

A Review on Knowledge, Perception, Practice and Associated Factors of Sunscreen Usage among the Population

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ABSTRACT

Background: The use of sunscreen is a critical component of skin cancer prevention and overall skin health. Nevertheless, inconsistencies in sunscreen knowledge, perceptions, and practices persist among different populations, which are influenced by various factors. This review aims to synthesise and analyse the existing literature on the knowledge, perceptions, and practices related to sunscreen use across different populations and regions. It explores the factors influencing sunscreen application and the barriers to proper sunscreen use.

Methods: A comprehensive review of studies published between 2015 and 2023 was conducted, focusing on quantitative research on sunscreen knowledge, perceptions, and practices. Journals were obtained from EBSCO, Scopus and Mendeley databases.

Results: The initial article obtained from databases was 1250 articles, and the final articles chosen for review is 32 articles. This review highlights significant knowledge gaps about sunscreen use, particularly the need for sunscreen on cloudy days and understanding SPF values. Despite high awareness of UV radiation's harmful effects, actual use remains inconsistent. Common misconceptions, such as believing sunscreen is unnecessary in winter or indoors, persist across demographics. Perceptions of sunscreen's efficacy vary. Factors like sex, skin phototype, age, and education level significantly influence use, with barriers including forgetfulness, discomfort, cost, and lack of habit.

Conclusion: The findings underscore the need for enhanced educational campaigns to correct misconceptions and promote consistent sunscreen use. Targeted interventions should address specific barriers and tailor messages to different demographic groups to improve sunscreen practices and reduce the risk of UV-induced skin damage.

Keywords: Sunscreen use; Knowledge; Sun protection; Demographic factors in sunscreen use

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INTRODUCTION

Skin is the largest organ in the human body and is continuously exposed to ultraviolet radiation (UVR) which comes from the sun. Excessive exposure to UVR without adequate protection, will exacerbate skin ageing, the formation of erythema or sunburns, and development of skin cancer. Immediate reaction to UVR is tanning and erythema or inflammation on the skin, or which we would typically call sunburns. However, prolonged exposure may cause photoaging, which is characterised by wrinkles, dry skin, sagging, lines of expression, and the formation of spots on the skin, as well as photo-carcinogenesis which results in human cell deoxyribonucleic acid (DNA) alterations that result in mutations and cancer (1,2).

A research conducted in Japan by Mizuno et. al. in 2016 displays the effects of sunscreen in reducing photoaging among Japanese elderly people (3). A total of 32 Japanese elderly people with photoaged skin were enlisted and divided into two groups, with one group applying sunscreen on their face, neck, and dorsal hands four times a day for 18 months, while the other group did not apply any sunscreen. Participants' skin was analysed at the beginning and end of the study using a digital image analysis system to calculate the number of pigmentation spots and wrinkles on the face as well as examining skin colour tone uniformity. At the end of the research, participants in the sunscreen group had a substantial reduction in the number of pigmentation spots and wrinkles on their face, as well as an improvement in skin colour tone uniformity. Hence, this research concluded that the use of sunscreen is effective in preventing photoaging in Japanese elderly people.

Therefore, wearing sunscreen is a must if we want to protect ourselves from damages on the skin caused by the sun, as wearing sunscreen is a part of photoprotection. According to Skin Cancer Foundation in 2022 (4), sunscreens should be worn indoors and outdoors, use sunscreen with SPF 30 or higher with broad spectrum, 15 minutes before going out, sunscreen reapplication every two hours as it may degrade and we will need at least one ounce to the entire body for each application. In addition, people with skin diseases such as acne vulgaris, melasma, rosacea, psoriasis and actinic keratosis needs sun protection as their condition may worsen with prolonged sun exposure (5).

However, inconsistencies in sunscreen knowledge, perceptions, and practices persist. Briefly, many people lack detailed knowledge about regular sunscreen use and misunderstand the necessity of applying it indoors or during winter (6,7). Misconceptions about Sun Protection Factor (SPF) and broad-spectrum protection are common, with significant gaps in understanding across different regions (8,9). Perceptions of sunscreen efficacy vary, with some falsely believe it does not prevent skin damage or aging (10,11). Moreover, application practices are inconsistent, with many using less than the recommended amount or failing to reapply (12,13). In addition, gender disparities and other factors further complicate usage patterns and contribute to less use of sunscreen (14,15).

This review aimed to gain insight on the level of knowledge, perception and practice of sunscreen usage, as well as factors associated with sunscreen practice from various population within the past nine years (2015-2023). The observations from this review may assist health professionals and policymakers to identify gaps and develop tailored educational content which addresses these gaps. Furthermore, it allows us to understand and overcome barriers in sunscreen use and evaluate behavioural patterns to develop effective interventions. On top of that, identifying factors associated with sunscreen use aids in understanding who is most at risk and why.

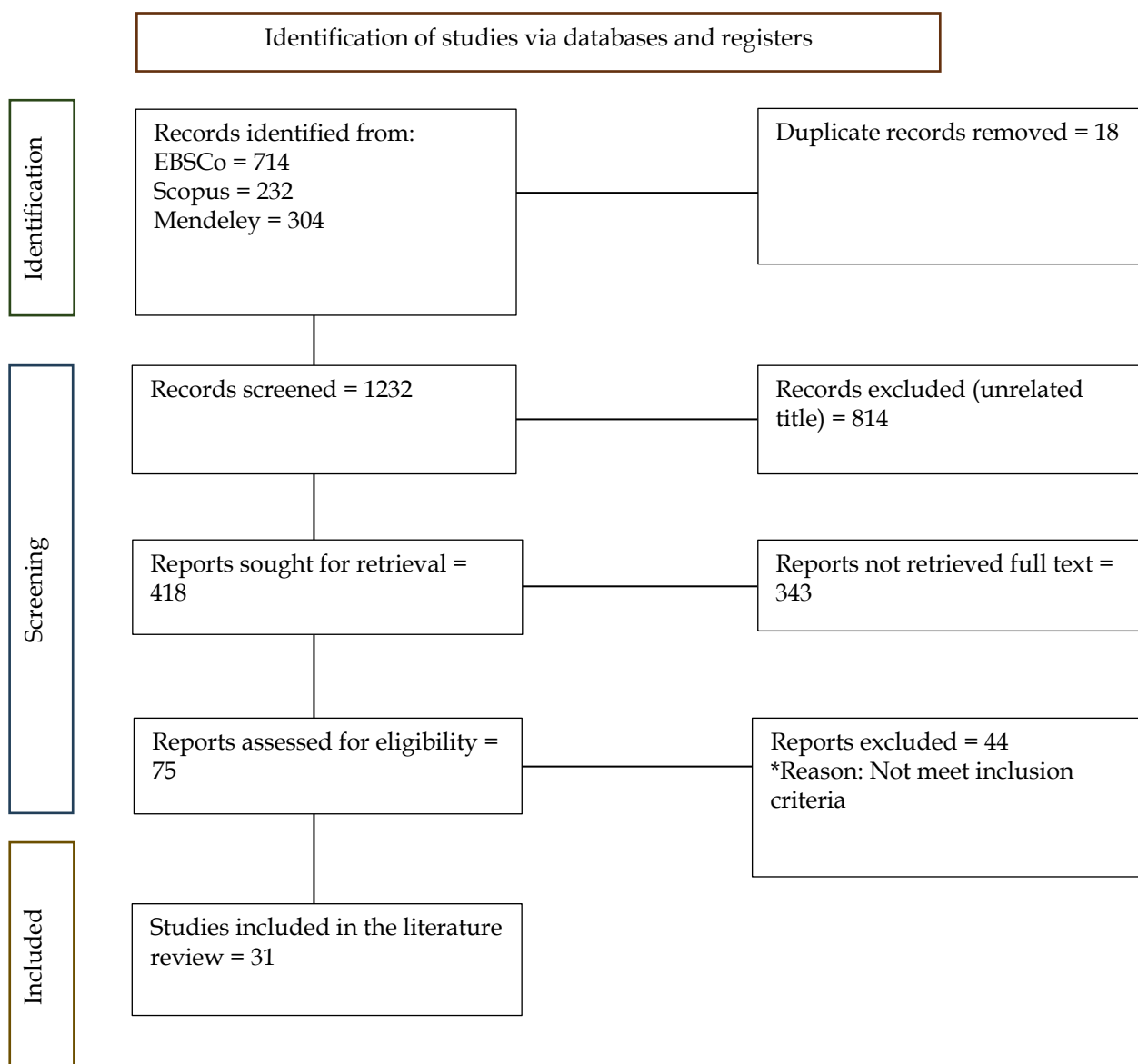
METHODS

EBSCO, Scopus and Mendeley databases have been used to obtain reliable and relevant research papers and articles. These databases were chosen due to wide range of academic sources across various disciplines, includes peer-reviewed articles to ensure high quality as well as a good search feature and analytic tools for an effective literature search. Boolean search, "AND" and "OR" have been applied to the search bar. The keywords used to search relevant articles and journals were arranged in **Table 1** and is chosen based on the similarity to its original phrases. The inclusion criteria of the studies included full-text accessible studies, peer-reviewed paper, articles published between 2015-2023 and published in English. Qualitative studies were to be excluded. An overview of the selection process is according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram as presented in **Figure 1**.

Table 1: Keywords for searching literature materials

	Sunscreen	OR	Sun protection		
AND	Usage	OR	Application		
AND	Sun exposure	OR	Ultraviolet radiation	OR	UV ray
AND	Knowledge				
AND	Perception				
AND	Practice				
AND	Factors associated	OR	Risk factor		

Figure 1: PRISMA flow diagram



Thirty-one selected studies were included in the final analysis as shown in **Table 2**. These studies were conducted in thirteen different countries. Seven studies were from United States of America, nine studies from West Asia countries (Saudi Arabia and Jordan), three studies from South Asia countries (Nepal and Pakistan), three studies from Latin America countries (Peru, Brazil and Ecuador), three studies from Spain, two studies from Malaysia, one study conducted in multiple countries in Asia, Africa and America,

and one studies each from Japan, Indonesia and Ireland. Majority of these studies employed cross-sectional designs (n=27). Other than that, two studies used observational studies, one study used mixed-method and one study employed single arm interventional study. The critical appraisal and evaluation of the included articles were conducted using the Critical Appraisal Skill Program (CASP) tool to ensure only studies that are excellent and of good quality is being employed for review.

Table 2: Literature Findings

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
2015 Saudi Arabia	Knowledge, attitudes and practices of the general public toward sun exposure and protection: A national survey in Saudi Arabia Khalid M. AlGhamdi, Aeed S. AlAklabi, Abdulla Z. AlQahtan	This study aimed to explore the KAP of the public toward sun exposure and sun-protection measures among Saudis	A cross-sectional survey using a specially designed questionnaire was conducted on a stratified random sample of the general population in the five geographical regions of Saudi Arabia.	Knowledge about sun exposure was moderate among respondents, with a majority recognizing the need to avoid the sun during peak hours and the potential risks of skin damage. Sunscreen usage was low, with only a minority reporting regular application during outdoor activities, and many unaware of its duration of effectiveness. Factors influencing sunscreen use included gender, employment status, student status, and age, with women, employed individuals, students, and younger respondents more likely to use sunscreen regularly compared to their counterparts.
2015 25 countries across Asia, Africa and the Americas.	Sun Protection Use Behaviour among University Students from 25 Low, Middle Income and Emerging Economy Countries Supa Pengpid, Karl Peltzer	The aim of this study was to investigate the sun protection use behaviour among university students from 25 low, middle income and emerging economy countries.	Cross sectional study. Using anonymous questionnaires, data were collected from 18,687 undergraduate university students aged 18-30 years (mean age 20.8, SD=2.8) from 26 universities in 25 countries across Asia, Africa and the Americas.	Various factors contribute to sun protection behavior, with younger age, female gender, higher socioeconomic status, lighter skin tone, and certain health behaviors being associated with more consistent sunscreen use. These findings suggest that individuals with these characteristics may have a better understanding of sun protection importance and are more likely to engage in sun protection practices.
2016 Peru	Factors associated with regular sunscreen use by medical students of a Peruvian university P.Rodríguez-	To determine the factors associated with regular sunscreen use among first year medical students from a Peruvian university.	Cross-sectional study. Population was first-year medical students from a Peruvian university.	Only 72.9% knew that SPF 15 sunscreen is not better than SPF 30, and just 23.1% recognized the need for sunscreen on cloudy days. Most respondents preferred shaded areas (66.9%), used sunscreen (38.1%), and wore

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	Gambetta, M.G. Moscoso-Porras, A. Taype-Rondan			long pants (30.1%). 7.4% believed SPF 15 sunscreen was superior to SPF 30. Females used sunscreen and wore long pants more than males ($p = 0.010$ and $p = 0.011$, respectively). Those reminded to use sunscreen were more likely to do so but forgetting and lack of habit remained significant barrier.
2016 Japan	The effects of continuous application of sunscreen on photoaged skin in Japanese elderly people - the relationship with the usage Makoto Mizuno, Kayo Kunimoto Eiji Naru Koichi Kameyama Fukumi Furukawa Yuki Yamamoto	Investigated the effects of continuous application of sunscreen for 18 months on photoaging in elderly people.	This 12-week study involved 32 elderly Japanese individuals with photoaged skin. They were split into two groups: one applied sunscreen four times daily to their face, neck, and dorsal hands, while the other didn't use sunscreen. The subjects' skin was assessed using digital image analysis at the beginning and end of the study.	Using sunscreen continuously for 18 months showed it can help prevent photoaging in elderly Japanese people. Those who used sunscreen had fewer pigmentation spots and wrinkles on their face and better skin tone compared to those who didn't. It also recommends using the right amount of sunscreen over a long period, like what's recommended for Caucasians. However, the study found that people used sunscreen differently, and some might not have used enough.
2018 Malaysia	Sun Protection Awareness Among Schoolchildren In Malaysia Kesedaran Perlindungan Matahari Dikalangan Pelajar Sekolah Di Malaysia Noor Ezati Shuib, Darvinrajbarath Muniandy	To randomly sample schoolchildren and school representative in Malaysia in order to establish their knowledge, attitudes, behaviour and school effort of protection against adverse effects of solar UV radiation from sun.	Cross-sectional study using Google Form.	Most respondents (96.2%) acknowledge that sun exposure can harm their skin, yet only 42.4% use SPF sunscreen lotion, and 46.2% wear protective clothing against UV radiation. Despite this awareness, nearly 60% of respondents expose themselves to the sun during peak hours (1 pm to 4 pm), and 78% have experienced sunburns. This highlights the need for educating schoolchildren on sun protection measures, especially since only 8.3% report having a Sun Policy at school, and merely 34.8% are encouraged to wear sun protection clothing. Females demonstrate better UV protection practices compared to males, as indicated by the study.
2018 Dallas, Texas, United States of America	Wrinkles, brown spots, and cancer: Relationship between appearance- and health-based knowledge and sunscreen use	This study characterizes skin health and photoaging knowledge among adults in an urban community, their	Cross-sectional survey based on a convenience sample of 300 adults. The survey was designed using questions based on	About 13% of respondents remained unaware of sun exposure's significant role in causing skin cancer, while a larger portion lacked knowledge about its aging effects. While 87% were

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	Hongjing Cao, Mary Brehm, Linda Hynan, Heather W. Goff	relationship to sunscreen use, and where individuals prefer to receive sun protection information.	the Health Belief Model and from pre-existing instruments.	aware of sun exposure's link to skin cancer, only 65% recognized its role in causing leathery skin, a prominent sign of aging. The study revealed a lack of appreciation for the severity of sun exposure and the benefits of sunscreen. Notably, 42% didn't believe that all sun exposure could harm the skin, and 33% doubted sunscreen's efficacy in preventing signs of aging. However, preventing skin cancer emerged as the primary motivator for sunscreen use, followed by avoiding sunburn and photoaging. Educating individuals about the adverse effects of sun exposure proved influential in promoting sunscreen usage. Sunscreen usage was suboptimal, with only 30% applying it daily, and 32% not using it at all during a typical week. Most (59%) applied sunscreen only when expecting more than an hour of sun exposure.
2018 Kathmandu, Nepal	Photodermatitis and Photo protection in Metropolitan Traffic Police in Kathmandu city Aryal E, Bhattarai S, Pokhrel G, Shrestha SB	To evaluate their knowledge and practice regarding ultraviolet radiation, photo protection, sunscreens and sun-related photodermatitis.	Cross-sectional study involving traffic police officers working at different locations in Kathmandu.	Among officers, awareness of the necessity of sunscreen during duty hours varied, with 32.7% of males and 57.1% of females acknowledging its importance. The age group of 18-25 exhibited the highest awareness (82%) of sunscreen's significance during duty. Knowledge concerning Ultraviolet Radiation (UVR) stood at 39.6%, while awareness of the Ultraviolet Index (UVI) was lower, at 24.9%. Some officers held misconceptions about sunscreen, with 19% considering it purely cosmetic, 10.9% believing it softens the skin, and 15.8% thinking it imparts a glow while protecting from the sun. Overall, only 34% of officers recognized the importance of sunscreen during work hours.
2018 Ireland	Sun-related risks and risk reduction practices in Irish outdoor workers	To describe the solar UVR risk, and explore associations between Demographic	Cross-sectional study involving 156 participants who work as golf course	While 76% of respondents claimed to use sunscreen, only 17% reported using it correctly. Many spent over 4

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	S. P. Cetintepe, B. McElroy, A. Drummond	characteristics and sun-safety knowledge, risks and practices, in golf-course maintenance workers on the island of Ireland.	maintenance worker.	hours daily outdoors during summer and experienced sunburn in the past year, yet correct sunscreen use was low. Notably, skin cancer knowledge positively correlated with sunscreen usage.
2019 Iowa, United States of America	Assessing factors affecting sunscreen use and barriers to compliance: a cross-sectional survey-based study. Emily A. Weig, Rechelle Tull, Jina Chung, Zoe O. Brown-Joel, Rumbidzai Majee & Nkanyezi N. Ferguson	To better understand patients' barriers to sunscreen use	Cross-sectional study, conducted on 429 participants at the University of Iowa Hospital Dermatology Clinic.	Patient-related factors linked to sunscreen use comprised higher income (p<.001), lower Fitzpatrick skin type (p<.001), higher education level (p=.002), younger age (p=.0262), history of melanoma (p=0), and female gender (p=.045). Personal barriers to sunscreen use included dislike of sunscreen feel or appearance (33.7%) and time constraints (15.3%). Cost was a barrier for 16.4% of cases, highlighting the need for dermatologists to address socioeconomic obstacles and offer cost-effective sun protection counseling.
2019 Jordan	Awareness about proper use of sunscreen in people of color: A Jordanian-based survey Firas Al-Qarqaz, Maha Marji, Khaldon Bodoor, Diala Al ALshiyab, Jihan Muhaidat, Saleh Al Ghamdi	To examine the knowledge, proper use, and reasons for stopping use of sunscreen in Jordanians, a population with predominantly skin of colour.	Cross-sectional study of 2000 individuals. A structured questionnaire was designed to collect data on general knowledge and use of sunscreen as well as reasons for stopping use of sunscreen.	Knowledge: 70.6% of participants believed sunscreen wasn't necessary indoors. Regarding application sites, 65.4% thought only the face and hands required sunscreen, 25.8% believed it was solely for the face, and 8.8% assumed the entire body needed coverage. Notably, 46.3% believed children shouldn't use sunscreen, and 13% feared harmful effects from prolonged use. Factors: Sunscreen usage was significantly higher among females (73.1%) compared to males (25.3%). Younger participants (below 40) showed higher usage (60%) compared to older individuals (38.1%). Barriers: Common obstacles included side effects, cost, poor compliance, lack of improvement, and unawareness of sunscreen's long-term necessity.

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				Reported side effects included texture dislike, irritation, acne, increased sweating, skin darkening, among others.
2019 Brazil	Non-use of sunscreen among adults and the elderly in southern Brazil Elizabet Saes da Silva, Samuel Carvalho Dumith	Investigate the prevalence of non-use of sunscreen and its associated factors.	Cross-sectional study with individuals aged 18 years or over living in the urban area.	Men were 1.82 times more likely to not use sunscreen compared to women. Participants over 40 years old, with brown or black skin, or perceiving their health as regular or poor were more likely to not use sunscreen. Those who hadn't consulted a physician in the last year and didn't engage in leisure physical activity had a higher probability of not using sunscreen. Lower educational level and wealth index were associated with a higher probability of not using sunscreen.
2019 Saudi Arabia	Knowledge, attitude, and practices toward sun exposure and use of sun protection among non-medical, female, university students in Saudi Arabia: A cross-sectional study Reema Ruddah Almuqati, Ali Saeed Alamri, Nawal Ruddah Almuqati	To evaluate the knowledge, attitude, and practices toward sun exposure, and the use of sun protection among non-medical female students on the Sulaymaniyah campus of the King Abdul-Aziz University.	Cross-sectional study. The study collected data using a self-administered questionnaire that was specifically designed and tested on a pilot group of 15 students.	Knowledge: 64.9% of students lacked knowledge about the SPF of sunscreen products. Only 35.1% and 22.2% knew about SPF and PA values, respectively. 30.2% of sunscreen users didn't know the SPF value of their products. Perception: 34.1% believed sunscreen products could harm the skin. 72% believed sunscreen is protective, while 70.9% didn't think it harms their vitamin D levels. Practice: Only 23.6% of students used sunscreen regularly. Most commonly used SPF was 50 (35.1%), but 17.4% used SPF 70 or higher. 84.5% applied sunscreen 15-20 minutes before sun exposure, yet 63.1% never reapplied it. Only 3.7% regularly reapplied sunscreen. Among those who reapplied, intervals varied: 21% every 4 hours, 9.1% every 3 hours, and 6.7% every 2 hours. Sunscreen was mostly applied on face, neck, and hands (39.3%),

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				with 25.6% on the face only, and 25.3% on the face and hands.
2020 Spain	Sun Protection Behaviour and Sunburns in Spanish Cyclists Doncel Molinero, D., Ruiz Paulano, M., Rivas Ruiz, F., Blázquez Sánchez, N., de Gálvez Aranda, M. V., de Castro Maqueda, G., & de Troya Martín, M.	To describe the sun protection habits and rate of sunburns associated with the practice of cycling and to identify predictive factors of sunburn among cyclists.	Descriptive observational study	Less than 20% correctly identified sunscreen as the best protection against the sun and skin cancer prevention. Similar low percentages understood that dark clothes don't offer better sun protection than light-colored clothes. 39.2% of cyclists reported using sunscreen. While many acknowledged the importance of sunscreen and concerns about sunburn or skin cancer, less than half regularly used sunscreen with SPF 15 or higher.
2020 Saudi Arabia	Sunscreen Use among a Population of Saudi University Students AlJasser, M. I., Aljumah, A., Alzaydi, M., Alassaf, A., Alassafi, S., Alassafi, M. T., Almedlej, M., & Masuadi, E	To assess the prevalence, practices, and factors associated with sunscreen use among Saudi university students.	A cross-sectional study was performed at King Saud bin Abdulaziz University for Health Sciences in Riyadh, Saudi Arabia. A questionnaire on the use of sunscreen was created in English. Quota sampling technique was used since the sample was divided according to gender and college year.	Practice: 51% of students reported using sunscreen, but only 35% applied it on both sunny and cloudy days. 45% applied sunscreen solely during outdoor activities, and 62% didn't reapply it throughout the day. Half of the students used less than a quarter teaspoon of sunscreen, and 41% used between a quarter to half a teaspoon. 28% were unaware of the SPF of their sunscreen. Factors: Female students, those from higher-income families, with a history of sunburns, tanning bed usage, and other sun protection practices were more likely to use sunscreen. Females were about 10 times more likely to use sunscreen than males, and students with more past sunburns were five times more likely to use sunscreen. Barriers: Main barriers to sunscreen use were time consumption (36%), inconvenience (31%), and perceived lack of efficacy (19%). Cost issues (11%) and lack of awareness about sunscreen (6%) were also reported.
2020	Sun Awareness and Sun Protection	To estimate the level of sun protection	Cross-sectional study. An online	Education, household size, and income relative to

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Saudi Arabia Bahrain	Practices Nahid Sultana	practices and determine the factors that have a significant impact on the level of adoption of sun protection practices by residents in the Arabian Peninsula.	survey form was distributed among participants via social media. A total of 830 completed answers.	expenses are linked to sunscreen use. A quarter of respondents who use high sun protection are often female, married, educated, economically stable, and live in smaller households. Those who experienced sunburn four times or more are more likely to use higher sun protection. Only 34% of 830 respondents use sunscreen, mostly females. Main reasons for not using sunscreen: forgetfulness (38.5%) and belief it's unnecessary (33.5%). 64% believe sunscreen isn't harmful to skin. Many know sun exposure can cause skin cancer and aging, but 54% think a tan is healthy if avoiding sunburn. 30% know about UV index, but only 20% understand its meaning. 40% use sunscreen with SPF over 30, 24% SPF 15-30, 5% SPF below 15, and 31% don't know SPF of their sunscreen.
2020 Spain	Sun Exposure and Photoprotection: Habits, Knowledge and Attitudes Among Elite Kitesurfers Guillermo de Castro Maqueda, José Vicente Gutiérrez-Manzanedo, José Luis González-Montesinos, Carmen Vaz Pardal, Francisco Rivas Ruiz, Magdalena de Troya Martín	To analyse the photoprotection and photoexposure habits and knowledge of elite kitesurfers and their beliefs and attitudes in this respect.	Cross-sectional descriptive study based on health surveys on sun exposure-related habits, attitudes, and knowledge of elite professional kitesurfers. Convenience sampling was used in this study, based on athletes taking part in the world championships and Spanish kiteboarding league events.	Respondents generally knew about sunscreen; most used SPF > 30 (48.6% SPF 30-50, 37.5% SPF > 50). Over 75% agreed it's good to use sunscreen, and 43.2% recognized sun exposure could cause skin cancer. Average correct answer rate for ten questions was 66.9%. Positive view of sunscreen: Over 75% agreed it's good to use. However, 31.9% didn't like using it. 62% of kitesurfers use SPF > 30 sunscreen. Other athletes had lower usage: 20% of skaters used SPF > 15, and 44% of golfers used SPF < 30.
2020 Indonesia	Behavior of Sunscreen Usage Among Medical Students Triana Novitasari, Subur Prajitno, Diah Mira Indramaya	To describe the knowledge and the practice of sunscreen usage among medical students of Universitas Airlangga and find out the relationship between the knowledge and the practice of sunscreen usage.	Analytic-observational study that used a purposive sampling method. The sample consisted of medical students from Universitas Airlangga, class of 2016, 2017, and 2018.	Knowledge: Medium knowledge score: 59.12% knew about sunscreen, and 64.78% practiced using it. Awareness: 50.31% knew sunscreen should be used indoors, 83.02% knew about broad-spectrum sunscreen benefits, and 73.59% knew to apply it 15 minutes before sun exposure. Only 21.38% knew the right amount of sunscreen for the whole

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
				body. Practice: 66.04% used sunscreen daily, all opting for broad-spectrum types. 60.38% applied sunscreen 15 minutes before sun exposure, but only 25.16% used the correct amount (1 teaspoon or more for the face). Only 10.69% reapplied every 2 hours during outdoor activities. Majority (70.44%) used sunscreen with SPF 30 or higher.
2021 United States of America	Attitudes and Behaviors That Impact Skin Cancer Risk among Men Gabrielle J. Adams, Elianna K. Goldstein, Beth G. Goldstein, Kristen L. Jarman, Adam O. Goldstein	To close the gap in research, regarding men's perceptions and behaviors about skin cancer, sun exposure, and tanning.	Cross-sectional study. participants completing a 15-minute questionnaire about their daily exposure to the sun, skin type, sun protection behaviors, and attitudes toward tanning.	The study found that 74.4% of men experience skin reactions to the sun, such as burning, blistering, or peeling. However, only 17.1% reported daily sunscreen use, with 38.6% using it weekly, 16.1% monthly, and 28.3% infrequently. Regarding protective behaviors, 48.0% used sunscreen, 53.5% wore sunglasses, and 40.2% wore a baseball cap or sun visor. These results indicate that men often engage in behaviors that increase their risk of skin cancer without adequately protecting themselves.
2021 Spain	Sun Exposure during Water Sports: Do Elite Athletes Adequately Protect Their Skin against Skin Cancer? Guillermo De Castro-Maqueda , Jose V. Gutierrez-Manzanedo, Carolina Lagares-Franco and Magdalena de Troya-Martin	To examine the sun exposure and protection habits of elite athletes in water sports, according to their age, gender, and sports discipline.	The study included elite athletes aged 16-30 years who were participating in the world championship of their sports discipline. The athletes were asked to complete a two-page health-focused questionnaire that was prepared by experts in the field of photoprotection and sun exposure.	The research revealed that a considerable portion (22.5%) of participants never used sunscreen, and nearly half (49.6%) employed inadequate sun protection measures. Those with adequate photoprotection habits were typically older, with an average age of 23.28 years, compared to those with inadequate protection, averaging 20.69 years. This age discrepancy was statistically significant, indicating that younger athletes are less likely to protect their skin adequately from solar exposure. No notable differences in sun protection practices between male and female athletes.
2022 Saudi Arabia	Dermatology Patients' Knowledge of Sunscreen Guidelines at a	To assess the knowledge and attitude of dermatology patients	Cross-sectional study. conducting a survey of dermatology	Knowledge Although 93.4% of participants were familiar with sunscreen, their

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	University Hospital in Saudi Arabia Amal Al-Balbeesi , Eman AlMukhadeb, Mohammed BinMayouf , Sultan AlNasser, Abdulelah Aldossari, Fahad Alfaiz, Abduljabbar Alyamani, Ali Alammari, Qais Almuhaideb	regarding sunscreen use as recommended by the American Academy of Dermatology.	patients at a university hospital in Saudi Arabia. The sample size was calculated to be 277 participants with a confidence level of 95%. Data was analysed using SPSS version 25.	understanding of its usage guidelines was lacking. Only 20.5% knew sunscreen should be used daily throughout the year, and merely 13.5% knew the recommended minimum SPF. Awareness of application timing and amount was also low, with only 34% aware of the time before sun exposure and 4.5% knowing the proper quantity for full-body coverage. However, 80% were aware of the worst time for sun exposure. Perception A significant portion (58.3%) expressed uncertainty about sunscreen safety, while 41.7% deemed it safe. Regarding necessity, 45.5% believed in sunscreen's importance for sun protection, whereas 54.5% did not. Only 33% believed in its efficacy against skin cancer. Practice Seventy-two percent reported previous sunscreen use. Factors Gender and education level significantly influenced sunscreen use, with women and postgraduates exhibiting higher rates compared to men and those with lower education level. Age and skin type were not significant factors.
2022 Ohio, United States of America	Sun-Exposure Habits and Sun Protection Practices of Collegiate Athletes Kent Axcell, Jon Beaton, Aidan Maxwell, Paul J. Wirth	To assess the level of university involvement in skin protection for their outdoor student athletes and the student population's level of compliance.	Cross-sectional design. An anonymous online survey platform, SurveyMonkey, was used to directly contact Division 1 student-athletes in Ohio participating in outdoor sports	The study reveals a concerning trend in sunscreen use among participants, with only 28% reporting consistent usage and 33% admitting to never using sunscreen. Instead, reliance on other protective measures like hats (70%) and sunglasses (60%) was more common. University involvement in skin protection was notably lacking, with only 14% providing sunscreen. This highlights a potential gap in education and awareness

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2022 Saudi Arabia	Knowledge, attitude, practice and perception of sunscreen among Saudi population Zahraa Alshayeb, Dalal Alsaadoun, Hawra Alyaseen, Maram Albadan, Sarah Alyaseen, Bayan Alhussain	The awareness of sunscreen utilization was evaluated amongst Saudi population in conjunction with other sun-protective attitudes and practices.	Cross-sectional design. The population sample was 3235 participants aged 18 years and above.	regarding skin protection among athletes. Knowledge Around half of participants demonstrated good knowledge of sun protection measures, with younger individuals, females, singles, and those with higher education showing higher levels of understanding. Skin type also played a role, with lighter skin types showing better knowledge. Employment status also influenced knowledge, with non-employed individuals displaying better awareness. Perceptions Selection of sunscreen products was primarily influenced by SPF and PA values, with recommendations from dermatologists, friends, and pharmacists also considered. A significant portion applied sunscreen shortly before going outdoors and only once a day. The face, neck, and hands were the most commonly covered areas. Reasons for sunscreen use varied, with most citing prevention of dark spots and sunburns. Factors Groups with higher knowledge and sunscreen utilization included younger individuals, females, singles, indoor workers, and those with higher education. This suggests that demographic factors significantly influence sunscreen usage and understanding of sun protection measures.
2022 Saudi Arabia	Knowledge and attitude of Princess Nourah University Students Towards Sun Protection Faten Albukhari, Nouf Alzahrani, Raghad M. Alamri,	To estimate PNU student's awareness and knowledge of sun safety, to compare between healthy and non-healthy students in regards to knowledge and practice, to assess the protective	Cross-sectional study conducted among 900 Princess Nourah University students using convenient sampling. Data was collected by a paper-based questionnaire of 46 questions.	Knowledge The level of knowledge about sunscreen among Princess Nourah University students was notably poor, with only 32.4% of participants demonstrating good knowledge and 67.6% showing poor knowledge. Misconceptions were

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
	Wejdan T. Abokhesheim, Munira S. Alqahtani, Abeer A. Alasiry, Renad Zaini, Raghad E. Alsubki	behaviors toward sun exposure among PNU students, and to provide the public with information regarding safe sun protection.	Statistical analysis was conducted using SPSS software	<p>prevalent, with 57% of respondents mistakenly believing that sunscreens only protect against cancer. Furthermore, 64% of participants incorrectly thought that using sunscreen could decrease the skin's production of vitamin D.</p> <p>Perception The perception of sunscreen among Princess Nourah University students was generally negative. Common deterrents from using sunscreen included its sticky texture and high cost. A mere 30% of respondents reported reading labels before purchasing sunscreen, and only 11% applied sunscreen to all parts of their body. Additionally, 58% of respondents believed that sunscreen prevents tanning, reflecting a misunderstanding of its protective functions.</p> <p>Practice Poor sunscreen usage practices among Princess Nourah University students. Only 5.2% reported using a double application of sunscreen. Surprisingly, despite higher knowledge levels among health students, the rate of sunscreen application between health and non-health students was similarly low. Factors such as time spent under the sun, tanning habits, and previous sunburns did not significantly influence sunscreen application practices.</p>
2022 United States of America	Sun Exposure Prevention Practices Within U.S. Naval Aviation Willis H. Lyford, Angela Crotty, Nicholas Fred Logemann	To evaluate rates of sunburn, sun-protective practices, and perceptions regarding sun exposure and prevention practices in their workplace.	Cross-sectional survey distributed to active duty (AD) U.S. Navy service members assigned to 1 of 19 aircraft squadrons based in Southern California and deployed on missions across the	62.2% of people surveyed said they "always" or "most of the time" use sun protection when exposed to sunlight for an hour or more. The most common method was sunscreen (36.5%, 324 people), followed by protective clothing like hats and long sleeves (34.5%, 306 people).

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
			Pacific theater of operations.	Lighter skin was linked to more reports of sunburn. The study showed that 75.9% of service members used sunscreen with an SPF over 15. However, only 12.3% used sunscreen while working in the sun, compared to 36.5% who used it during sun-heavy leisure activities. The study suggests that the lack of reminders to use sun protection might be a factor, as 57.7% said they were rarely or never reminded to use it while working in direct sunlight.
2023 Malaysia	Knowledge of Sunscreen Usage and Skin Cancer Among Malaysian Medical Students - A cross sectional study Nuruljannah H, Fadzilah H, Yea L, Thirasaree M, Dumingu Hewage J, Salima F, Azme M, Htoo H, Soe K, Moe S, Nu M, Htay N	To assess knowledge, attitude, practice of sunscreen and knowledge of skin cancer among undergraduate medical students in a private medical university in Malaysia.	Cross-sectional study was conducted from October 2022 to November 2022 among the clinical year medical students in a private medical university in Malaysia. The respondents were recruited by purposive sampling method. The content validated questionnaire was used to collect the data, and the data collection was done via online platform.	Factors Female respondents in this study were more likely to utilize sunscreen compared to male respondents. Knowledge Majority of the respondents (59.8%) had poor knowledge with regards to sunscreen. However, 65.0% of the respondents had good knowledge about skin cancer. Attitude Approximately half of the respondents (48.7%) had a good attitude towards sunscreen. Practice A total of 64 respondents (54.7%) reported that they always or frequently used sunscreen every time they went out in daylight.
2023 California, United States of America	Sun-Protective Behaviors in Patients with Melasma Laura J. Conahan, Sue Robertson	to gain perspective about barriers to SPBs of patients with melasma and to develop evidence-based practice recommendations for patient education.	A mixed-methods approach used a validated survey measuring SPBs and qualitative interviews to understand participants' perceptions of living with melasma.	67.5% of participants reported using sunscreen, but only 7.6% reapplied it every 2 hours, showing a need for more education even among motivated users. Although many said they "always" wear sunscreen, 77% did not reapply it as recommended. The study found that participants often overlooked incidental sun exposure and were more consistent with sun protection during summer or at the beach/pool. They

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
				did not consider sun exposure at other times, like being outside, near open windows, or while driving. Older participants reapplied sunscreen less often, and those who didn't reapply frequently were mainly Hispanic/Latino and Asian/Pacific Islander. Even motivated patients, like those with melasma, struggled with reapplication.
2023 Nepal	Evaluation of the knowledge of sun exposure and sun protective measures in healthcare workers Aryal E, Shrestha PR, Gautam S	To determine the knowledge of healthcare workers regarding the solar spectrum, sunscreen, the relation of Vitamin D with sun exposure, the practice of using sunscreen and other sun protection methods.	Descriptive cross-sectional study was carried out on healthcare workers (medical staff) in Kathmandu Medical College Teaching Hospital. A questionnaire was distributed to the target study population without disturbing or hampering the healthcare worker's duty.	Knowledge Out of 264 participants, only 196 (74.2%) knew the proper terminology for SPF (Sun Protection Factor) and only 59 (21.6%) agree that the value of SPF is related to age. Practice Regarding the sunscreen application time, 91(34.4%) used it in the morning, while 51(19.3%) used sunscreen whenever they go out in sun. Reapplication of sunscreen was done only by 73 (27.6%) participants. Most of the participants i.e. 124 (46.5%) used SPF of 30-50 and a majority of participants (62.1%), applied sunscreen only on the face followed by face and neck by 128 (48.4%) and arm 32 (12.1%).
2023 Saudi Arabia	Pervasiveness sunscreen use and knowledge among university students in Riyadh. Sami Fathi Abdullah, Rasheed A. M., Majed Marshad Alanazi, Yazan Jaber, Abdulrazaq Mohammed Alshammari, Khalid Issam Alhoms, Rakan Abdullah Alzabadin, Mohammed Shar Alahmari	To demonstrate the knowledge and use of sunscreen among university students.	Cross-sectional study was carried out among university students, Riyadh Saudi Arabia. Questionnaires were distributed to 600 university students. The Chi-square test and one-way analysis of variance were used to evaluate the data.	291 people (48.4%) said they use sunscreen, while 310 people (51.6%) said they do not. More females (61%) use sunscreen compared to males (36%), a statistically significant difference (p-value 0.04). More people with lighter skin (photo types I, II, and III) use sunscreen compared to those with darker skin (photo types IV, V, and VI), with a p-value of 0.042. More individuals who have had sunburns use sunscreen compared to those who have not, with a p-value of 0.024. Factors linked to higher sunscreen use include being female, having lighter skin, having had sunburns

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
				before, using multiple sun protection methods, believing sunscreen is effective against skin cancer, and believing everyone should use sunscreen, regardless of skin color.
2023 Pakistan	Prevalence of sunscreen usage and perception about sun exposure and sunscreen: A lower-middle-income country's perspective Shayana Rukhsar, Sadia Masood, Unzela Ghulam, Eisha Hannan	To evaluate the knowledge of a subset of our local population about exposure to sun and assess the attitude about the importance of sunscreen usage.	Prospective cross-sectional study conducted at the dermatology outpatient clinic, patient selected through convenient sampling and self-administered questionnaire. Total participant: 200	<p>Knowledge 30% strongly disagree that sun exposure causes darkening. 37.5% disagree that sun exposure causes wrinkles. 38.5% agree that sun exposure causes allergies. 37.5% strongly agree that sun exposure causes cancer.</p> <p>51% of patients were unaware that sun exposure can cause skin darkening, likely due to low literacy levels. However, over 50% knew that sun exposure can cause wrinkles, allergies, and skin cancer. Most participants believed sunblock can protect against UV rays and prevent sun damage, sunburn, tanning, premature aging, and skin cancer. However, many did not know sunscreen should be applied 30 minutes before sun exposure for proper effectiveness.</p> <p>Perception 57.5% strongly agree that sunscreen protects against UV rays and sun damage. 46% strongly agree that sunscreen prevents tanning and sunburn. 55% disagree that sunscreen can make skin fair. Opinions were split on whether sunscreen prevents premature aging, with 32.5% strongly agreeing and 33% disagreeing. 72.5% agree that sunscreen can prevent skin cancer.</p> <p>Practice 49% reported using sunblock, but 54% use it only occasionally.</p>
2023 United States of America	Sunscreen Knowledge and Sun Protective Behaviors among Medical Students at a	To ascertain the knowledge of sun protection and the implementation of these practices by	Cross-sectional study, online survey given through email, class messaging boards,	Knowledge & Perception 98% of students believe sunscreen can protect against skin cancer. Out of seven questions, only two

Year/Country	Title/Author	Objectives/Aim	Methodology	Findings
	Southern US Institution Meagan Mandabach Olivet, Lauren C.S. Kole	medical students at a United States Southeastern institution.	and posters on campus.	<p>had less than 80% correct responses. Additionally, 70% of students understand that a “base tan” does not protect against further sun damage, and 59% know that sunscreen should be applied 15 minutes before going outdoors.</p> <p>Factors Female students are more likely to recognize the photoaging benefits of sunscreen (p=0.022) and that a “base tan” does not offer further protection (p=0.006). White students are more likely to identify >30 as the recommended SPF level (p<0.001) and understand that a base tan does not protect skin from additional damage (p=0.010). Dermatology patients are more likely to correctly state the recommended SPF level (p=0.017).</p> <p>Practice Only 48% of students regularly wear sunscreen when spending time outdoors. Female students are more likely to wear sunscreen both outdoors (p=0.003) and indoors (p<0.001), as well as wear long sleeves in the sun (p=0.04). White students are more likely to reapply sunscreen every 2 hours (p<0.001) and wear sunscreen indoors (p=0.016).</p>

FINDINGS

Knowledge of Sunscreen

Sunscreen is a product that helps protect the skin from the harmful effects of ultraviolet (UV) radiation from the sun. UV radiation can cause sunburn, premature ageing, and increase the risk of skin cancer. A study done on Malaysia’s schoolchildren by Shuib et. al. (16) found that the majority (96.2%) of the respondents know that sun exposure can cause harmful effects to their skin yet only 42.4% of them wear SPF sunscreen lotion. Although the knowledge was good, 59.8% of the respondents exposed themselves to the sun during

peak solar noon at 1 pm to 4 pm range, and this action showed its effects as 78% of them have had sunburn before. In addition, a study done on Spanish cyclists discovered that the percentage of correct answers was below 20% for the item “using sunscreen is the most appropriate way of staying protected from the sun and preventing skin cancer” (17). This shows that cycling athletes who spent a lot of time under the sun had low knowledge regarding the use of sunscreen as a method to protect themselves from the sun. Another study conducted in a university in Saudi Arabia by Albukhari et. al. (18) stated that 57% of respondents think that sunscreen only protect from cancer, which is not

true as it can protect from overall sun damage and its effects.

Moreover, some studies also inquire participants about the need for sunscreen while not being directly under the Sun. A study in Jordan by Al-Qarqaz et. al. (6) stated that 40% of participants did not think sunscreen was needed during winter and 70.6% of participants thought sunscreen was not needed while being indoors. A survey done on medical students in Peru found that only 23.1% correctly answered that it is necessary to use sunscreen on cloudy days (7). These alarmingly low percentages, even with a population of medical background, reveal that a lot of people still have misconceptions regarding ultraviolet rays as it can still penetrate cloud cover, and it's possible to get sunburned even when the sun is not visible. However, another study conducted on medical students in Indonesia found that 50.31% of respondents knew that sunscreen must be used even when they are indoors and 83.02% of respondents knew that broad-spectrum sunscreens, which is a type of sunscreen that provides protection against both UVA and UVB rays, were better used in daily activities (19).

In relation to sunscreen's protection order and its efficacy with a higher number of SPF, a study in Peru by Rodríguez-Gambetta et. al. (7) found that only 72.9% correctly answered that a sunscreen of SPF 15 is not better than one of SPF 30 and that only 23.1% correctly answered that on a cloudy day it is also necessary to use sunscreen. A research in Jordan found that more than half participants were not aware of the appropriate strength of different sunscreen (7). Another study done in Saudi Arabia (9) found that 64.9% of participants did not know about the sun protection factor (SPF) of sunscreen products. Additionally, the percentage of students who were knowledgeable about the sun protection factor (SPF) and protection grade of ultraviolet A (PA) values of sunscreen products were 35.1% and 22.2%, respectively. Furthermore, 30.2% of sunscreen product users did not know the SPF value of their products. A study done on elite kitesurfers in Spain discovered that sunscreen that most commonly used had a protection factor more than 30. Precisely, 48.6% using SPF 30–50 and 37.5% using SPF more than 50 (20). In addition, 83.02% of respondents in Indonesia knew that broad-spectrum sunscreens, which means sunscreens that protect from both UVA and UVB were better used in daily activities (19). Lastly, a study done with dermatology patients in a university hospital in Saudi Arabia found that 13.5% of its patients knew the correct minimum recommended SPF (8).

UVA and UVB radiation are the two primary forms of ultraviolet (UV) radiation emitted by the sun. Because UVA rays have a longer wavelength and can reach deeper into the skin, they may promote the appearance of fine lines and wrinkles. UVB radiation, on the other hand, has a shorter wavelength and mostly damages the skin's outer layer, which can result in sunburn and is a major factor in the emergence of several types of skin cancer. Awareness regarding ultraviolet radiation and its effects is crucial for people to be more attentive on using sunscreen daily. A study conducted by Aryal et. al. (21) on traffic police officers in Kathmandu shows that the percentage of officers who had knowledge regarding Ultraviolet Radiation (UVR) was 39.6%, and the percentage of officers who had knowledge about Ultraviolet Index (UVI) was 24.9%. In addition, the percentage of students who were knowledgeable about the sun protection factor (SPF) and protection grade of ultraviolet A (PA) values of sunscreen products were 35.1% and 22.2%, respectively (9). Another study found that 30% of the participants of this study are aware of the UV index, and only 20% of all respondents know the correct meaning of the UV index (11). These overall low percentages shows that a lot of people are still not familiar with ultraviolet and its damages to skin.

Sunscreen use must take into account its adequate quantity and knowledge on the correct application. A study by Al-Qarqaz et. al. (6) in Jordan found that 65.4% of participants thought that face and hands are the only sites of application, 25.8% thought sunscreen is used on the face only, and 8.8% thought sunscreen should be applied to the entire body. In the meantime, studies in Saudi Arabia showed that only 4.5% knew the proper amount of sunscreen to cover the entire body (8) and 50% applied less than a quarter teaspoon amount of sunscreen, and 41% applied a quarter to half teaspoon (12). To add on, a study in Indonesia (19) stated that 73.59% of respondents knew that sunblock must be used at least 15 minutes before being exposed to sunlight, and only 21.38% of respondents knew the correct number of sunscreens that must be used on the whole body.

Perception of Sunscreen

Perceptions towards sunscreen usage can vary among individuals and are influenced by a combination of factors. There are a few studies which explore respondents' perceptions towards sunscreen usage. Above all, people

have to perceive the fact that correct application of sunscreen may ward off harmful effects of sun exposure. A study conducted by Rukhsar et. al (22) in Pakistan found that 57.5% strongly agree that sunscreen protects against ultraviolet radiation and sun damage, and 46% strongly agree that sunscreen protects against skin tanning and sunburn. Moreover, there is a tie majority regarding whether sunscreen can prevent premature ageing, strongly agree with 32.5% and disagree with 33%. Another study found that 72%, which amounts to a significant majority of its respondents, found that they agreed that sunscreen products are protective (9) and likewise, Sultana (11) discovered that 64% of the respondents think that sunscreen is not harmful to the skin in any way.

However, a majority of individuals with good perception regarding sunscreen may also be seen as quite hard to achieve. More studies found a higher percentage of people having misconceptions and wrong notions regarding sunscreen. For example, a study conducted by (8) on dermatology patients in Saudi Arabia found that a total of 58.3% of the participants stated that they did not know if sunscreen was safe to use. A total of 54.5% did not believe that sunscreen was necessary for sun protection and a vast majority of 67% did not believe it was effective in preventing skin cancer. These were quite alarming percentages, as dermatology patients commonly meet up with their physicians and should be educated and endorsed on using sunscreens by their respective physicians.

In addition, a study by Cao et. al. (10) in Dallas, Texas also found that many people are still unaware of the dangers of prolonged sun exposure and the advantages of wearing sunscreen, as 42% of participants do not believe that all sun exposure could damage the skin and 33% did not believe sunscreen use prevents signs of skin ageing. Another study conducted among traffic police in Kathmandu found that 19% of the officers believed that sunscreen was for mere cosmetic purposes, while 10.9% believed that sunscreens make skin soft (21).

It would be worthwhile to investigate athletes' perception regarding sunscreen, as they may spend a significant amount of time outdoors, and exposure to the sun is often a part of training and competition routines. A study conducted by de Castro Maqueda et. al. (20) on elite kitesurfers stated that participants had a positive perception of sunscreen, as 87.5% of respondents had answered agree or totally agree on the item "It's a good idea to use sunscreen cream", meanwhile 31.9% agreed

with "I don't like using sunscreen cream.". However, another study conducted by the same author in 2021 (23) mentioned that some athletes cited discomfort and impaired sports performance as reasons for not reapplying sunscreen. Those athletes have commented that contact with the water can lead to sunscreen entering the eyes thus causing irritation. These reports might give an insight on why a number of athletes may have negative perceptions of sunscreen.

Practice of Sunscreen

The prevalence of sunscreen use might vary according to location, population, culture and many more. Furthermore, in most of the studies conducted regarding sunscreens, the amount of people wearing sunscreens does not mean that most of them have the correct usage of sunscreen. A study in Saudi Arabia by Al-Jasser et. al. (12) stated that 51% of the students used sunscreen, however only 35% applied sunscreen on both sunny and cloudy days and 45% applied sunscreen only when doing outdoor activities. A study in Dallas, Texas stated that only 30% of its respondents used sunscreen on a daily basis, 32% did not use sunscreen in a typical week and 59% applied sunscreen only when anticipating more than one hour of sun exposure (10). Moreover, a study conducted in Ireland by Cetintepe et. al. (24) stated that 76% of the respondents reported using sunscreen, however, only 17% of the respondents reported using sunscreen correctly.

According to the American Academy of Dermatology (AAD), the recommended amount of sunscreen per application is 1 ounce or approximately 28 grams. One study in Saudi Arabia found that 50% of its participants apply less than a quarter teaspoon amount of sunscreen, and 41% apply a quarter to half a teaspoon (12). Another study in Saudi Arabia asked participants whether they knew how much sunscreen is needed; a small percentage of 3% knew how much they needed while the remaining 97% did not know (6). Hence, the sunscreen applied is inadequate to cover the entire area intended. This could lead to sunscreen application being inefficient to protect the skin from ultraviolet radiations.

Sun protective measures do not limit to sunscreen use only. Wearing long-sleeved pants or shirts, wearing hats and sunglasses, as well as staying in the shade are some of the sun protective measures that we can adopt.

However, using sunscreens on top of these sun protective behaviours may optimise protection against the Sun. A study by Almuqati et. al. (9) found that the most commonly used sun protection methods among its participants were seeking shade (58.1%) and wearing protective clothing (43.1%), and sunscreen users made up only one third of the sample (23.6%). A study focused on men's attitude regarding skin cancer prevention found that 48.0% of men reported using sunscreen, 53.5% reported wearing sunglasses, and 40.2% reported wearing a baseball cap or sun visor (25). Lastly, a study conducted in Ohio by Axcell et. al. (26) stated that the most common protective measures among men were wearing hats with 70% and wearing sunglasses with 60%. These data show that sunscreen usage is not the most popular means of protecting oneself against the sun.

The recommended Sun Protection Factor (SPF) of a sunscreen according to the American Academy of Dermatology is a sunscreen with an SPF 30 or higher and a broad-spectrum sunscreen; which protects from both ultraviolet A (UVA) and ultraviolet B (UVB). 75.9% reported using sunscreen with a sun protection factor >15 (27). 46.5% used SPF of 30-50 (21). In Malaysia, 46.4%, which is the majority of the respondents, used sunscreen lotion with SPF more than 30, 39.3% used SPF between 15 to 30 and only 14.3% used SPF less than 15 (16). Lastly, a study by Almuqati et. al. (9) found that 35.1% among participants who used sunscreen used SPF 50, and 17.4% used sunscreen products with an SPF 70 or higher. These studies suggest that the SPF value might be well understood among populations, as the majority of them opted to use sunscreens with SPF more than 15.

Reapplication is crucial when using sunscreen, as its effectiveness diminishes over time due to factors such as sweat, water exposure, and natural degradation due to limited duration of protection, of which we can determine by looking at its SPF number. The American Academy of Dermatology (AAD) determined that the appropriate time intervals for reapplication is about two hours or immediately after swimming or sweating. A study conducted by Conahan et. al. (13) on patients with melasma found that only 7.6% patients followed AAD's endorsement of reapplying every 2 hours. To add on, most patients stated that they "always" wear sunscreen, but 77% did not reapply sunscreen at recommended intervals. Moreover, studies in Saudi Arabia suggested that a vast 62% do not reapply sunscreen throughout the day (12), and that 32.4% reapply sunscreen every 8 hours (28). These studies suggested that a lot of individuals are

still unfamiliar with the knowledge and habit of reapplying sunscreen.

Another aspect of sunscreen practices that need to be looked into is parts of the body where sunscreen is applied. By right, sunscreen should be applied on body parts that were exposed to prevent sun damage. This must include body parts other than the face such as hands and neck. A study done on schoolchildren in Malaysia (16) stated that respondents reported that 69.7% of respondents apply SPF sunscreen on face, 53% on hands and 15.9% on legs. A study on healthcare workers in Nepal found that 62.1% of participants applied sunscreen only on the face, followed by face and neck with 48.4% and 12.1% of respondents applied sunscreen on arms (21). We can observe through these data that the majority still have misconceptions on applying sunscreens on exposed parts of the body, instead they still apply sunscreen only on the face.

Some of the papers included in this literature review also discussed barriers and reasons on why some of the participants did not use sunscreen. A study conducted in Peru (7) reported that one of the biggest barriers hindering sunscreen use is forgetting to apply it and lack of habit. Similarly, another study also found that the most common reasons for not using sunscreen were forgetfulness by 38.5% and 33.5% of respondents believe that it is not necessary (11). Moreover, a research by Weig et. al. (29) reported that 33.7% of patients dislike the feel or appearance of sunscreen and 15.3% reported time constraints. Additionally, 16.4% stated that the cost of sunscreen products are barriers for them to use sunscreen.

Factors Associated with Practice of Sunscreen

Sex

One common denominator that we can observe clearly in studies regarding sunscreen practice is that statistically there are more women who use sunscreen than men. Pengpid and Peltzer (30) carried out research on 26 universities in 25 countries across Asia, Africa and America. Using multivariate logistic regression, it was discovered that using sun protection was related to a number of factors, including being female, young age, living in an upper middle-class or high-income country, having lighter skin tone, and coming from an affluent or fairly well-off family background. This implies that these groups may have greater awareness of the value of using sunscreen and protecting themselves

from the sun.

To further support claims that women are more influenced in using sunscreens, a study by Al-Ghamdi et. al. (14) found that women reported a higher rate of sunscreen use compared to men. Study done by Al-Jasser et. al. (12) in Saudi Arabia stated that women were approximately 10 times more likely to use sunscreen than men. To support the previous statement, other studies done in Saudi Arabia (28) found a higher proportion of females using sunscreen (61%) compared to males (36%), and 56.9% of women had a good knowledge level compared to 28.2% of males (15). Moreover, Olivet et. al. (31) discover that female students in the United States of America are more likely to correctly identify the photo-ageing benefits of sunscreen ($p = 0.022$).

Likewise, if we look into Malaysian context, a study (16) stated that females take better care of themselves from UV exposure as compared to males, and according to Nuruljannah et. al. (32), female respondents in this study were more likely to utilise sunscreen compared to male respondents.

Concerning men's motivations on sunscreen usage, a study done by Adams et. al. (25) reported that 74.4% of men stated that their skin type either always, often, or moderately burns, blisters, or peels in response to the sun. However, only 17.1% reported daily use of sunscreen, 38.6% reported weekly use, 16.1% reported monthly use, and 28.3% reported using sunscreen infrequently. Likewise, another study by Roberts et. al. (33) stated that a vast majority of 83% of men did not use sunscreen daily. These findings indicate that men are not fully interested in using sunscreen as a sun-protection behaviour, despite constantly having sunburns.

Fitzpatrick Skin Phototype Classification (FSPC)

The Fitzpatrick Skin Phototype Classification (FSPC) is a common factor that can be found in every research that studies the relationship between the skin and the Sun and its effects. Dr. Thomas Fitzpatrick, a Harvard University dermatologist, developed the Fitzpatrick Skin Phototype Classification (FSPC) in 1975. This system categorises skin types based on the amount of pigment in the skin and its reaction to sun exposure. This scale may aid in estimating an individual's overall risk of sun damage and skin cancer. This well-known scale's validity and reliability are widely accepted, and it has been used in numerous research studies. Hence, the Fitzpatrick Skin Phenotype Classification has been the standard guide for the classification of skin

types. The Fitzpatrick scale consists of: Type I "always burns, never tans (palest; freckles), Type II "usually burns, tans minimally" (light colored but darker than fair), Type III "sometimes mild burn, tans uniformly" (golden honey or olive), Type IV "burns minimally, always tans well" (moderate brown), Type V "very rarely burns, tans very easily" (dark brown), Type VI "never burns" (deeply pigmented dark brown to darkest brown).

However, there has been some criticism towards FSPC as the benchmark on assessing photodamage caused by the Sun on human skin, specifically for people not from European descent. The Fitzpatrick classification, which was originally developed to categorise white skin based on ultraviolet radiation sensitivity, has been identified as less useful in people of colour, particularly people of African descent, Asians, Arabs/Mid-Easterners, and lighter-skinned Hispanics (34). When skin photosensitivity in individuals with darker skin is oversimplified, it may result in health disparities. Moreover, the FSPC system depends on human memory and interpretation of their skin sensation. The terms used to describe the frequency of burning and tanning can be difficult for people to understand, and some individuals may believe that none of the response options adequately describes their skin type (35). Nevertheless, no other skin classification has superseded FSPC by far.

In terms of sunscreen use, most studies found that individuals with Fitzpatrick skin classification of I, II, and III have a higher rate of using sunscreens than type IV, V and VI. In general terms, this means that people with a lighter skin tone have a greater likelihood for using sunscreens than people with darker skin tones. A study done by Weig et. al. (29) stated that lower Fitzpatrick skin types are more likely to use sunscreen. In addition, knowledge of the correct time to apply sunscreen before sun exposure was higher among those with Fitzpatrick skin types I, II, and III with 55.1% compared to those with skin types IV, V, and VI with 44.9% (8). Lastly, a study conducted by Abdullah et. al. (28) also reported a higher proportion of individuals with skin phototypes I, II and III using sunscreen compared to those with skin phototypes IV, V and VI, with p-value of 0.042. Those figures found in various studies could occur because people with lighter skin are commonly known to have a higher probability of getting skin cancer, as their skin contains less melanin than people with darker skin types.

Age

Another factor that increases likelihood of sunscreen use is age. Most studies found that people of younger age are more associated with sunscreen use. According to research by Alshayeb et. al. (15), they discovered that 54.1% of young participants aged 18-25 had good knowledge of sun protection measures compared to 42.4% of those aged over 45 years. Moreover, another study found that approximately 60% of younger participants below the age of 40 years used sunscreen, while only 38.1% of those above the age of 40 used sunscreen (6). Participants in another study in Brazil that are over 40 years of age showed higher probability of non-use of sunscreen (36).

Education Level

Similarly, another factor that may increase likelihood of sunscreen usage is education level. A research conducted by Silva et. al. (36) stated that a higher probability of not using sunscreen could be linked with lower educational level. Study conducted by Al-Balbeesi et. al. (8) also came to a conclusion that the rate of sunscreen use is higher among the participants with a postgraduate education than among those with undergraduate and high school education.

History of Sunburn

One study revealed that there was a trend towards increased likelihood of sunscreen use in participants who had more sunburns in the past. Participants with a history of more than three times getting sunburns in the past were approximately 5 times more likely to use sunscreen (12). In addition, another study (28) reported a higher proportion of individuals who have experienced one or more sunburns using sunscreen compared to those who have not experienced any sunburns, with a p-value of 0.024. To add on, the percentage of respondents who adopt a higher level of sun protection is higher among those who have suffered sunburn four times or more compared to those who have suffered sunburn fewer times or never (11).

Relationship Between Knowledge and Practice of Sunscreen

Knowledge influences our behaviour by shaping our thought process, influencing attitudes and beliefs and providing information about risks and benefits. Hence, logically, people who had knowledge regarding ultraviolet radiation, sun damage and sunscreen should be able to be motivated on using sunscreen. Based on the study

by Novitasari et. al. (19) respondents who had good knowledge about sunscreen were more likely to use sunscreen. Moreover, according to a study by Cetintepe et. al. (24), there was a positive correlation between workers' knowledge about skin cancer and sunscreen use. This implies that employees who were better informed about skin cancer might have thought more favourably of sunscreen and its value in preventing skin cancer.

While it is true that knowledge might encourage someone to start to use sunscreens, however, one study in Saudi Arabia concluded that the rate of sunscreen application between the health and non-health course students was equivalent despite health course students scoring a higher knowledge level (9). According to the Skin Cancer Organization (4), it is recommended to apply sunscreen on all parts of the body that is directly exposed to the Sun. However, only 11% of both courses adhere to the recommendation. Another example that we can see is one study where 96.2% of the respondents know that sun exposure can cause harmful effects to their skin yet only 42.4% of them wear sunscreen (16). This shows that despite a previous knowledge of sun exposure and its damages, some people still lack effort on protecting their skin.

DISCUSSION

The knowledge of sunscreen and its importance in protecting against harmful UV radiation is generally widespread but still contains significant gaps and misconceptions. Studies from diverse regions highlight a common understanding that sun exposure is harmful. For instance, in Malaysia, while 96.2% of schoolchildren are aware of the dangers of sun exposure, only 42.4% use SPF sunscreen lotion regularly (16). This discrepancy between knowledge and practice is alarming, especially since a significant percentage of these children continue to expose themselves to peak solar radiation and experience sunburns.

Furthermore, misconceptions about sunscreen use are prevalent among various demographics. Spanish cyclists, for example, displayed a particularly low level of understanding regarding the protective benefits of sunscreen against skin cancer (17). Similarly, university students in Saudi Arabia often mistakenly believe that sunscreens only protect against cancer and not other forms of sun damage (18).

The misunderstanding extends to the necessity of sunscreen during non-summer months or while indoors. In Jordan, many participants did not see the need for sunscreen during winter or indoors (6), while in Peru, only a small fraction of medical students recognized the need for sunscreen on cloudy days (7). Contrastingly, medical students in Indonesia demonstrated better knowledge, with a substantial proportion understanding the need for broad-spectrum sunscreens and indoor application (19).

Regarding SPF knowledge, it is clear that there is a widespread misunderstanding of the effectiveness of different SPF levels. Many individuals are unaware that higher SPF values do not necessarily mean prolonged protection, nor do they apply sunscreen adequately or frequently enough. Studies in Saudi Arabia revealed that a significant percentage of participants were unfamiliar with SPF values and their implications (8,9).

Perceptions towards sunscreen are varied and often reflect significant gaps in understanding and trust in its efficacy. While some studies indicate a positive perception, such as in Pakistan where a majority recognize the protective benefits of sunscreen (22), other studies reveal substantial skepticism and misinformation. For example, a significant portion of dermatology patients in Saudi Arabia did not believe in the necessity or effectiveness of sunscreen (8). Athletes, who spend considerable time outdoors, also show mixed perceptions. While elite kitesurfers generally agree on the importance of sunscreen, issues like discomfort and impaired performance during sports activities can hinder consistent use (20,23). Reported side effects which is stated to be an obstacle to use sunscreen included disliking sunscreen textures, irritation, acne, increased sweating and skin darkening (6). Another study by Weig et. al. (29) stated that personal barriers to sunscreen use included dislike of sunscreen texture too, which may prompt researchers to formulate sunscreens that are tailored to these problems.

The practice of sunscreen use is inconsistent and often inadequate. The frequency and correct application of sunscreen are major concerns. For instance, while a significant number of individuals use sunscreen, many do not apply it correctly or consistently. In Saudi Arabia, only a minority know the proper amount of sunscreen required for effective protection, and many apply less than recommended (12). Similarly, reapplication practices are often neglected, with many users not adhering to the recommended reapplication intervals (13).

Moreover, sunscreen use is not the predominant method of sun protection. Other protective measures, such as wearing protective clothing and seeking shade, are more commonly adopted (9). However, combining these methods with sunscreen could offer optimal protection. The SPF value of sunscreens used also varies, with a notable preference for higher SPF values, which is encouraging. Yet, knowledge about reapplication and the correct amount to apply remains low, affecting overall efficacy.

Several factors influence sunscreen use, including sex, skin type, age, education level, and history of sunburn. Women generally show higher sunscreen usage rates than men, possibly due to greater awareness and concern about sun exposure's impact on skin appearance (14,16). The statistics of women constantly being the majority in sunscreen use as found in multiple articles could occur because women are more likely to be aware of the risks associated with sun exposure and to be concerned about their appearance, which influences their knowledge of and attitudes toward sunscreen. Lighter-skinned individuals are more likely to use sunscreen compared to those with darker skin tones, likely due to the higher perceived risk of skin cancer (8,29).

Younger individuals and those with higher education levels are also more likely to use sunscreen, reflecting better access to information and health literacy (15,36). Younger people tend to use social media the most compared to older people. Hence, younger people have easy access to information about skincare and sun protection, especially those who grew up in the digital age. Information on the benefits of sunscreen is shared through mainstream social media. We can also see more skincare brands that primarily utilize social media as its main sources of advertisement, as well as using individuals and celebrities with huge followings on the social media as their ambassadors, which may attract youngsters. This could be one of the primary causes of younger age being a link towards sunscreen use. Not to mention, the association between higher education and increased sunscreen use can be explained by increased access to scientific information due to furthering education, an increased health literacy due to chances of expanding knowledge as well as a higher income which allows access to information and products.

Based on the insights observed above, policymakers may develop a thorough public

health campaign to raise awareness about the importance of sunscreen, correct misconceptions, and highlight its benefits. Targeted education tailored for specific demographics that use less sunscreen based on the factors found from various studies is vital to ensure equality in education and promoting skin health to people of all background. Moreover, schoolchildren in Malaysia are constantly exposed to the sun, hence integrating sunscreen education into school curriculum by creating school policies to promote sun safety, educational programs, providing sunscreens to school to ensure accessibility to all students and practical demonstrations is needed. Parental involvement is encouraged as learning process begins at home, and parents may also benefit by improving their sun protection behaviours. Workplace and public space initiatives, such as guidelines for outdoor workers and informational signage in public places, may support these efforts. Regular evaluation is important to help monitor effectiveness and to update existing guidelines.

CONCLUSION

In conclusion, this analysis of various studies emphasizes the diverse perceptions and practices related to sunscreen knowledge, perception and practice. Opinions and habits regarding sunscreen are varied and positive views of sunscreen frequently coexist with common misconceptions. Moreover, certain demographics are more knowledgeable and adopt sun protection behaviours better, such as women, younger people, fair-skinned individuals, people with history of sunburn and higher educational level. While some individuals adhere to sunscreen use, there is a notable percentage that does not incorporate sunscreen into their daily skincare routines.

Correct application also remains a challenge to tackle while educating the public on sunscreen as photoprotection. Knowledge gaps are evident, ranging from the recommended amount of sunscreen to the significance of SPF values and the necessity for reapplication. Additional sun protection measures, such as seeking shade and wearing protective clothing, are acknowledged but may not always be prioritized over sunscreen. The findings highlight the importance of targeted education campaigns to address misconceptions, enhance knowledge, and establish consistent and correct sunscreen practices for better skin health.

Future research should focus on addressing key gaps identified in current studies of sunscreen use. Notably, there is a need to better understand why high levels of awareness do not always translate

into consistent usage. Investigating the effectiveness of educational interventions could enhance the adoption of proper sunscreen practices. In addition, exploring the barriers to correct application and reapplication would provide valuable insights. Lastly, evaluating the effectiveness of various sun protection strategies that combine sunscreen with other protective measures could offer a more comprehensive approach to reducing sun damage and skin cancer risk.

CONFLICT OF INTEREST

The authors affirm that there are no conflicts of interest associated with this study.

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AUTHOR CONTRIBUTIONS

NYAH, MAIR, NMA: Drafted the manuscript and contributed to the conceptualization, design, data collection, analysis, and interpretation for the article.

NAM: Critically revised the manuscript, enhancing its intellectual content, and approved the final version.

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