



# Awareness and knowledge of sun exposure and use of sunscreen among adults in Aseer region, Saudi Arabia

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## ABSTRACT

**Background:** Excessive sun exposure and inadequate sunscreen use can lead to skin cancer and other harmful effects on the skin, eyes, and immune system.

**Purpose:** This observational cross-sectional study aimed to assess awareness and knowledge of sun exposure and sunscreen use among adults in the Aseer region, Saudi Arabia. This study also focused on evaluating the risks of skin cancer and participants' sun-protective attitudes and practices.

**Methods:** A population-based cross-sectional study was conducted among adults in the Aseer region, Saudi Arabia. Data were collected using a questionnaire from November 2022 to January 2023 that assessed participants' knowledge, practices, and beliefs regarding sun exposure and sunscreen use. A total of 400 participants were selected for the study. Approval for the study was granted by the Local Research Ethics Committee of the University of Bisha, Saudi Arabia.

**Results:** The results revealed that (59.8 %) of the participants were female, while (40.3 %) were male. Regarding age, the majority fell within the 26–35 age range (37.5 %), with (16.0 %) of participants using sunscreen regularly, with a total of (74.0 %) of participants using sunscreen. Men exhibited a higher prevalence of negative attitudes towards sun protection, while women demonstrated more favourable sun protection practices. In addition, (1.25 %) of the participants had skin cancer in the past; (81.0 %) of participants agreed that skin cancer could cause death, while (19.0 %) were unsure of the effects of skin cancer. Moreover, the results indicated that sun exposure had a significant positive effect on awareness levels ( $p < 0.05$ ), indicating that increased sun exposure was associated with higher awareness of the harmful effects of the sun. Additionally, awareness level significantly positively affected sunscreen use ( $p < 0.01$ ), suggesting that individuals with higher awareness were more likely to use sunscreen.

**Conclusion:** There was an average awareness of sun exposure and its detrimental effects. In addition, a significant portion of the population demonstrates proactive measures to minimize sunlight exposure. However, sunscreen usage among Saudi adults was low despite having knowledge and awareness. Future research must enhance sun protection practices and reduce sun-related skin damage in the Aseer region.

## 1. Introduction

The skin is a protective barrier separating the body's internal environment from the external surroundings, which is vital in preserving overall well-being (Luger et al., 2021). Ultraviolet (UV) radiation emitted by the sun is a mutable environmental peril widely known as the primary contributor or a pivotal carcinogen to the onset of skin cancer (Al Robaee, 2010). Ultraviolet A (UVA) and Ultraviolet B (UVB) radiation have been linked to carcinogenesis within the solar radiation spectrum. Exposure to UV radiation during childhood and adolescence is identified as a crucial factor in the future development of skin cancer

(Alsudairy et al., 2019). Greater exposure to sunlight is the primary factor responsible for detrimental effects on the skin, eyes, and immune system. Notably, four out of five skin cancer cases can be prevented, and reducing sun exposure can minimize the harmful effects of UV radiation (Sultana, 2020). Short-term exposure to UV radiation can lead to acute skin damage, including sunburn and tanning. Conversely, long-term exposure to UV radiation can result in chronic skin diseases such as hyperpigmentation (e.g., solar lentigines, freckles, and melasma), skin aging (e.g., visible blood vessels and loss of skin elasticity), the altered immunological response of the skin, disturbance of skin barrier functions, photodermatoses, and the development of skin cancer (Almuqati

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et al., 2019; Beshna et al., 2022; Passeron et al., 2020).

Skin cancer is the most prevalent cancer observed in humans (Al-Atif, 2021; Qadir, 2016). Skin cancer predominantly emerges within various layers of the skin, particularly the epidermis, which is easily detectable. The propensity for developing skin cancer differs based on individual factors such as skin colour and skin type (Gupta et al., 2016). The incidence of skin cancer is generally lower among individuals with darker skin tones compared to those with lighter skin tones. This can be attributed to higher levels of epidermal melanin, which provides greater photoprotection. Melanin acts as a natural sunscreen by absorbing and scattering UV rays, thereby reducing the penetration of UV radiation into the deeper layers of the skin (Passeron et al., 2020). Hereditary factors also play a role in developing skin cancer (Qadir, 2016).

Fig. 1 illustrates the UVB and UVA radiation transmission rates in different skin colours. The black epidermis has a lower UVB transmission rate of 7.40 % and UVA of 17.5 %, while the Caucasian epidermis allows higher UVB transmission rates of 24 % and UVA of 55 %, respectively.

Skin cancer, comprising both Melanoma and Non-Melanoma Skin Cancer (NMSC), is a neoplastic condition primarily affecting the skin (Almutlaq et al., 2021; Woo et al., 2022). NMSC is a widely prevalent form of cancer, showing a rising incidence globally. NMSC refers to all malignant growths on the skin that are not associated with melanocytes (Woo et al., 2022). It is strongly correlated with the formation of various skin malignancies, notable Basal Cell Carcinoma (BCC), Squamous Cell Carcinoma (SCC), collectively called Keratinocyte Cancer (KC), comprising up to 99 % of cases and certain melanoma variants (Al Robaee, 2010; Szumera-Ciećkiewicz & Massi, 2021; Woo et al., 2022). Additionally, it is causally linked to other diseases of skin impairment, such as sunburn and photoaging, such as sagging, wrinkling, and photocarcinogenesis (Agarwal et al., 2018; Al Robaee, 2010). Solar keratosis, benign growths associated with sun exposure, are significantly more prevalent, occurring at least ten times more frequently than skin cancers (Qadir, 2016). Moreover, Malignant Melanoma (MM) is recognized as a fatal type of skin cancer, accounting for 75 % of all deaths related to skin cancer (Woo et al., 2022). Over the past four decades, skin cancer incidence and mortality rates have consistently risen, accounting for 1 in 3 cancer cases worldwide (Olsen et al., 2019). Skin cancer ranks 9th among individuals in Saudi Arabia, and the regions with the highest Age-Specific Rates (ASR) of skin cancer in Saudi Arabia were as follows: Riyadh had a rate of 4.4 cases per 100,000 people, Tabuk had a rate of 4.3 per 100,000, Jazan had a rate of 3.8 per 100,000, the eastern region had a rate of 3.6 per 100,000 and both the northern and Qassim regions

had a rate of 3.4 per 100,000 each (AlSalman et al., 2018).

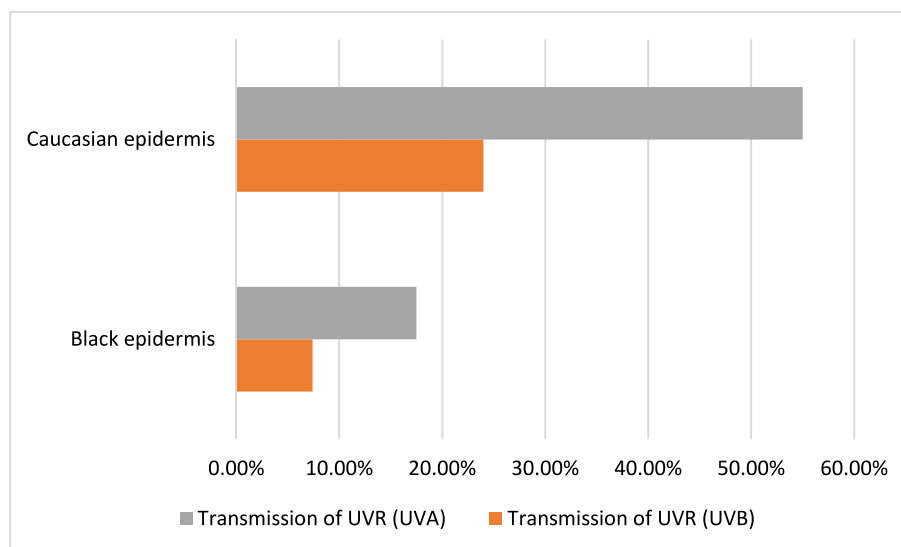
Table 1 compares different types of skin cancer based on their severity and occurrence.

Moreover, UV radiation affects immune responses in sun-exposed areas and suppresses aberrant immune responses throughout the body, even in non-exposed regions (Olsen & Whiteman, 2020). As a result, the influence of UV radiation on the immune system can be described as immune modulatory rather than solely immune suppressive, as it involves a complex interplay of immune processes (Neale et al., 2023). Therefore, sun protection is a crucial primary preventive measure to mitigate the adverse effects of sun exposure on the skin (Almuqati et al., 2019). The key recommendations for effective sun protection include minimizing sun exposure between 10 a.m. and 2 p.m., seeking shade, utilizing broad-spectrum sunscreen or sunblock products, and wearing wide-brimmed hats, protective clothing, and sunglasses. Adhering to these practices helps to safeguard the skin from the harmful effects of UV radiation and reduce the risk of sun-induced damage (Almuqati et al., 2019).

Sunscreens are cosmetic products that contain UV filters as active compounds (Santos et al., 2022) and are designed to protect against the penetration of UV radiation into the skin when exposed to sunlight and solar erythema (Beshna et al., 2022). Applying sunscreen is essential for preventing actinic keratosis and lowering the chance of developing skin cancer (Agarwal et al., 2018). Consequently, organic and inorganic sunscreen filters the UVR emitted by the sun with different absorption spectrums (Bens, 2014), reducing its penetration into the skin (Serpone, 2021). On the contrary, sunblocks work by reflecting the sun's rays away from the skin's surface, creating a physical barrier. Both sunscreen and sunblock with UVA/UVB and physical blocks protect against diseases and conditions caused by sun exposure (Williams et al., 2018). Regular use of sunscreen effectively prevents the occurrence of photo-induced and photo-aggravated dermatoses. Sunscreens have obtained approval from regulatory bodies such as the Food and Drug Administration (FDA) for their efficacy in preventing sunburn, photo-induced pigmentation disorders, premature aging of the skin, and the

**Table 1**  
Non-Melanoma Skin Cancer.

| Types                   | Severity    | Occurrence                           |
|-------------------------|-------------|--------------------------------------|
| Basal cell carcinoma    | Less severe | Most widely occurred cancer          |
| Squamous cell carcinoma | More severe | Less occur than basal cell carcinoma |
| Melanoma                | Most severe | It occurs rarely                     |



**Fig. 1.** Comparison of UVR Transmission in Different Skin Colours.

development of carcinoma (Health & Welfare, 2018). A sunscreen with a Sun Protection Factor (SPF) of 15–100+ is designed to prevent a significant amount of ultraviolet rays (UVR) from penetrating the epidermis (Egambaram et al., 2020). However, a sunscreen with SPF 10 also provides some level of protection against UVR, but to a lesser extent than SPF levels that are greater (Hughes et al., 2021). Sunscreens enhance the skin's ability to tolerate UV radiation by reflecting, absorbing, and scattering the incoming rays (Agarwal et al., 2018; Wolverson & Wu, 2019).

Additionally, sunscreens should possess cosmetic appeal and be convenient to apply and spread to encourage compliance, ensuring a consistent distribution of UV filters across the skin's surface, forming a uniform film (Gonzalez-Bravo et al., 2022). Suncare products are available in various forms, such as oils, creams, lotions, sprays, gels, and sticks. Sunscreens contain different UV filter agents, moisturizers, and preservatives and often include additional photoprotectants like antioxidants (Reichrath et al., 2014). It is recommended to apply sunscreen 15–30 min before sun exposure and reapply every two hours, especially after activities that may remove the sunscreen (Reichrath et al., 2014). Sunscreen products must protect against UVB and UVA radiation, with a minimum SPF of 6 for UVB and  $\geq 1/3$  for UVA. SPF is an internationally recognized indicator (Uzdrowska & Górska-Ponikowska, 2022). Skin protection against UVR based on SPF factors is classified in Table 2.

Table 2 outlines sunscreen protection levels based on the SPF. The level of protection defends against sunburn and UVR-induced skin damage. This helps individuals choose the most appropriate sunscreen for their needs.

SPF is a metric that quantifies the effectiveness of sunscreen in preventing the harmful effects of ultraviolet radiation. Higher SPF values indicate greater protection against sunburn, as they require more solar energy to induce skin damage. The following formula can calculate the value of the SPF factor:

$$\text{SPF} = \frac{\text{MED}_{\text{UVBProtected}}}{\text{MED}_{\text{UVBUnprotected}}}$$

Consequently, 90 % of skin cancers are linked to harmful radiation from sun exposure, emphasizing the significance of preventive measures such as sunscreen usage (Neale et al., 2023). Despite limited prior research on the correlation between sun exposure and sunscreen use, it is widely acknowledged that sunscreen plays a pivotal role in mitigating the risks associated with excessive sun exposure (Paiva et al., 2020). However, a significant percentage of the population does not know how to apply sunscreen for protection properly.

Therefore, this study aimed to assess awareness and knowledge of sun exposure, risks of skin cancer, sunscreen use, and sun-protective attitudes and practices among adults in the Aseer region, Saudi Arabia.

## 2. Material and methods

### 2.1. Study design

An observational cross-sectional study approach was used. The study questions were addressed using a population-based survey design, establishing the correlations between the variables.

**Table 2**  
Classification of Sunscreen Protection Levels Based on SPF Factor.

| Degree of Protection | SPF Factor |
|----------------------|------------|
| Minimum              | 2–12       |
| Low                  | <15        |
| Medium               | 15–30      |
| High                 | 50+        |
| Very High            | 50+–90++   |

### 2.2. Ethical approval

Approval for the study was granted by the Local Research Ethics Committee of the University of Bisha, Saudi Arabia. All the data was collected for research purposes only. The confidentiality of the data was intentionally maintained. All the participants' personal information was kept confidential and secure upon data collection. Moreover, the study was carried out in conformity with the EQUATOR (STROBE) guidelines and followed the University's ethical standards.

### 2.3. Study setting and period

The study was conducted among adults in the Aseer region, Saudi Arabia, from November 2022 to January 2023.

### 2.4. Sampling technique

The minimum sample size for this study was determined using the Raosoft website to ensure an appropriate sample size. The population of the Aseer region, based on data from the General Authority of Statistics, was 2.3 million individuals. To achieve a confidence interval of 95 % with a 5 % error margin, a sample size of around 385 participants was recommended. However, 400 participants were selected for this study in response to data collection requests. This sample size allowed for a representative sample that can provide reliable results and meaningful insights regarding awareness of sun exposure and sunscreen use among adults in the Aseer region. The data was collected using a pre-designed questionnaire covering all the essential items of the research. The questionnaire's parameters included age, gender, and other significant socio-demographics like educational attainment, marital status, residency, nationality, and median family income per month (in SR) questions about using sunscreen and awareness of sun exposure.

### 2.5. Study sample and population size

A population-based cross-sectional study was conducted among adults in the Aseer region, Saudi Arabia, from November 2022 to January 2023 to assess the general population's awareness of sun exposure and the use of sunscreen. A total of 400 participants were selected for the study. This significant sample size provided a substantial dataset for analyzing and evaluating the awareness levels, attitudes, and practices related to sun exposure and sunscreen use among adults in the study population. The study's inclusion criteria encompassed male and female adult participants from Saudi and non-Saudi residing within the Aseer region. Certain exclusion criteria were established to ensure the relevance and representativeness of the study findings. Individuals below 18 years were excluded from the study, as the focus was on the adult population. Additionally, individuals outside the Aseer region were excluded to maintain the study's geographical scope within the targeted region. By implementing these criteria, the study sought accurate insights into the study variables.

### 2.6. Data collection

A cross-sectional study initially decided how to operationalize variables and gather data. The primary researchers collected data from participants after studying the pertinent literature on the use of sunscreen and practices used by adults in Aseer, Saudi Arabia, and a self-administered questionnaire was devised for this study that queried individuals about their frequency and amount of sunscreen use. It was considered a close-ended question, where participants had to select a single answer from multiple choices. Data was collected through a soft copy of the questionnaire, distributed primarily through online social media platforms. The questionnaire was designed using Google Forms and was available in English and Arabic. The study encouraged the involvement of both male and female participants within the designed

age range and did not restrict participants to individuals with previous diagnoses of skin cancer. In general, all questionnaires were completed without any missing data. The study was conducted at a specific location (Aseer region) for a defined duration (3 months). Responses were gathered, and investigations were performed during the data collection process. Before any information was acquired, the data collection was planned. The questionnaire was modified to evaluate sunscreen usage, exposure awareness, and skin cancer risks.

## 2.7. Data analysis

The collected data were coded and tabulated using the appropriate statistical significance tests to determine the relationships between the variables. All data were entered into the SPSS (Statistical Software Package) Inc.'s (Chicago, IL, USA) version 20.0. The frequencies and percentages were used for the categorical variables, and a descriptive statistical analysis was performed to determine the frequency, mean, regression and standard deviation. A chi-squared test examined the significance between the sociodemographic data and the dependent variable. A p-value  $\leq 0.05$  was considered statistically significant. Moreover, Participants were instructed to respond to the survey items using a 5-point Likert scale, ranging from 1 (never), 2 (rarely), 3 (sometimes), 4 (often), to 5 (always).

## 3. Results

The results of the data analysis and the statistical interpretations of each variable based on the data collected from the questionnaire are represented in the results section. A 25-item research questionnaire was developed specifically aimed at Saudi adults in the Aseer region who were over 18 years old. The questionnaire underwent validation, clarity, and relevance checks through a pilot study. A descriptive analysis determines the sociodemographic characteristics of the study sample, as shown in Table 3, and an inferential analysis was conducted to address the study questions. Simple statistics, including frequencies and percentages, were employed. Categorical variables were analyzed using the

**Table 3**  
Sociodemographic Data of Participants (n = 400).

| Factors          |                     | Frequency | Percentage |
|------------------|---------------------|-----------|------------|
| Gender           | Male                | 161       | 40.3 %     |
|                  | Female              | 239       | 59.8 %     |
| Age              | 18–25               | 102       | 25.5 %     |
|                  | 26–35               | 150       | 37.5 %     |
|                  | 36–45               | 101       | 25.3 %     |
|                  | 46–60               | 45        | 11.3 %     |
|                  | Above 60            | 2         | 0.5 %      |
| Nationality      | Saudi               | 356       | 89.0 %     |
|                  | Non-Saudi           | 44        | 11.0 %     |
| Education        | PhD                 | 68        | 17.0 %     |
|                  | Masters             | 49        | 12.3 %     |
|                  | Bachelors           | 213       | 53.3 %     |
|                  | Diploma             | 19        | 4.8 %      |
|                  | High School         | 32        | 8.0 %      |
|                  | Intermediate School | 12        | 3.0 %      |
|                  | Primary School      | 4         | 1.0 %      |
|                  | Not Educated        | 3         | 0.75 %     |
|                  | Residency           | Abha      | 160        |
| Khamis Mushait   |                     | 86        | 21.5 %     |
| Bisha            |                     | 64        | 16.0 %     |
| Muhayil Aseer    |                     | 39        | 9.8 %      |
| Other            |                     | 51        | 12.8 %     |
| Marital Status   | Single              | 205       | 51.3 %     |
|                  | Married             | 170       | 42.5 %     |
|                  | Divorced            | 17        | 4.3 %      |
|                  | Widowed             | 8         | 2.0 %      |
| Financial Status | <5000 SR            | 132       | 33.0 %     |
|                  | 5000–10,000 SR      | 58        | 14.5 %     |
|                  | 10,000–20,000 SR    | 137       | 34.3 %     |
|                  | >20,000 SR          | 73        | 18.3 %     |

Chi-square test. A p-value of  $\leq 0.05$  was considered statistically significant.

Furthermore, regression analysis examined the relationship between sun exposure, awareness level, and sunscreen use. The analysis aimed to determine whether these variables had a significant association. The results revealed that sun exposure had a significant positive effect on awareness levels ( $\beta = 0.25$ ,  $p < 0.05$ ), indicating that increased sun exposure was associated with higher awareness of the harmful effects of the sun. Additionally, awareness level significantly positively affected sunscreen use ( $\beta = 0.32$ ,  $p < 0.01$ ), suggesting that individuals with higher awareness were more likely to use sunscreen. These findings highlight the importance of increasing awareness about sun exposure and its associated risks to promote the use of sunscreen for sun protection. Moreover, Table 10 provides statistical measures of sunscreen usage among (n = 400) participants. The table includes the categories of sunscreen usage, the mean score (2.87), p-value less than 0.05 (i.e., 0.002), confidence interval (95 %), variance (1.924), and standard deviation (1.387), which provides information about the variability or dispersion of the data.

Table 3 illustrates the participant's information. This descriptive profile provides an overview of the participant characteristics regarding gender, age, marital status, socioeconomic status, and educational attainment.

Table 3 presents a breakdown of participant characteristics. Among 400 participants, (59.8 %) were female, while (40.3 %) were male. Regarding age, the majority fell within the 26–35 age range (37.5 %); Saudi nationals accounted for (89.0 %) of the participants. Moreover, most participants had a bachelor's degree (53.3 %), and the largest group had a medium socioeconomic status (34.3 %).

Fig. 2 displays study participants' sociodemographic characteristics in a clustered column, representing percentages and frequency of each factor, including gender, age, marital status, socioeconomic status, and educational attainment.

Table 4 shows the participant's occupational data. Among 400 participants, (32.0 %) were employed, (57.3 %) were students, and (10.8 %) were unemployed. The data helps understand the study participants' occupational characteristics and sun exposure patterns.

Fig. 3 displays the occupational profile of the participants, illustrating their percentage distribution within occupational categories based on occupation location and peak sunshine duration.

Table 5 displays the frequency and percentage distribution of sunscreen use among study participants, with (16.0 %) of participants using sunscreen regularly, (22.0 %) rarely, and (21.8 %) never. Reasons for not using sunscreen include ineffectiveness, cost, time-consuming, inconvenience, allergies, and not knowing about it. Reasons for using sunscreen include avoiding skin cancer, sunburns, dark skin spots, aging, doctor recommendation, family or friend endorsement, social media guidance, and reading about it.

Fig. 4 displays participants' responses on sunscreen usage, categorizing it as Never, Rarely, Sometimes, Often, and Always. Reasons for not using sunscreen include ineffectiveness, cost, inconvenience, allergies, and lack of awareness. Sunscreen prevents skin cancer, sunburns, dark spots, aging, and recommendations from healthcare professionals, family, or personal research.

Table 6 reveals participants' sunscreen application habits and preferences, including daytime application, amount, timing, reapplication frequency, and preferred formulation. It reveals patterns and preferences in sunscreen usage. Moreover, it shows the reasons and time for exposure to the sun.

Table 7 reveals that (83.8 %) of participants avoid prolonged sun exposure, with (35.8 %) using UVA and UVB-protected sunscreen. Most use one tube per month, with (16.0 %) of participants using water-resistant sunscreen. Most have no skin cancer or family history, and (0.5 %) have experienced more than three sunburns. This information can inform public health interventions and educational campaigns to promote sun protection.

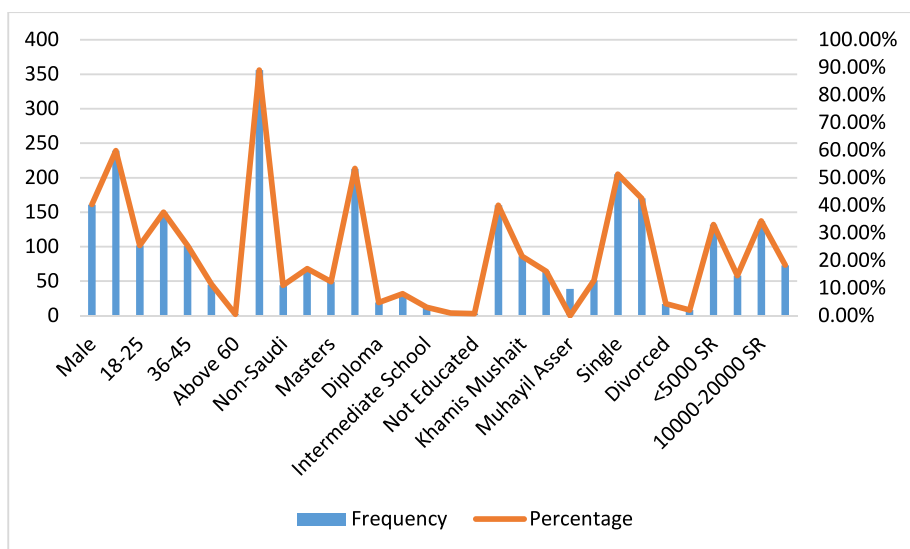


Fig. 2. Participant's information (n = 400).

Table 4 Occupational Characteristics of the Participants (n = 400).

| Status           |   | Frequency | Percentage |
|------------------|---|-----------|------------|
| Occupation       | Employee                                    | 128       | 32.0 %     |
|                  | Student                                     | 229       | 57.3 %     |
|                  | Unemployed                                  | 43        | 10.8 %     |
| Occupation Place | Outdoor                                     | 117       | 29.3 %     |
|                  | Indoor                                      | 283       | 70.8 %     |
| Time Duration    | Work more than 1 h per day in peak sunshine | 356       | 89.0 %     |
|                  | Work more than 3 h per day in peak sunshine | 44        | 11.0 %     |

Table 8 shows participants' awareness of sunscreen, SPF, potential skin cancer, and face cover adequacy, the most recognized benefits.

Table 9 shows participants' attitudes, behaviours, sun protection practices, and sources of information about the sun's harmful effects. Among 400 participants, (46 %) perceive a tan as healthiness, while (19 %) seek a tan or use tanning booths. Furthermore, (74 %) use sunblock/

sunscreens, and (18 %) rely on friends, family, and social media.

Fig. 5 illustrates the attitudes, behaviors, and practices indicating that 74 % of total participants use sunscreen for skin protection.

Table 10 provides additional statistical measures to assess the distribution and significance of the data.

#### 4. Discussion

This study evaluated sun exposure and sunscreen usage patterns among adults in the Aseer region, Saudi Arabia. Among 400 participants, (89.0 %) were Saudi nationals, with (40.0 %) residing in the Abha city. The study results showed that women exhibited higher sunscreen usage than men (Tilwani et al., 2018), which aligns with previous research highlighting women's greater awareness of the health risks associated with UV radiation exposure (Alsudairy et al., 2019; Cao et al., 2019). Furthermore, the results revealed that (59.8 %) of the participants were female, while (40.3 %) were male. Regarding age, the majority fell within the 26–35 age range (37.5 %), with (16.0 %) of participants using sunscreen regularly, with a total of (74.0 %) of

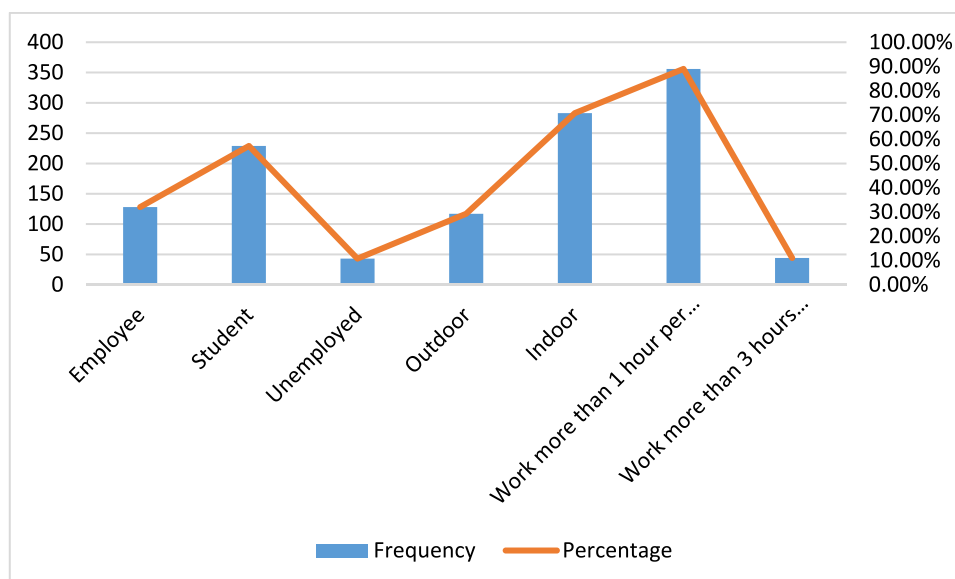


Fig. 3. Occupational Profile and Sun Exposure Patterns (n = 400).

**Table 5**  
Sunscreen Usage and Reasons Among Participants (n = 400).

| Sunscreen Analysis                    |   | Frequency | Percentage |
|---------------------------------------|---|-----------|------------|
| How often do you use sunscreen?       | Never                                       | 87        | 21.8 %     |
|                                       | Rarely                                      | 88        | 22.0 %     |
|                                       | Sometimes                                   | 79        | 19.8 %     |
|                                       | Often                                       | 82        | 20.5 %     |
| The reason(s) for not using sunscreen | Always                                      | 64        | 16.0 %     |
|                                       | It is ineffective                           | 80        | 20.0 %     |
|                                       | It is expensive                             | 132       | 33.0 %     |
|                                       | It is time-consuming                        | 76        | 19.0 %     |
|                                       | It is inconvenient                          | 82        | 20.5 %     |
| The reasons(s) for using sunscreen    | I have allergy                              | 11        | 2.75 %     |
|                                       | I have not heard about it                   | 19        | 4.75 %     |
|                                       | To avoid skin cancer                        | 112       | 28.0 %     |
|                                       | To avoid sunburns                           | 83        | 20.8 %     |
|                                       | To avoid the development of dark skin spots | 36        | 9.0 %      |
|                                       | To avoid skin wrinkling and aging           | 48        | 12.0 %     |
|                                       | Doctor recommendation                       | 45        | 11.3 %     |
|                                       | Family or friend endorsement                | 17        | 4.25 %     |
|                                       | Social media guidance                       | 29        | 7.25 %     |
|                                       | Read about it                               | 18        | 4.5 %      |
| Other                                 | 12  | 3.0 %     |            |

participants using sunscreen. It was further examined that individuals with a lower socio-economic status had a lower percentage of sunscreen usage than those with higher socio-economic statuses. These results align with previous research that highlighted the decreased prioritization of sun radiation protection among individuals in lower socio-economic groups, who often have other important things as life needs (Seité et al., 2017; Yan et al., 2015).

Most of the study participants were students (57.3 %), while (32.0 %) were employed. Among the employed participants, (29.3 %) worked outdoors, with (89.0 %) working more than 1 h per day in peak sunshine. In contrast, (70.8 %) of the participants worked indoors, with (11.0 %) working more than 3 h per day in peak sunshine. The data helps understand the study participants' occupational characteristics and sun exposure patterns. Among the 400 participants, (19.0 %) considered using sunscreen time-consuming, while (33.0 %) perceived it as expensive, and (20.0 %) believed it was ineffective. On the other hand, (28.0 %) of the participants used sunscreen specifically to avoid skin cancer, while (20.8 %) used it to prevent sunburns. Furthermore, (12.0

%) used sunscreen to protect against aging and wrinkles. Additionally, (11.3 %) of the participants applied sunscreen based on the doctor's recommendations. Consequently, among the participants, (35.5 %) applied sunscreen exclusively during outdoor activities, while (7.75 %) practised using it indoors as well. Additionally, (14.5 %) applied indoor and outdoor sunscreen, and (42.3 %) applied it whenever exposed to the sun. In terms of timing, (36.3 %) applied sunscreen less than 10 min before going out, (48.0 %) applied it 10–20 min before going out, and (15.8 %) applied it more than 20 min before going out. Moreover, (49.5 %) of the participants applied sunscreen in the recommended amount, a quarter to half of a teaspoon for the face. The findings of this study were consistent with previous research conducted by (Li et al., 2019; Mancuso et al., 2017). Among the participants, (37.3 %) reported reapplying sunscreen every two to three hours. Additionally, (5.3 %) of the participants stated that they reapply sunscreen after sweating excessively. However, (50.0 %) of the participants mentioned that they do not reapply sunscreen. These results were supported by the study conducted by Mancuso et al., 2017, which also emphasized the reapplication of sunscreen (Mancuso et al., 2017).

Likewise, the majority of the participants (62.3 %) preferred using sunscreen in a cream formulation, followed by (25.8 %) preferred lotion form. Only (3.0 %) of participants preferred spray formulation, which dermatologist does not recommend due to inadequate spread on the face. In line with the findings of Mancuso et al., 2017, participants in a study also showed a preference for the cream formulation of sunscreen (Mancuso et al., 2017). The study further found that a significant portion of the participants (15.5 %) reported being exposed to the sun for more than 3 h per day daily. Among them, the majority (56.8 %) experienced sun exposure between 8 a.m. and 3 p.m., considered the peak hours for UV radiation. Additionally, (32.0 %) of the participants reported sun exposure ranging from 1 to 3 h, mostly between 9 a.m. and 5 p.m. Reasons for sun exposure varied, with (58.5 %) attributing it to transportation, (29.0 %) to outdoor work or activities, and (1.25 %) for other reasons. It is noteworthy that (11.5 %) of the participants intentionally sought longer sun exposure, while the majority (83.8 %) actively avoided prolonged exposure to the sun.

Furthermore, the study findings demonstrated that most participants (70.5 %) were unaware of the meaning of SPF, indicating their lack of knowledge regarding the significance of sunscreen products. Additionally, (35.8 %) of the participants reported using sunscreens that protect against UVA and UVB radiations, indicating their adherence to comprehensive sun protection measures. However, it is important to

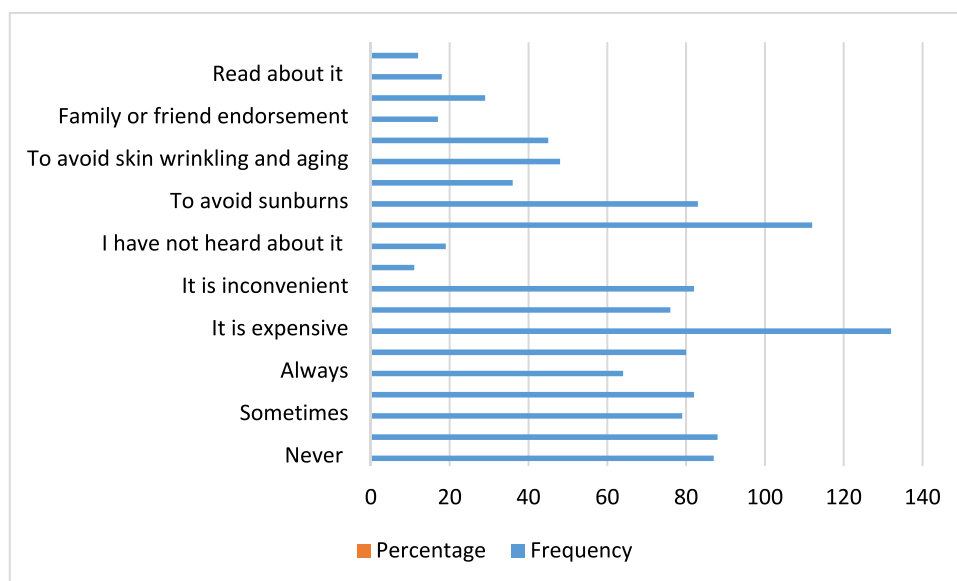


Fig. 4. Sunscreen Analysis (n = 400).

**Table 6**  
Sunscreen Application and Preferences (n = 400).

| Sunscreen Insights                               | Frequency                                 | Percentage |
|--|---|------------|
| When do you apply sunscreen during the day?      | Only with outdoor activity                | 142 35.5 % |
|  | Indoor                                    | 31 7.75 %  |
|  | With outdoor activity and indoor          | 58 14.5 %  |
|  | Whenever I am exposed to the sun          | 169 42.3 % |
| The amount of sunscreen applied to your face     | Less than a quarter of a teaspoon         | 158 39.5 % |
|  | Quarter to half of a teaspoon             | 198 49.5 % |
|  | More than half of a teaspoon              | 44 11.0 %  |
| When do you apply sunscreen before going out?    | Less than 10 min before going out         | 145 36.3 % |
|  | 10–20 min before going out                | 192 48.0 % |
|  | More than 20 min before going out         | 63 15.8 %  |
| When do you reapply sunscreen?                   | Every two to three hours                  | 149 37.3 % |
|  | After I sweat excessively                 | 21 5.3 %   |
|  | After I swim                              | 10 2.5 %   |
|  | After I take a shower                     | 20 5.0 %   |
|  | I do not reapply it                       | 200 50.0 % |
| What sunscreen formulation do you prefer to use? | Cream                                     | 249 62.3 % |
|  | Lotion                                    | 103 25.8 % |
|  | Spray                                     | 12 3.0 %   |
|  | Powder                                    | 3 0.75 %   |
|  | Stick                                     | 33 8.25 %  |
| Hours of sun exposure every day                  | Less than 1 h                             | 161 40.3 % |
|  | 1–3 h                                     | 177 44.3 % |
|  | More than 3 h                             | 62 15.5 %  |
| The time of exposure to the sun                  | 8:00 a.m. and 3:00 p.m.                   | 227 56.8 % |
|  | 9:00 a.m. or 5:00 p.m.                    | 130 32.5 % |
|  | All day                                   | 43 10.8 %  |
| The reason(s) for exposure to the sun            | Transportation from home to the workplace | 234 58.5 % |
|  | Leisure or recreational                   | 31 7.75 %  |
|  | Outdoor work or activity                  | 116 29.0 % |
|  | To get enough vitamin D                   | 14 3.5 %   |
|  | Other                                     | 5 1.25 %   |

note that a significant proportion (42.8 %) of the participants did not know about sunscreens with dual protection. In terms of usage, the majority (77.8 %) reported using 1 tube of sunscreen per month, suggesting regular application. Regarding affordability, (16.3 %) of the participants considered commercially available sunscreens affordable, while (72.8 %) held the opposite view. These findings highlight the study participants' varying awareness, practices, and perceptions of sunscreen usage.

In addition, (1.25 %) of the participants had skin cancer in the past, while (90.5 %) did not have a history of skin cancer, indicating a low prevalence of this condition in the study population. However, a significant proportion of participants (20.0 %) reported experiencing sunburn once. These findings underscore the importance of sun protection measures to prevent sunburn and potentially reduce the risk of developing skin cancer. As a consequence, (81.0 %) of participants agreed that skin cancer could cause death, while (19.0 %) were unsure of the effects of skin cancer. Furthermore, (73.8 %) of participants acknowledged that a face cover alone is insufficient and recommended applying sunscreen to all exposed areas of the body.

On the contrary, a smaller group of participants (36.0 %) practised applying sunscreen specifically on the face and hands, and an even smaller percentage (17.0 %) recommended applying it only on the face. As for sun protection practices, (34.5 %) of participants used a headcover, (18.0 %) covered their face, (21.8 %) wore sunglasses, (14.8 %) preferred to stay in shaded areas, and (11.0 %) used an umbrella. These results indicated the importance of comprehensive sun protection measures that include sunscreen application and other protective

**Table 7**  
Sunscreen Usage and Sunburn History (n = 400).

| Usage and History   | Frequency     | Percentage |
|---|---------------|------------|
| Do you tend to get sun exposure for a longer time intentionally?        | Yes           | 46 11.5 %  |
|   | No            | 335 83.8 % |
|   | I do not know | 19 4.75 %  |
| Do you use sunscreen that protects against both UVA and UVB radiations? | Yes           | 143 35.8 % |
|   | No            | 86 21.5 %  |
|   | I do not know | 171 42.8 % |
| How many tubes of sunscreen do you use per month?                       | 1             | 311 77.8 % |
|   | 2             | 58 14.5 %  |
|   | 3             | 20 5.0 %   |
|   | 4             | 8 2.0 %    |
|   | 5             | 3 0.8 %    |
|   | More than 5   | 0 0.00 %   |
| Do you use water-resistant sunscreen?                                   | Yes           | 64 16.0 %  |
|   | No            | 152 38.0 % |
|   | I do not know | 184 46.0 % |
| Do you think that commercially available sunscreens are affordable?     | Yes           | 65 16.3 %  |
|   | No            | 291 72.8 % |
|   | I do not know | 44 11.0 %  |
| Have you had skin cancer in the past?                                   | Yes           | 5 1.25 %   |
|   | No            | 362 90.5 % |
|   | I do not know | 33 8.3 %   |
| Did any family members have skin cancer in the past?                    | Yes           | 3 0.75 %   |
|   | No            | 282 70.5 % |
|   | I do not know | 115 28.8 % |
| How many sunburns have you had in the past?                             | 0             | 287 71.8 % |
|   | 1             | 80 20.0 %  |
|   | 2             | 22 5.5 %   |
|   | 3             | 9 2.3 %    |
|   | More than 3   | 2 0.5 %    |

**Table 8**  
Awareness Level Among Participants (n = 400).

| Knowledge Regarding Sunscreen                                | Frequency                                    | Percentage |
|--|--|------------|
| I know the meaning of (SPF) on sunscreen product             | Yes  | 118 29.5 % |
|  | No   | 282 70.5 % |
| Can skin cancer cause death?                                 | Yes  | 324 81.0 % |
|  | No   | 76 19.0 %  |
| I agree that a face cover is enough instead of sunscreen use | Yes  | 105 26.3 % |
|  | No   | 295 73.8 % |
| Which of the following do you often use during the daytime   | Headcover                                    | 138 34.5 % |
|  | Face cover                                   | 72 18.0 %  |
|  | Sunglasses                                   | 87 21.8 %  |
|  | Stay in shade                                | 59 14.8 %  |
|  | Umbrella                                     | 44 11.0 %  |
| Parts of the body to be covered with sunscreen               | Face only                                    | 68 17.0 %  |
|  | Face and Hands                               | 144 36.0 % |
|  | All exposed areas of skin                    | 188 47.0 % |
| As per your knowledge, what benefits sunscreen provides      | Protects the skin from ultraviolet radiation | 96 24.0 %  |
|  | Prevents darkening of the skin               | 83 20.8 %  |
|  | Protects the skin from aging                 | 52 13.0 %  |
|  | Prevents skin cancer                         | 79 19.8 %  |
|  | Prevents skin burns                          | 66 16.5 %  |
|  | Useless                                      | 24 6.0 %   |

measures such as clothing and accessories to minimize the risk of sun damage (AlGhamdi et al., 2016). Moreover, the results indicated that sun exposure had a significant positive effect on awareness levels ( $p <$

**Table 9**  
Attitudes, Behaviors, and Practices Among Participants (n = 400).

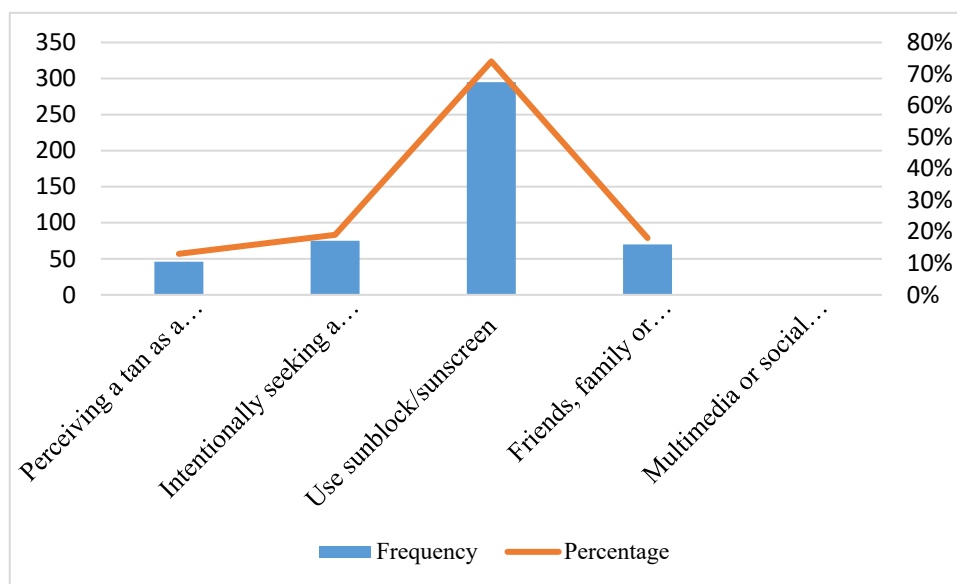
| Participants Insights                                      |  | Frequency | Percentage |
|--|--|-----------|------------|
| Attitudes  | Perceiving a tan as a sign of healthiness                              | 46        | 13 %       |
| Behaviour  | Intentionally seeking a tan or frequent utilization of a tanning booth | 75        | 19 %       |
|  | Use sunblock/sunscreen   | 295       | 74 %       |
| Sources of Information regarding the sun's harmful effects | Friends, family or personal experience and                             | 70        | 18 %       |
|  | Multimedia or social media sites                                       |           |            |

0.05), indicating that increased sun exposure was associated with higher awareness of the harmful effects of the sun. Additionally, awareness level significantly positively affected sunscreen use ( $p < 0.01$ ), suggesting that individuals with higher awareness were more likely to use sunscreen. According to experts, sunscreen products are recognized as the first line of defence and primary protective measure against the detrimental consequences of radiation exposure (Urasaki et al., 2016). Further, the findings of this study were in line with previous research in the same domain conducted among the Saudi population and worldwide (Bryant et al., 2015; Saridi et al., 2016; Ugurlu et al., 2016).

In a study, AlJasser et al., 2020, demonstrated that sunscreen application was a crucial strategy for sun protection, and a substantial cohort of Saudi university students evaluated its utilizations. The study showed that approximately half of the students (51 %) reported using sunscreen (AlJasser et al., 2020). In another cross-sectional study conducted across various regions of Saudi Arabia, the prevalence of sunscreen use among the general population was approximately (24 %) (AlGhamdi et al., 2016). Conversely, among participants from a Saudi

university, the rate of sunscreen use was approximately (35 %) (NA et al., 2016). Comparatively, a study conducted in Brazil reported a higher sunscreen usage rate (63 %) among the population (Rombaldi et al., 2017). Additionally, a study involving primary and secondary school children in Switzerland showed that (69 %) of the participants utilized sunscreen (Ackermann et al., 2016). Moreover, the policy group concluded that experimental studies and randomized trials provide robust evidence supporting the effectiveness of daily sunscreen use in reducing the risk of skin cancer. Additionally, there was consistent and compelling evidence affirming sunscreens' safety, with rare adverse events typically of minor and temporary nature (Whiteman et al., 2019). In another study conducted in India (Bemina Srinagar Kashmir) among medical students, the significance of sunscreen usage was highlighted. The study revealed that (48.08 %) of students used sunscreen only, and the usage was quite low among undergraduates. Females (66.6 %) were more likely to use sunscreen than males (28.57 %). The primary reasons for using sunscreen were to prevent skin cancer and sunburn.

Moreover, most of the participants did not consider sunscreen usage necessary. The study's overall results align with the present study's findings. The knowledge of proper sunscreen use among participants was quite low among medical undergraduates (Tilwani et al., 2018). A cross-sectional survey was conducted at a central hospital in Durban, South Africa, targeting general outpatients for four months. The study results showed that only half of the white respondents regularly used sunscreen, with black and Indian respondents having lower percentages. Less than 20 % of white respondents had skin checks. Most black respondents were unaware of skin cancer risks, with only 10 % aware of acral sites and nails. This highlights the need for increased awareness and education on skin cancer and sun protection (Dlova et al., 2018). Another study was conducted in Lima, Peru, among the population attending dermatology clinics, and the results found satisfactory awareness about solar radiation risks, particularly among higher



**Fig. 5.** Attitudes, Behaviors, and Practices Among Participants.

**Table 10**  
Statistical Analysis of Sunscreen Usage (n = 400).

| Sunscreen Analysis              |           | Frequency | Percentage | Mean | P-Value | C.I (95 %) | Variance | S.D.  |
|---------------------------------|-----------|-----------|------------|------|---------|------------|----------|-------|
| How often do you use sunscreen? | Never     | 87        | 21.8 %     | 2.87 | 0.002   | 0.1        | 1.924    | 1.387 |
|                                 | Rarely    | 88        | 22.0 %     |      |         |            |          |       |
|                                 | Sometimes | 79        | 19.8 %     |      |         |            |          |       |
|                                 | Often     | 82        | 20.5 %     |      |         |            |          |       |
|                                 | Always    | 64        | 16.0 %     |      |         |            |          |       |



education individuals. However, there was a discrepancy between knowledge and behaviour regarding sun protection measures, resulting in lower daily implementation (Thomas-Gavelan et al., 2011). Furthermore, a cross-sectional survey study in Maryland revealed the importance of implementing skin cancer prevention programs. The study results found that the youth of Maryland lacked awareness about skin cancer and sun protection, and the participants' knowledge level was low (Alberg et al., 2002). Consequently, another study investigated the awareness, beliefs, and behaviours related to skin cancer and sun exposure among participants in Dallas, TX. Due to inadequate healthcare resources, prolonged exposure, and limited access, the incidence of skin cancer was high (Joseph et al., 2020).

Finally, the study's results underscore the importance of targeted awareness programs to address the low usage of sunscreen among the Saudi population and mitigate the occurrence of skin cancer. To address this issue, it is crucial to enhance public knowledge and understanding of the significance of sunscreen and its role in protecting against sun damage. This can be achieved by developing targeted educational initiatives integrated into schools, healthcare institutions, and other relevant organizations. Increasing awareness and promoting sunscreen use would empower individuals to take proactive measures to safeguard their skin health and reduce skin cancer risk (Haluzá et al., 2015).

## 5. Conclusion

In conclusion, this study provides valuable insights into the awareness, behaviour and practices of sun exposure and sunscreen use among adults in the Aseer region, Saudi Arabia. Moreover, the findings revealed moderate awareness about the importance of sunscreen in protecting against skin cancer and skin-related diseases or damage. Men exhibited a higher prevalence of negative attitudes towards sun protection, while women demonstrated more favourable sun protection practices. The use of sunscreen remains low among the Saudi population despite adequate knowledge of sun exposure hazards. However, a significant proportion of the population adopted measures such as wearing sunglasses to reduce sun exposure. Therefore, this highlights a need for increased awareness programs to address the low usage of sunscreen and misconceptions. Furthermore, the findings should inform the development of a sun policy for the Saudi general public, focusing on promoting the correct use of sunscreens and addressing local conditions. Further research and interventions are needed to enhance sun protection practices and reduce the burden of sun-related skin conditions in the Aseer region. Consequently, future research should also explore additional variables associated with sun protection to gain a more comprehensive understanding of the factors.

## 6. Limitations and strengths

- The study was conducted in a specific region, which may limit the generalisability of the findings to other populations.
- However, the study included a sample size of 400 participants, providing a substantial dataset for analysis and enhancing the findings' reliability and generalizability to the target population.
- The novelty of this study lies in its focus on the Saudi population and their awareness attitudes.
- The study utilized a questionnaire that underwent validation and piloting, ensuring the questions were relevant, clear, and reliable for capturing the intended information.

## 7. Recommendations

- Implement targeted public education campaigns to raise awareness about sun exposure's harmful effects, sunscreen use, skin cancer risks, SPF, UVA/UVB protection, proper application techniques, and regular reapplication.

- Incorporate sun protection education in schools to teach students about sunscreen use, safety, and shade.
- Promote affordable sunscreen products and collaborate with manufacturers, retailers, and healthcare organizations to ensure availability.
- Encourage workplace sun safety policies and provide professional training for healthcare providers to promote sun protection during patient consultations.
- Support research and development in sun protection technology to develop more effective and user-friendly products.
- Collaborate with community leaders and organizations to promote sun-safe practices through social media, events, and public awareness campaigns.
- Regularly monitor and evaluate campaigns' effectiveness to assess knowledge, attitudes, and behaviours.

By implementing these recommendations, it is possible to increase awareness, improve sun protection behaviours, and reduce the risks associated with excessive sun exposure, ultimately decreasing the incidence of sun-related skin conditions, including skin cancer.

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## CRediT authorship contribution statement

**Emad Bahashwan:** Conceptualization, Funding acquisition, Data curation, Writing – original draft, Writing – review & editing, Visualization, Investigation, Validation, Formal analysis, Methodology, Supervision, Resources, Project administration, Software.

## Declaration of competing interest

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

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## References

- Ackermann, S., Vuadens, A., Levi, F., Bulliard, J.-L., 2016. Sun protective behaviour and sunburn prevalence in primary and secondary schoolchildren in western Switzerland. *Swiss Med. Wkly.* 146.
- Agarwal, S.B., Godse, K., Patil, S., Nadkarni, N., 2018. Knowledge and attitude of general population toward effects of sun exposure and use of sunscreens. *Indian J. Dermatol.* 63 (4), 285–291. <https://doi.org/10.4103/ijd.LJD.609.17>.
- Al Robaee, A.A., 2010. Awareness to sun exposure and use of sunscreen by the general population. *Bosn. J. Basic Med. Sci.* 10 (4), 314–318. [10.17305/bjms.2010.2678](https://doi.org/10.17305/bjms.2010.2678).
- Al-Atif, H.M., 2021. A cross-sectional survey of knowledge of skin cancer in Saudi Arabia. *Dermatol. Pract. Concept.* 11 (3).
- Alberg, A.J., Herbst, R.M., Genkinger, J.M., Duszynski, K.R., 2002. Knowledge, attitudes and behaviors toward skin cancer in Maryland youths. *J. Adolesc. Health* 31 (4), 372–377. [10.1016/S1054-139X\(02\)00377-4](https://doi.org/10.1016/S1054-139X(02)00377-4).
- AlGhamdi, K.M., AlAklabi, A.S., AlQahtani, A.Z., 2016. Knowledge, attitudes and practices of the general public toward sun exposure and protection: a national survey in Saudi Arabia. *Saudi Pharm. J.* 24 (6), 652–657.
- AlJasser, M.I., Aljumah, A., Alzaydi, M., Alassaf, A., Alassafi, S., Alassafi, M.T., Almedlej, M., Masuadi, E., 2020. Sunscreen use among a population of Saudi University students. *Dermatol. Res. Pract.*
- Almuqati, R.R., Alamri, A.S., Almuqati, N.R., 2019. 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. *Int. J. Women's Dermatol.* 5 (2), 105–109. [10.1016/j.ijwd.2018.11.005](https://doi.org/10.1016/j.ijwd.2018.11.005).
- Almutlaq, B.A., Al-Gebaly, A.S., Al-Qahtani, W.S., Alfraihi, R.S., Alqahtani, A.S., Almurshedi, A.S., Elsbali, A.M., Ahmed, H.G., 2021. Assessment of the knowledge,

- attitude, and practice towards sun-exposure and skin cancer in Riyadh city, Saudi Arabia. *Int. J. Burns Trauma* 11 (1), 20.
- AlSalman, S.A., Alkaff, T.M., Alzaid, T., Binamer, Y., 2018. Nonmelanoma skin cancer in Saudi Arabia: single center experience. *Ann. Saudi Med.* 38 (1), 42–45. <https://doi.org/10.5144/0256-4947.2018.21.01.1515>.
- Alsudairy, F.K., Alharbi, T.I., Qadi, A.B., Almutairi, S.M., Asiree, H.H., 2019. Awareness of sun exposure and use of sunscreen among adults in Saudi Arabia, 2018. *Int. J. Med. Dev. Ctries* 3, 389–394.
- Bens, G., 2014. Sunscreens. *Adv. Exp. Med. Biol.* 810, 429–463. [https://doi.org/10.1007/978-1-4939-0437-2\\_25](https://doi.org/10.1007/978-1-4939-0437-2_25).
- Beshna, E., Amir, S., Swead, R.T., Aldoubali, K.A., Ashour, A.M., Benzaed, S., Elouzi, A.A., 2022. Perception, knowledge and attitude of solar radiation diseases and use of sun screen among Al Zawia Medical University students in Libya. *Med. Pharm. J.* 1 (2), 74–83.
- Bryant, J., Zucca, A., Brozek, I., Rock, V., Bonevski, B., 2015. Sun protection attitudes and behaviours among first generation Australians with darker skin types: results from focus groups. *J. Immigr. Minor. Health* 17, 248–254.
- Cao, H., Brehm, M., Hynan, L., Goff, H.W., 2019. Wrinkles, brown spots, and cancer: relationship between appearance-and health-based knowledge and sunscreen use. *J. Cosmet. Dermatol.* 18 (2), 558–562.
- Dlova, N.C., Gathers, R., Tsoka-Gwegweni, J., Hift, R., 2018. Skin cancer awareness and sunscreen use among outpatients of a South African hospital: need for vigorous public education. *S. Afr. Fam. Pract.* 60 (4), 132–136.
- Egambaram, O.P., Kesavan Pillai, S., Ray, S.S., 2020. Materials science challenges in skin UV protection: a review. *Photochem. Photobiol.* 96 (4), 779–797.
- Gonzalez-Bravo, A., Montero-Vilchez, T., Arias-Santiago, S., Buendia-Eisman, A., 2022. The effect of sunscreens on the skin barrier. *Life* 12 (12), 2083.
- Gupta, A.K., Bharadwaj, M., Mehrotra, R., 2016. Skin cancer concerns in people of color: risk factors and prevention. *Asian Pac. J. Cancer Prev.* 17 (12), 5257.
- Haluza, D., Schwab, M., Simic, S., Cervinka, R., Moshammer, H., 2015. Perceived relevance of educative information on public (skin) health: results of a representative, population-based telephone survey. *Int. J. Environ. Res. Public Health* 12 (11), 14260–14274.
- Health, A.I.O., & Welfare, 2018. *Cancer Data in Australia; Australian Cancer Incidence and Mortality (ACIM) books: melanoma of the skin.*
- Hughes, S.N., Lowe, N.J., Gross, K., Mark, L., Goffe, B., Hughes, H., Cole, C., 2021. Assessment of natural sunlight protection provided by 10 high-SPF broad-spectrum sunscreens and sun-protective fabrics. In: *Challenges in Sun Protection*, Vol. 55. Karger Publishers, pp. 157–169.
- Joseph, A., Kindratt, T., Pagels, P., Gimpel, N., 2020. Knowledge, attitudes, and practices regarding skin cancer and sun exposure among homeless men at a shelter in Dallas, TX. *J. Cancer Educ.* 35, 682–688.
- Li, H., Colantonio, S., Dawson, A., Lin, X., Beecker, J., 2019. Sunscreen application, safety, and sun protection: the evidence. *J. Cutan. Med. Surg.* 23 (4), 357–369.
- Luger, T., Amagai, M., Dreno, B., Dagnelie, M.-A., Liao, W., Kabashima, K., Schikowski, T., Proksch, E., Elias, P.M., Simon, M., 2021. Atopic dermatitis: role of the skin barrier, environment, microbiome, and therapeutic agents. *J. Dermatol. Sci.* 102 (3), 142–157.
- Mancuso, J.B., Maruthi, R., Wang, S.Q., Lim, H.W., 2017. Sunscreens: an update. *Am. J. Clin. Dermatol.* 18, 643–650.
- NA, O.B., Alanazi, B.G., Aleid, M.Y., Alaql, A.B., Al-Ogail, N.A., Alghulaydhawi, F.A., 2016. Sun exposure behaviours, attitudes and protection practices among Prince Sattam bin Abdulaziz University Students—a survey study. *J. Pak. Med. Assoc.* 66 (12), 1528–1534.
- Neale, R., Lucas, R., Byrne, S., Hollestein, L., Rhodes, L., Yazar, S., Young, A., Berwick, M., Ireland, R., Olsen, C., 2023. The effects of exposure to solar radiation on human health. *Photochem. Photobiol. Sci.* 1–37.
- Olsen, C.M., Green, A.C., Pandeya, N., Whiteman, D.C., 2019. Trends in melanoma incidence rates in eight susceptible populations through 2015. *J. Invest. Dermatol.* 139 (6), 1392–1395.
- Olsen, C.M., Whiteman, D.C., 2020. Clinical epidemiology of melanoma. *Cutaneous Melanoma* 425–449.
- Paiva, J.P., Diniz, R.R., Leitao, A.C., Cabral, L.M., Fortunato, R.S., Santos, B.A., de Padula, M., 2020. Insights and controversies on sunscreen safety. *Crit. Rev. Toxicol.* 50 (8), 707–723.
- Passeron, T., Krutmann, J., Andersen, M., Katta, R., Zouboulis, C., 2020. Clinical and biological impact of the exposome on the skin. *J. Eur. Acad. Dermatol. Venereol.* 34, 4–25.
- Qadir, M.I., 2016. Skin cancer: etiology and management. *Pak. J. Pharm. Sci.* 29 (3).
- Reichrath, J., Leiter, U., Eigentler, T., Garbe, C., 2014. Epidemiology of skin cancer. *Sunlight Vitamin D Skin Cancer* 120–140.
- Rombaldi, A.J., Canabarro, L.K., Neutzling, M.B., Silva, M.C., 2017. Prevalence and factors associated with exposure to sunlight and sunscreen among physical education teachers in Pelotas, southern Brazil. *An. Bras. Dermatol.* 92, 785–792.
- Santos, A.C., Marto, J., Chá-Chá, R., Martins, A.M., Pereira-Silva, M., Ribeiro, H.M., Veiga, F., 2022. Nanotechnology-based sunscreens—a review. *Mater. Today Chem.* 23, 100709. [10.1016/j.mtchem.2021.100709](https://doi.org/10.1016/j.mtchem.2021.100709).
- Saridi, M., Lionis, D.S., Toska, A., Kafkia, T., Vonoparti, S., Barmpari, M.-M., Fasoula, Z., Souliotis, K., 2016. Evaluation of students' knowledge and attitudes on sun radiation protection. *Int. J. Caring Sci.* 9 (2), 400.
- Seité, S., Del Marmol, V., Moyal, D., Friedman, A., 2017. Public primary and secondary skin cancer prevention, perceptions and knowledge: an international cross-sectional survey. *J. Eur. Acad. Dermatol. Venereol.* 31 (5), 815–820.
- Serpone, N., 2021. Sunscreens and their usefulness: have we made any progress in the last two decades? *Photochem. Photobiol. Sci.* 20, 189–244.
- Sultana, N., 2020. Sun awareness and sun protection practices. *Clin. Cosmet. Investig. Dermatol.* 717–730.
- Szumera-Ciećkiewicz, A., Massi, D., 2021. Pathology of melanoma and skin carcinomas. *New Ther. Adv. Cutaneous Malignancies* 3–30.
- Thomas-Gavelan, E., Sáenz-Anduaga, E., Ramos, W., Sánchez-Saldaña, L., Sialer, M.C., 2011. Knowledge, attitudes and practices about sun exposure and photoprotection in outpatients attending dermatology clinics at four hospitals in Lima, Peru. *An. Bras. Dermatol.* 86, 1122–1128.
- Tilwani, M.R., Sameen, F., Manzoor, S., Nabi, N., Hassan, A., Qazi, I., 2018. Sunscreen awareness in medical undergraduates. *Int. J. Contemp. Med. Res. [IJCMR]* 5 (10), J1–J3.
- Ugurlu, Z., Işık, S.A., Balanuye, B., Budak, E., Elbaş, N.Ö., Kav, S., 2016. Awareness of skin cancer, prevention, and early detection among Turkish university students. *Asia Pac. J. Oncol. Nurs.* 3 (1), 93–97.
- Urasaki, M.B.M., Murad, M.M., Silva, M.T., Maekawa, T.A., Zonta, G.M.A., 2016. Exposure and sun protection practices of university students. *Rev. Bras. Enferm.* 69, 126–133.
- Uzdrowska, K., Górska-Ponikowska, M., 2022. Sunscreen cosmetics as basic protection against photoaging.
- Whiteman, D.C., Neale, R.E., Aitken, J., Gordon, L., Green, A.C., Janda, M., Olsen, C.M., Soyer, H.P., 2019. When to apply sunscreen: a consensus statement for Australia and New Zealand. *Aust. N. Z. J. Public Health* 43 (2), 171–175.
- Williams, J.D., Maitra, P., Atillasoy, E., Wu, M.-M., Farberg, A.S., Rigel, D.S., 2018. SPF 100+ sunscreen is more protective against sunburn than SPF 50+ in actual use: results of a randomized, double-blind, split-face, natural sunlight exposure clinical trial. *J. Am. Acad. Dermatol.* 78 (5), 902–910 e902.
- Wolverton, S.E., Wu, J.J., 2019. *Comprehensive Dermatologic Drug Therapy*. Elsevier Health Sciences.
- Woo, Y.R., Cho, S.H., Lee, J.D., Kim, H.S., 2022. The human microbiota and skin cancer. *Int. J. Mol. Sci.* 23 (3), 1813.
- Yan, S., Xu, F., Yang, C., Li, F., Fan, J., Wang, L., Cai, M., Zhu, J., Kan, H., Xu, J., 2015. Demographic differences in sun protection beliefs and behavior: a community-based study in Shanghai, China. *Int. J. Environ. Res. Public Health* 12 (3), 3232–3245.