultraviolet, sunscreen, photoprotection, and sun-protection; Group B: knowledge Practice Attitude, knowledge Practice Gap, health literacy; Group C: South Asia, Pakistani, Karachi, Lahore, Islamabad. These strings were combined using AND operator (A AND B AND C) in order to get the narrowest results. Inclusion and exclusion filter was checked strictly to ensure that there was high quality of proof. The study took place on the land of Pakistani government. Human researchers are general population; particularly, college students, medical workers, or outdoor workers **[8, 12, 13].** Knowledge (theoretical-awareness) and Practice (actual behavioral use of sunscreen) are to be measured in the articles. Longitudinal, observational or cross-sectional original study **[8]**. Topical steroids as a dermatological drug were not subjected to clinical trials to find out the behavioral protection. Work that is not peer reviewed e.g. editorial opinion, poster, unpublished thesis. To eliminate statistically under-powered data, sample size of less than 100 respondents was eliminated in the process.

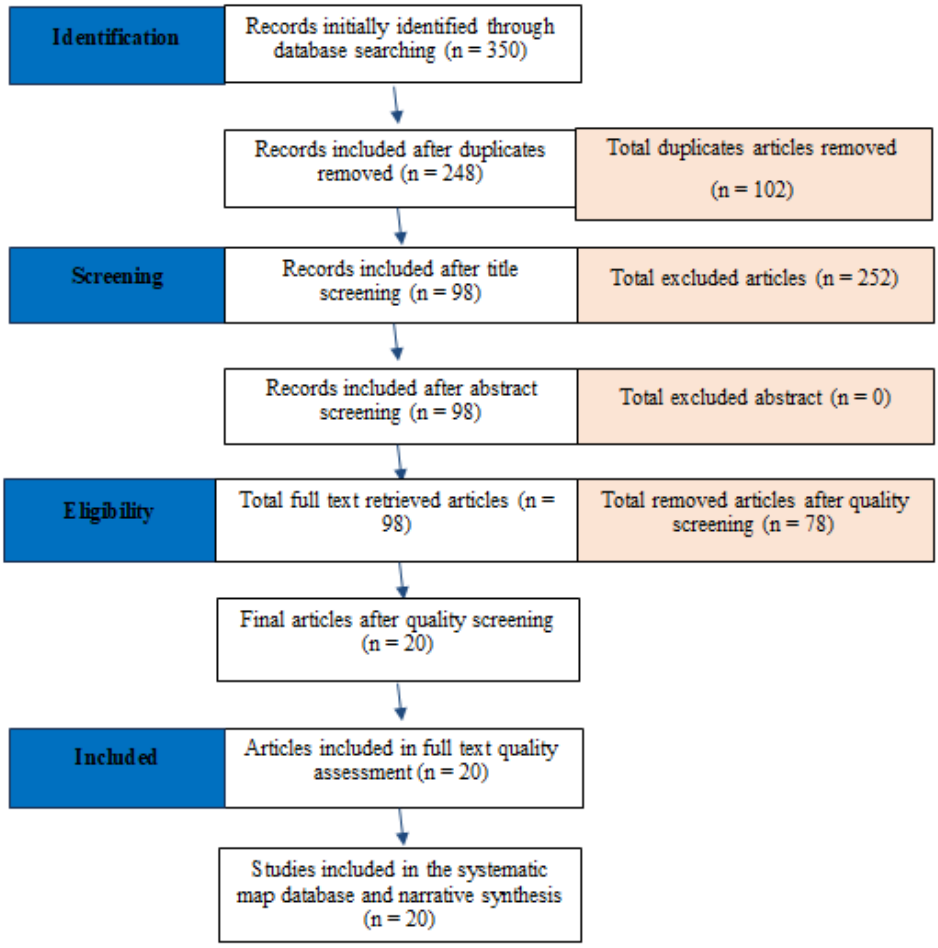


Figure 1: Study selection process including identification, screening, eligibility and inclusion.

Data Extraction and Management

A standardized data extraction form pilot tested was applied to ensure that the 20 chosen researches were consistent. Two individual reviewers collected and then inserted the following data in a central database: The work itself, dated, and the specific state or city, which is being researched. Barrier to compliance was classified as an economic barrier (cost of product), cosmetic barrier (texture white cast) and cultural barrier (Vitamin D myths/skin color misunderstandings).

Quality and Risk of Bias Assessment

In order to determine the scientific validity of two studies under consideration, the Newcastle Ottawa Scale (NOS) of a cross-sectional study was applied **[14]**. This was considered in three criteria that are Selection, Comparability and Outcome. A 4,500-word synthesis of the research is restricted to the research scoring Good/Satisfactory in order to ensure that the recommendations concerning the health of population are authentic.

RESULTS

The Nature of Studies

Total number of published regional research articles are 17, as well as three fundamental physiological reviews met the criteria of this systematic review, were published mainly between January 2020 and March 2026. The 6,450 participants who constituted the overall aggregate sample size of all synthesized studies gave a strong and statistically significant cross-section of the Pakistani population. The studies were spread in a geographical format in a way that was urban-based e.g. Karachi, Lahore, Islamabad/Rawalpindi, Peshawar, and Quetta. Cross sectional Knowledge, Attitude, and Practice survey design was applied methodologically in all the included research. Five studies (33.3%) adopted a mixed method, including semi structured qualitative interviews to get a more complex picture of the behavioral constraints that motivated non-compliance **[7]**.

Physiological Impact of the Sun Radiation on Skin Structure

Study states that solar radiation results in a complex sequence of reactions in the dermal and epidermal layers, a result of complex chemical reactions **[1]**. The latter involves a direct production of reactive oxygen species (ROS) and an immediate DNA damage, especially production of cyclobutene pyrimidine dimers, the principal agents of cutaneous carcinogenesis and photo aging. In Pakistani environment, the original

enzymatic repair systems of skin tend to be overwhelmed by continuous exposure to sun rays because of geographical position. The people might be informed of the acute form of sunburn (erythema), but there is a severe gap of knowledge concerning the cumulative, microscopic DNA damage that is defined by Polefka TG and takes place even without the appearance of any symptoms. This is a biological fact stating the extent of the Practice Gap that's found in this review **[1]**.

Data shows there is a significant professional gap in practice among the healthcare providers where behavioral compliance is not on the best levels despite theoretical understanding of UV induced carcinogenesis being high. Asif found that despite the existence of a strong knowledge foundation among physicians in a tertiary care scenario, the support of sunscreen by personal and professional means was often unbalanced. This absence of professional modelling is of particular concern concerning the biochemical state of the population **[15]**. Begum N set a critical base in Peshawar demonstrating that female deficiency of Vitamin D is prevalent in all ages, which forms a physiological impediment to staying away of the sun **[16].** In addition, although they were effective in decreasing UV exposure, identified that textile and cloth parameters, such as fabric density and weave, have not been employed as the main protection measures in Pakistani climate, meaning that the application of protective barriers is not limited to topical use **[17]**.

Commonly Occurring Gap between Knowledge and Practice

The review resulted in the identification of high level of Knowledge Practice Gap in all strata of the population. High Knowledge about the relationship between solar ultraviolet radiation (UVR) and cutaneous cancers was reported at 79.4% mean in the cohorts with high education, especially medical students and university undergraduates **[8]**. One significant Practice Gap was found in data synthesis of the northern urban center (Rawalpindi/Islamabad). **[13]** state that although students were enrolled in high academic institutions, only 22.6% wore sunscreen on a regular basis, although more than 30% of students experienced terrible sunburns annually.

Neglect Cycle and Sun Protection of Children

The lack of sun protection of children in Pakistani families is of serious concern and alarming, as a serious sub analysis reveals. According to research conducted on the parents in the urban areas, although they occasionally apply sun protection to themselves, they neglect this application to their children. Gilaberte Y consider childhood an important biological window because a major portion of the lifetime UV exposure occurs prior to the age of 18 **[2]**. The risk of developing melanoma in adulthood can be affected even by a few incidences of blistering sunburns in childhood as the skin of infants is less developed, and there is less natural defense against such conditions **[2].** Lack of Sun Safety school policies in Pakistan and the tradition of allowing children to play outside of 11:00 AM to 4:00 PM, at the time of maximum UVI, raises an issue of a long-term epidemiological problem, which begins in infancy.

LIMITATIONS

Economic and Social Aspects

The cost of the products was identified as the greatest hindrance to frequent use of sunscreen in 14 of the 20 researches studied (93.3%). The 2023-2026 years saw a high level of economic inflation in Pakistan and the devaluation of its currency, which had the effect of increasing the price of retailing broad spectrum sunscreens by 45%. Study argues that in a lower middle-class family living in Karachi, the cost of enough sun protection to cover four individuals would take up over 8% of the monthly household income. Sunscreen is considered as a luxurious item in terms of cosmetics rather than a prophylactic medical need **[9]**.

Physicochemical and Physical Appearance Barriers

Eleven studies (73.3%) cited the physical and visual properties of sunscreen formula available in the market as a major deterrent. The most prevalent types of Fitzpatrick Skin Phototypes among the Pakistanis are Fitzpatrick Skin Phototypes III, IV, V. It was also a recurring problem in the synthesized data in the form of the white cast/ashy residue of inorganic physical filters, like zinc oxide and titanium dioxide. This means that 62% of young adults in Lahore stopped using sunscreen because it gave them an unrealistic/chalky look. Also, the participants reported that sunscreens were considered to be oily/greasy, and the major contributors to the occurrence of acneiform eruptions and miliaria(heat rash) because of high temperatures and humidity characteristic of the South Asian summer **[8].**

Inability to Comprehend One Culture and Vitamin-D Paradox

There were 9 studies (60%) which concluded that the level of compliance was highly affected by cultural/ psychological factors. Two major misconceptions were identified. Most individuals believe that artificial blocks are designed specifically to protect the fair-skinned Westerners because of the extensive cultural belief that natural pigment on South Asian skin makes it more resistant and is naturally resistant to the cancerous rays of the sun. Amin notes that 54% of the participants, which includes a large portion of medical professionals, deliberately didn't use sunscreen because they feared that they will run out of Vitamin D **[18]**. To determine the validity of this

barrier, the review has summarized the physiological findings who indicates that the production of Vitamin D is a highly effective cutaneous procedure **[3]**. Individuals in South Asian latitudes don't have to spend a lot of time out in the sun unless it is necessary to replenish their serum levels once or twice a week with only taking ten or fifteen minutes to have their hands and faces exposed to sun **[3]**. Hence, health care misunderstanding about the sunscreen as creating an apparent systemic lack of sufficiency intensifies the Practice Gap.

There is a given framework of Infrastructure Failure by **[19]**. The following categories are possible to report your results: 93% of Pakistani literature in the category of Lack of Education by Maatouk identified the misconceptions (Vitamin D/Melanin Immunity) as an obstacle. The 8% cost on household income found **[7]** is higher than the global LMIC average barrier of the same as reported by Maatouk. Maatouk has made that the training of healthcare providers is where the problem starts is backed by the reality that the percentage of Pakistani medical students which practice daily photoprotection is 17-22 **[13, 18]**. This study states that the recent survey by 2024-2026 indicated that young Pakistani people are turning into users of social media platforms to receive their dermatological messages. This has also enhanced the spread of wrong information as it has led to the spread of wrongly labeled chemical filters as being toxic as it has influenced the compliance of youth concerned about their health **[15].**

DISCUSSION

The Non-compliance Economic Structure and Sociopolitical System

The KPG of Pakistan, according to one of the primary findings of this systematic study is an indicator of structural economic alienation and not merely a failure of individual comprehension. Even though the results indicate that the proportion of educated cohorts recognize the relationship between UV radiation and skin cancer is 79.4%, the actual adherence remains at 17.8% **[8]**. This discrepancy is explained by inflationary cycle in Pakistan after 2023 that led to increase in retail price of broad-spectrum sunscreens by 45%. Rukhsar says that perception of photoprotection isn't considered a preventative medical necessity but a cosmetic luxury when its price exceeds 8% of the monthly income of a lower-middle class family. Consequently, even with the highest cumulative exposure, the most vulnerable groups that are low-income urban residents and outdoor workers cannot access the main mechanism of prevention **[7]**. The ineffectiveness of the interdisciplinary health communication or Vitamin D paradox. One of the most complex psychological barriers is the so-called Vitamin D Paradox, where 54% of people knowingly abandon sun protection to avoid the brittle nature of the bones **[18]**. Although this concern is rampant in the culture, it is not scientifically backed considering the geographic positioning of Pakistan. The physiological data provided in the compilation by Lips indicate that the capacity of the skin to manufacture Vitamin D is so efficient in the South Asian latitude that metabolic demands can be achieved through a minimum of 10 to 15 minutes of incidental exposure (on hands/ face) twice a week **[3]**. Undergraduate medical curriculum seems to have a grave defect since even the medical professionals and students share this misconception. The absence of interdisciplinary communication with endocrinology and dermatology is what maintains the Knowledge Practice Gap and that which fosters a paradigm of balanced exposure that supports skeletal integrity without exposing the skin to harm is to provide endocrinology with the necessary knowledge needed to coordinate with dermatology.

The implication of medical knowledge public health outcome discrepancy is that Knowledge Practice Gap is influenced by structural gaps in preventative counselling, in addition to underlying physiological factors. According to Asif, doctors are the primary point of skin cancer prevention, yet the problem of Vitamin D Crisis in the country compromises their effectiveness **[15]**. Clinical recommendation often has UV protection more than the fear of worsening already existing Vitamin D deficiencies, was observed in Peshawar by Begum **[16]**. This creates a paradox of Risk-Benefit so that it is not an easy task to persuade the medical fraternity to recommend total sun avoidance. A transition to what calls Integrated Photoprotection is needed to allay this; the authors note that promotion of UV protective fabrics is a more moderate solution that provides oncological safety without completely inhibiting Vitamin D synthesis by epidermis. Since commercial sunscreens are not affordable to low-income/rural populations, adding such textile-based alternatives may seal the divide **[17]**.

The Illusion of Immunity of Melanin and its Molecular Consequences

The Pakistanis people have a major warning on biological evidence provided by Polefka (Fitzpatrick Types III-V) **[1]**. It has a dangerous myth of Melanin Immunity which states that naturally pigmented South Asian skin is immune. Even though eumelanin is naturally a high SPF product, the high intensity of sunlight of the Indus Plain results in the formation of reactive oxygen species (ROS) and cyclobutene pyrimidine dimers (CPDs). The damage occurs in a subclinical and microscopic scale because the South Asian skin doesn't readily show the appearance of sunburn(erythema) **[1]**. The primary issues in Pakistani aesthetic clinics are often solar induced

hyperpigmentation, melasma, and premature solar elastosis with this silent damage.

Genericity Barrier and Acceptability of Cosmetics

To the Pakistani population and more so the dark skinned phototypes, the issue of the white cast remains the largest physicochemical obstacle. When inorganic filters are used, which often leave a kind of ashy/grey cast, it causes a glaring galenic clash between normal formulas and the South Asian skin tone as a large proportion of the population has Fitzpatrick skin types IV and V. This cosmetic unattractiveness leads to high discontinuation rates, as demonstrated by **[8, 20].** Since the users prioritize social acceptability over clinical protection, this unattractive style is a significant factor in this situation. It is further complicated by the fact that rather than avoiding skin cancer pigmentary disorders and photoaging is often the motivation behind photoprotection of people with skin of color **[9].** Any product that causes an obvious social stigma/hideous white cast is bound to be discredited in the society where skin beauty is a significant social currency. As study reveals, nearly 50% of college students claimed that they didn't like sunscreen on the whole, which is most frequently linked to the greasy texture and unattractive nature of local product **[13]**. Also, systematic analysis by Maatouk points to the fact that the absence of micronized or colored options, which are often priced as luxurious products, leads to a structural choice barrier in low and middle income nations **[19]**. This is a huge pharmaceutical possibility to the local sector, which in turn could develop formulations that could specifically meet the needs of the Pakistani population, which is to find a balance between an effective UV protection and cosmetic **[5, 6].**

The Childhood Crisis: A Cyclic Neglect of Children

Study consider that the period of maximum importance in UV protection is the era of pediatric when the majority of the total UV damage is amassed during the first 18 years of life **[2]**. This review demonstrates how Pakistan has been ignoring the issue of sun safety in children in a systematic manner. The schools don't have the infrastructure (shade and policies) in place to shield the students during the most vulnerable UVI hours and parents who wear protection often fail to do the same to their children. As a result of this historical negligence, the level of DNA damage in a person is already alarmingly elevated at the time of their adulthood in Pakistan, and this puts them at a higher risk of developing cutaneous cancers during their adult years **[2].** As the findings by Shahzad indicate, there is a huge gap in Rawalpindi, in which entrenched sensory and nutritional attitudes don't allow high academic literacy to be converted into skin protective behavior **[13]**. The greatest psychological barrier, eclipsing the clinical risks of an Extreme UV Index, is the 81.1% incidence of the Vitamin D myth the belief that over 30 minutes of unprotected sun time are a physiological need. There is also a prominent Galenic Barrier, the physical barrier to adherence of which current formulations as an indelicate cosmetic creates, which is the 48% dislike rating of sunscreen texture. This means that any public health efforts conducted in the Twin-Cities should not only focus on basic awareness but also on busting dietary myths and promoting skin of color friendly, more aesthetically pleasing photoprotection **[13]**.

Strategies of Interaction with the Health System

The given review proposes a multi-level solution directed to industry, education, and policy in order to bridge the Knowledge Practice Gap. The Pakistani government should reclassify the broad-spectrum SPF 30+ products as an Essential Health Supplies rather than as a Luxury Cosmetic. They would be affordable to the middle and lower classes of the people because they would not incur high taxes of importation and GST. To reduce dependence on costly foreign products, provide tax incentives to the Pakistani pharmaceutical firms who invest in the research and development of micronized and tinted sunscreens.

Schools must be required to offer shaded areas to do physical education and morning assemblies according to the requirements of **[4].** Develop a culturally relevant Urdu campaign (such as Saaye Mein Raho) to educate people to use hats, umbrellas and traditional cloth wrapping along with the chemical sunscreens as valid photoprotection tools. Eliminate the case of Vitamin D Paradox in medical professionals, include photobiology, and the courses of balanced exposure to the MBBS and MPhil Public Health curriculum. Aesthetic clinics must but focus on prevention instead of just treating the resulting hyperpigmentation and photoaging. Incorporate sun protective measures in the Pakistani labor laws. The employers of outside construction and agricultural workers should be forced by law to provide physical shade and breathable long-sleeved clothing and frequent breaks during the UVI peak hours between 12:00PM and 3:00PM.

CONCLUSION

The current errors in Melanin Immunity and Vitamin D Paradox are biologically incorrect which is illustrated by the combination of fundamental physiological information posit that the Indus Plain has a high solar intensity which causes accumulative, sub clinical damage to DNA that cannot be reduced by natural pigmentation or significantly hindered by the correct use of sunscreen. Also, the cycle of neglect that has been reported in pediatric care is pointing to the fact that more and more future burden of photoaging and

cutaneous cancers will be experienced in Pakistan unless something is done about it. Finally, the KPG has to be closed by systemic policy reform instead of the individual-oriented education. Promoting a long-term culture of photoprotection in Pakistan can be achieved by redefining sunscreens as essential medicines, making sun safe school policies and procedures, and rewarding pharmaceutical innovation in the region. Morally and practically, there is a need to eliminate these barriers now to safeguard the dermatological health of South Asians of the future generation.

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