DOI: https://doi.org/10.3126/njdvl.v23i2.79395

# Enhancing Sunscreen Adherence among Persons with Albinism: A Quasi-Experimental Study with Policy Implications from Nigeria

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## Abstract

**Background**: Persons-with-albinism (PWAs) are at heightened risk for ultraviolet-induced skin malignancies. Despite the protective efficacy of sunscreen, its utilization among Nigerian PWAs remains suboptimal.

**Objectives**: To evaluate the effect of structured health-education intervention on sunscreen awareness, adoption, and adherence barriers among PWAs in southwestern Nigeria.

**Methods:** A quasi-experimental pre-post study was conducted among PWAs attending a community outreach program in Ile-Ife, Nigeria. Participants received targeted health-education on photoprotection and sunscreen use. Data were collected using interviewer-administered semi-structured questionnaires. Changes in awareness, use, and adherence were analyzed using McNemar's test and logistic regression. Significance was set at $p < 0.05$.

**Results:** Among 43 participants (mean age: 35.3 ± 10.8 years; 60.5% female), pre-intervention sunscreen awareness was 58.1%, with only 4.7% reporting consistent use. Post-intervention, awareness increased significantly ($p < 0.001$), and occasional use rose from 23.3% to 37.2% ($p = 0.032$). However, consistent use remained low (14.0%), hindered by cost (55.8%), limited availability (39.5%), and reapplication challenges (32.6%). Older age and indoor occupations predicted lower adherence ($p < 0.05$).

**Conclusion**: Health-education significantly improved sunscreen awareness but had limited impact on adherence. Addressing structural and behavioural barriers through subsidized access and context-specific interventions is critical to improving photoprotection among PWAs in Nigeria

**Key words:** Albinism, Health Education Intervention, Sunscreen, Ultraviolet Radiation

## Introduction

Albinism is a complex hereditary condition characterized by defects in the melanin synthesis pathway, resulting in partial or complete absence of melanin in the skin, hair, and eyes. This autosomal recessive condition affects approximately 1 in 17,000 individuals globally,[1] with a markedly higher prevalence among individuals of African descent. Recent estimates suggest that in Africa, the prevalence may be as high as 1 in 4,254 persons. [1,2]

The deficiency of melanin, a critical photoprotective pigment, predisposes persons with albinism (PWAs) to ultraviolet (UV)-induced skin damage, significantly increasing their risk of photodermatoses and skin cancers. PWAs residing in sub-Saharan Africa are particularly vulnerable due to the intense all year-round ultraviolet radiation in the region. Reports indicate that nearly all PWAs above the age of 19

**Funding:** None
**Conflict of Interest:** None

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**Date of Submission:** 29th May 2025
**Date of Acceptance:** 19th September 2025
**Date of Publication:** 20th October, 2025

**How to cite this article**
How to cite the article: Ajani AA, Olanrewaju F, Oripelaye M, Enitan A, Ologun O, Olasode OA. Enhancing Sunscreen Adherence among Persons with Albinism: A Quasi-Experimental Study with Policy Implications from Nigeria. NJDVL 2025; 23(2): 25–33. https://doi.org/10.3126/njdvl.v23i2.79395

Nigeria receive a diagnosis of at least one skin malignancy in their lifetime.[3–7] Notably, skin cancers in this population tend to be multiple, aggressive and disfiguring, with a profound impact on quality of life and life expectancy.[3,6–9]

Chronic unprotected sun exposure is the primary risk factor for both skin cancers and other UV-related dermatological conditions in PWAs.[10] The risk increases with age due to cumulative UV exposure, particularly in the equatorial regions of sub-Saharan Africa, where solar radiation is intense year-round.[4,6,10] Effective photo-protective measures, including consistent use of broad-spectrum sunscreens, have been shown to significantly mitigate these risks.[2,11,12] However, adherence to these protective behaviors especially the application of sunscreen lotions remains suboptimal among PWAs in Nigeria.[13]

While extensive research has documented the prevalence of UV-induced dermatoses among PWA in Nigeria,[3,4,7,13–17] there remains a critical gap in understanding the factors influencing photo-protective behaviors- particularly the barriers to sunscreen adoption and consistent use. Identifying and addressing these barriers is essential for developing targeted interventions that enhance adherence to sun-safe practices and mitigate the burden of UV-related morbidity and mortality in this vulnerable population.

This study sought to evaluate the effectiveness of health education intervention in improving sunscreen use and identify barriers to adherence among PWAs in southwestern Nigeria.

## METHODOLOGY

**Study design and setting:**

A community based quasi-experimental pre-post study was conducted in Ile-Ife, during a dermatology research sensitization and outreach program for PWAs residing in semi-urban and rural towns in southwestern Nigeria.

**Participants and Sampling.**

A total of 63 PWAs from four states (Oyo, Ondo, Ekiti and Osun) in the southwestern part of the country attended the outreach. Forty-eight of whom met the inclusion criteria. Eligible participants were persons with albinism, aged 18 years or older, who had the capacity to provide written informed consent. Minors were excluded due to the outreach setting, additional ethical requirements of parental consent and concerns about the reliability of self-reported sunscreen use and related behaviours in younger individuals. Participants with significant communication impairments or severe mental health conditions were also excluded. Given the small and clearly defined target population, a total population sampling strategy was employed to enhance representativeness within the accessible cohort. All eligible attendees were approached to participate out of which forty-five provided informed consent and were enrolled.

**Intervention:**

All the outreach attendees irrespective of enrolment in the research received structured health education on skin vulnerability in albinism, the importance of adequate sun protection, including benefits of sun avoidance, protective clothing and sunscreen and the importance of integrating multiple sun protective strategies. The participants were instructed on sunscreen formulations, application techniques and reapplication frequency. The educational sessions were interactive and included demonstrations, testimonials from dermatologists, and the distribution of sunscreen samples.

**Data collection:**

Data were collected at two time points using interviewer-administered semi-structured questionnaires developed by the researchers based on extensive literature review and expert input. The questionnaires were designed to assess baseline knowledge, attitude and practice (KAP) regarding sunscreen use before the health education intervention and to evaluate post-intervention changes in KAP, sunscreen adoption, adherence and perceived barriers to use.

At baseline, pre-intervention data on sunscreen awareness and use were obtained through face-to-face interviews, ensuring detailed responses and clarification of participant concerns. Follow-up data were collected using the same questionnaire administered via telephone interviews eight weeks post intervention to assess changes in sunscreen adoption, adherence and barriers to consistent use. The combination of in person and remote data collection balanced data accuracy and feasibility, ensuring robust follow-up while reducing participant burden and attrition.

**Operational Definitions and categorization:**

**Sunscreen awareness**: In this study, sunscreen awareness was defined as the participants' knowledge and understanding of sunscreen use for photoprotection. It was assessed using a structured questionnaire covering 4 key domains: (1) the purpose of sunscreen use (2) appropriate timing and frequency of application (3) body areas requiring application and (4) perceived importance of sunscreen use. Participants who responded correctly to at least three out of the four domains were classified as having adequate sunscreen awareness

**Consistent Sunscreen Use**: was defined as self-reported application of sunscreen to all sun-exposed areas on ≥ 5 days per week, every week, during the previous month. Individuals meeting this threshold were classified as exhibiting good adherence.

**Inconsistent sunscreen use** was defined as self-reported application of sunscreen fewer than 5 days per week or sporadic use limited to specific outings. Occasional users and non-users were classified as having poor adherence.

**Socio-economic stratification:** SES was determined

using the revised scoring scheme for the classification of socioeconomic status in Nigeria, which stratifies participants based on education and occupation[18]. Based on the scoring system, participants were categorized into lower and upper socioeconomic groups for analysis.

**Occupational classification.** Participant occupations were categorized into three groups based on the level of formal education, training and cognitive demands associated with the role.

**Skilled worker:** Occupation requiring specialized education, professional training or experience that equipe individuals with skills for critical thinking, independent judgement and complex decision making (e.g. lawyers, medical doctors, architects, engineers)

**Semi-skilled worker:** Occupations requiring some vocational training or practical experience but limited formal education, typically involving tasks with moderate autonomy (e.g. artisans, electricians, office clerks, retail workers).

**Unskilled worker**: Occupations requiring little to no formal education or specialized training, often involving basic tasks or manual labour (e.g. construction labourers, farmworkers, janitors). Unemployed participants were also included in this category.

**Outcome measures:** The primary outcome measure was the increase in sunscreen adoption rate, assessed as the proportion of participants who initiated sunscreen use (a) at any frequency b) consistently following the intervention. Secondary outcome measures included changes in sunscreen awareness level and improvements in self-reported adherence to sunscreen over time.

**Ethical Considerations:** The parent study for this sub-study was approved by the Obafemi Awolowo University Teaching Hospitals Complex Ethics and Research Committee on the 31st of July, 2023 (IRB: IRB/IEC/0004553, and protocol number: ERC/2022/07/20). All procedures adhered to the principles of the Declaration of Helsinki. Informed consent was obtained from participants, and data confidentiality was strictly maintained throughout the study.

**Data analysis:** Data were analysed using SPSS version 25.0. Descriptive statistics were used to summarize the participants sociodemographic characteristics. Pearson's Chi-square test or Fisher's exact tests were used to test for associations. Variables with significant associations were entered into a binary regression model to identify predictors of consistent use of sunscreen with the results presented as adjusted odds ratios (AOR) with 95% confidence intervals (CI). Additional statistical analysis was conducted to compare pre-and post-intervention responses. The relative change in sunscreen awareness and adherence was calculated as a percentage of the pre-intervention value using the formula;

$$\text{Percentage change} = \frac{(\text{Post-value} - \text{Pre-value})}{\text{Pre-value}} \times 100$$

*Where:* Pre-value = value before intervention
Post-value = value after intervention

McNemar's test was used to evaluate pre-post differences in sunscreen awareness and use, while logistic regression was employed to identify the predictors of post-intervention sunscreen adherence, with significance set at $p < 0.05$.

## RESULTS

**Participant retention:** Of the 48 eligible participants approached, 45 consented to participate, yielding a response rate of 93.8%. Of these, 43 participants completed the study, resulting in a retention rate of 95.6%. Two participants (4.4%) could not be reached for post-intervention assessment (lost to follow-up) and were excluded from the final analysis.

**Baseline Characteristics:** The final study sample comprised of 43 participants, with a mean age of 35.33 ±10.78 years. The majority were female (n= 26, 60.5%). Geographically, most participants resided in Ondo state (n=18, 41.9%) and Osun state (n=14, 32.6%), while Oyo (n =8, 18.6%,) and Ekiti (n=3, 7.0%) accounted for the remaining participants. Most participants (n=25, 58.1%) had secondary education or lower, and a majority (n = 28, 65.1%) belonged to the lower socioeconomic status (as shown in **Table 1**).

**Table 1:- Population sociodemographic characteristics**

| Variable | Frequency (N=43) | Percentage (%) |
|---|---|---|
| **Sex** | | |
| Female | 26 | 60.5 |
| Male | 17 | 39.5 |
| **Age group** | | |
| 19 – 29 years | 13 | 30.2 |
| 30 - 39 years | 18 | 41.9 |
| ≥ 40 years | 12 | 27.9 |
| **Education** | | |
| Secondary or lower | 25 | 58.1 |
| Tertiary or higher | 18 | 41.9 |
| **Social class** | | |
| Upper social class | 15 | 34.9 |
| Lower social class | 28 | 65.1 |
| **Work environment** | | |
| Predominantly Indoors | 22 | 51.2 |
| Predominantly Outdoors | 21 | 48.8 |
| **Job skill level** | | |
| Unskilled | 13 | 30.2 |
| Semi-skilled | 22 | 51.2 |
| Skilled worker | 8 | 18.6 |

**Table 2:- Impact of health education intervention on sunscreen awareness and adoption**

| | Pre-outreach Values | Post-outreach Values | % relative change | McNemar Exact test |
|---|---|---|---|---|
| **Awareness of sunscreen** | | | | |
| No | 18 (41.9) | 4(9.3) | -77.78% | 0.000^ |
| Yes | 25(58.1) | 39(90.7) | + 56.00% | |
| **Consistency of Use of Sunscreen** | | | | |
| No use | 33(76.7) | 27(62.8) | -18.18% | 1.00# |
| Inconsistent Use | 8(18.6) | 10(23.3) | +25.00% | |
| Consistent Use | 2(4.7) | 6(14.0) | + 200.00% | |
| **Any Use of sunscreen at all** | | | | |
| No Use | 33(76.7) | 27(62.8) | -18.18% | |
| Either Inconsistent or Consistent Use | 10 (23.3) | 16(37.2) | +60.00% | 0.032^ |

^ = McNemar's Test, # = Qilcoxon Signed – Rank Test

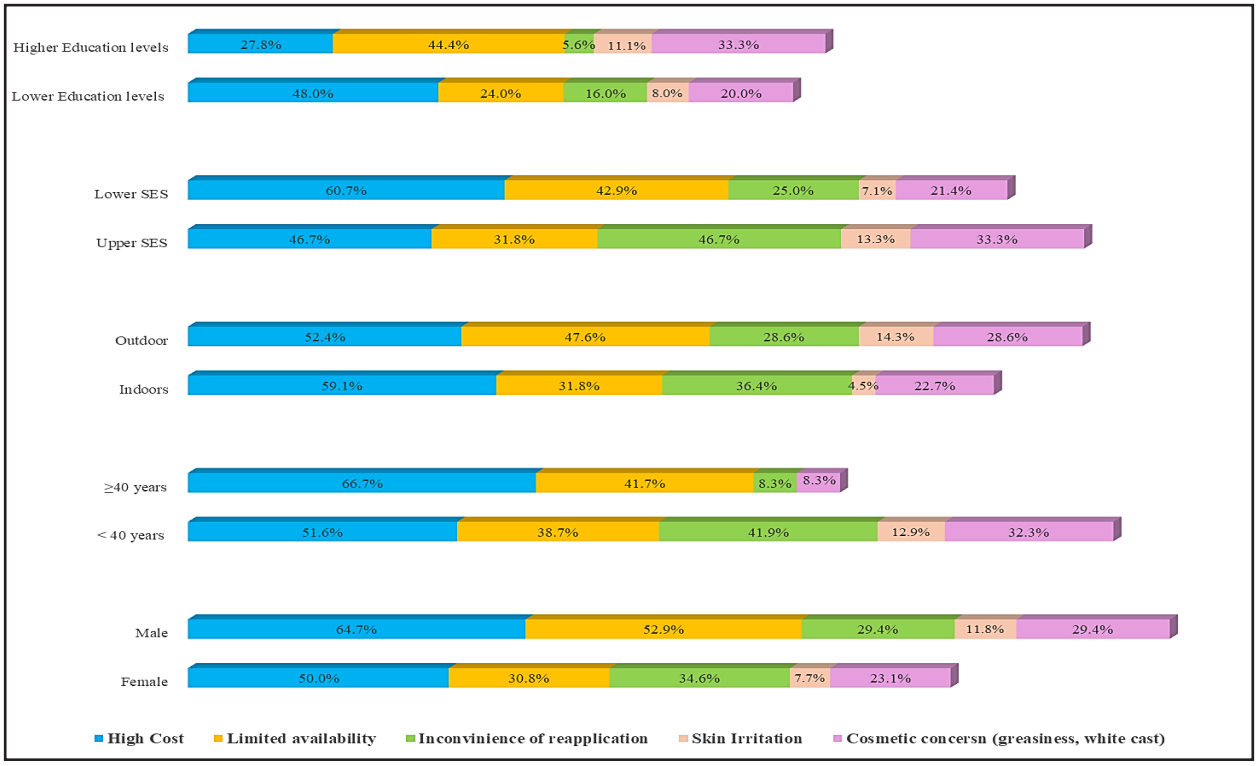


**Figure 1.** Frequency of perceived barriers to sunscreen use among persons with albinism stratified by key sociodemographic characteristics. Participants could select multiple applicable barriers; therefore, cumulative percentages may exceed 100% within each subgroup. Percentages reflect the proportion of respondents in each sociodemographic category who endorsed each specific barrier.
SES = Socio -economic Status.

**Impact of health education on sunscreen awareness and use:**

*Pre-intervention*: While majority of the participants (n=40, 93.0%) recognized the need for photo-protection, only 58.1% (n=25) were aware of sunscreen as a protective measure. Sunscreen use was low with 23.3% (n=10) reporting any use (consistent or inconsistent use) while only 4.7% (n=2) were consistent users. (Table 2.)

Post-intervention: Sunscreen awareness improved significantly (90.7% awareness, $p < 0.001$), with a corresponding increase in sunscreen use from 23.3% to 37.2% (p=0.032). However consistent use remained low (n=6, 14.0%) indicating persistent adherence barriers.

**Barriers to sunscreen use and adherence among persons with albinism:**

Over 2/3rds of the study participants (69.8%, n=30)

**Table 3:- Associations between perceived barriers and post intervention sunscreen adherence among adult PWAs**

| | [a]Poor Adherence n=37 (%) | [b]Good Adherence n=6 (%) | Total N=43(%) | Sig. | OR* | 95% CI | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| **Self-reported Barriers to Sunscreen Adoption** | | | | | | | |
| No Reported Barrier (ref) | 8 (21.6) | 5 (83.3) | 13(30.2) | | | | |
| At Least One Barrier reported | 29(78.4) | 1(16.7) | 30(69.8) | 0.013# | 0.055 | 0.006 | - 0.542 |
| **Specific Barriers to Sunscreen adoption and adherence** | | | | | | | |
| High cost | 24(64.9) | 0(0.0) | 24(55.8) | 0.004^ | 0.684 | 0.504 | - 0.929 |
| Limited availability | 17(45.9) | 0(0.0) | 17(39.5) | 0.038^ | 0.769 | 0.623 | - 0.949 |
| [c] Cosmetic concerns | 11(29.7) | 0 (0.00) | 11(25.6) | 0.149^ | 0.813 | 0.688 | - 0.960 |
| [d] Perceived Inconvenience | 13(35.1) | 1(16.7) | 14(32.6) | 0.351^ | 0.369 | 0.039 | - 3.505 |
| [e] Adverse reactions | 4(10.8) | 0(0.00) | 4 (9.3) | 0.535^ | 0.846 | 0.740 | - 0.967 |

* = Crude Odds Ratio, # = Chi Square Test, ^ = Fisher's Exact Test
[a] Poor Adherence – non- use or infrequent use, less than 4 days a week
[b] Good Adherence – consistent use at least 5 days a week with repeated applications of sunscreen
[c] Cosmetic concerns (e.g. oiliness, white residue)
[d] Perceived Inconvenience (e.g. frequent reapplication, difficulty integrating into routine)
[e] Adverse reactions (e.g. stinging, skin irritation, acne-form eruptions)

**Table 4:- Predictors of post intervention sunscreen adoption in the study populatio**n

| | Post Intervention Sunscreen use | p value. | AOR* | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| **Sex** | | | | | |
| Female (n=26) | 11(42.3) | 0.441 | 1.867 | 0.381 | - 9.148 |
| Male (n=17) (ref) | 5(29.4) | | | | |
| **Age group** | | | | | |
| <40 years (n = 31)(ref) | 14(45.2) | | | | |
| ≥ 40 years (n=12) | 2(16.7) | 0.030 | 0.093 | 0.011 | - 0.794 |
| **Work environment** | | | | | |
| Predominantly indoors (n=22) | 6(27.3) | 0.016 | 0.079 | 0.010 | - 0.625 |
| Predominantly outdoors (n=21) (ref) | 10(47.6) | | | | |
| **Socioeconomic Status (SES)** | | | | | |
| Upper SES (n=15) (ref) | 8(53.3) | | | | |
| Lower SES (n=28) | 8(28.6) | 0.207 | 0.123 | 0.005 | - 3.188 |
| **Educational level** | | | | | |
| Lower education (n= 25) (ref) | 7(28.0) | | | | |
| Higher education (n=18) | 9(50.0) | 0.838 | 1.389 | 0.059 | - 32.714 |
| Constant | | 0.276 | 7.166 | | |

AOR* = adjusted Odds Ratio

reported at least one barrier to sunscreen adherence. The most frequently reported barriers were high cost (55.8%), limited availability (39.5%) and inconvenience of frequent reapplication (32.6%) (Table 3). Self-reported perceived barriers did not vary significantly across the different sociodemographic categories as shown in Figure 1. & Supplemental Table

The analysis of the relationship between perceived barriers and consistent post-intervention sunscreen adherence revealed significant associations between self-reported barriers and poor adherence. Participants who perceived at least one barrier particularly high cost, and limited availability were significantly less likely to maintain consistent sunscreen use ($p < 0.05$).

(Table 3.) Regression analysis revealed that older age (≥ 40 years) p =0.030 and working indoors significantly (p= 0.016) predicted non-adherence. Sex, education and socioeconomic status were not significant predictors. (Table 4.)

## DISCUSSION

Skin cancers represent a major cause of morbidity and mortality among PWAs in Africa, primarily due to their heightened vulnerability to ultraviolet radiation.[10,19,20] Despite being a critical preventive measure, adequate sun protection- particularly the consistent use of sunscreen- remains significantly underutilized, especially in resource-limited settings such as Nigeria. [13]

The findings of this study highlight the potential of structured health intervention to enhance sunscreen awareness and encourage its use as a photoprotective strategy among PWAs in southwestern Nigeria. These results are consistent with evidence from other low- and middle-income countries (LMICs) in sub-Saharan Africa. For instance, Chu et al (2021) ascribed improved sun-protective behaviours among PWAs in Botswana to dedicated albinism care programs that integrated routine health services with targeted education on photoprotection[21]. Similarly, Gilberte et al (2022) documented a significant post-intervention increase in sunscreen use and related sun-protective behaviours among PWAs in Malawi, following a photoprotection health education intervention.[22]

In the present study, although post-intervention awareness of sunscreen benefits increased significantly by up to 56.0% (p <0.001) and overall sunscreen use improved from 23.3% to 37.2% (p =0.032), this did not translate to a statistically significant increase in consistent sunscreen application. This pattern aligns with findings from similar LMIC contexts and reflects a well-documented phenomenon in public health; the knowledge-behaviour gap, wherein increased knowledge does not necessarily result in sustained behaviour change.[23–25] This gap is often perpetuated by a constellation of individual, social and environmental barriers including costs constraints, availability and low perceived vulnerability.

### Barriers to Consistent Sunscreen Use Among Persons with Albinism

The high prevalence of self-reported barriers to sunscreen use (69.8%) observed in this study is consistent with reports from comparable LMIC countries in Africa, Asia and Latin America. [25–27] The most frequently cited barriers: high cost (55.5%), and limited availability (39.5%) were both significantly associated with poor adherence. This reinforces existing evidence that financial and logistical limitations remain the most prominent impediments to sunscreen use in low-resource environments. [13,24,25,27,28]

Beyond economic and accessibility constraints, behavioural factors also influenced adherence within this study population. Nearly one-third of participants (32.6%) reported that the requirement for frequent reapplication made sunscreen use inconvenient. Additionally, 25.6% cited cosmetic concerns such as greasiness and white residues, while 9.3% reported skin irritation as a barrier. Consistent with these findings, Diehl et al. (2020) and Lim et al (2024) reported that inconvenience, along with product related complaints such as greasiness and unpleasant odour, were among the most cited reasons for irregular sunscreen use, aside from a perceived lack of need.[27,29]

Although these concerns did not independently deter sunscreen use in PWAs in the present study, their cumulative impact could contribute to poor adherence and should not be overlooked. There is need for further qualitative research to explore underlying behavioural determinants of sunscreen adherence. A deeper understanding of these factors could inform targeted interventions such as the development of cosmetically acceptable formulations and educational strategies that address user concerns while reinforcing the importance of consistent photoprotection.

### Predictors of post-intervention sunscreen use

In addition to perceived barriers, understanding the sociodemographic factors that influence sunscreen use is critical for designing effective public health interventions aimed at improving photo-protection for PWAs. In this study, older age (≥ 40 years) and work environment were significant predictors of non-adherence. This finding aligns with previous research indicating that younger individuals and those with occupational sun exposure are more likely to adopt photo-protective behaviours due to a heightened perception of UV related risk.[12,13,27]

Contrary to expectations, sex, education, and socioeconomic status did not significantly predict adherence. While previous studies have linked female sex, higher education and socioeconomic status to greater sunscreen use, [13,20,27,30]the lack of statistical significance in this study suggests that structural and behavioural influences such as accessibility, workplace norms and personal attitudes or habits may outweigh individual level demographic factors in determining sunscreen adoption. This underscores the need for targeted interventions that address both workplace policies and age specific barriers to adherence. Future studies should further investigate context-specific barriers and facilitators to sunscreen use through longitudinal and qualitative approaches.

### Policy and Public health implications:

This study underscores critical public health and policy considerations for improving sunscreen adherence among PWAs in Nigeria. Cost was the most frequently cited barrier in our study population, consistent with evidence from Tanzania, and Congo. [25,26] This consistent

pattern across low-resource settings highlights the need to integrate sunscreen into government-subsidized health programs or national insurance schemes. Additionally, public-private partnerships could play a pivotal role in addressing cost-related barriers through the local production of affordable formulations. This model has shown promise in Malawi, where domestic production of sunscreen coupled with health education initiatives has improved both access and adherence among PWAs.[22]

Limited availability also emerged as a significant determinant of non-adherence in our study cohort. To address this, policymakers should mandate sunscreen availability in public health facilities and pharmacies particularly in regions with high PWA populations. Integrating sunscreen provision into albinism support programs may further enhance accessibility and uptake.

Beyond economic and logistical constraints, sociodemographic predictors of non-adherence such as older age and predominantly indoor occupation, highlight the need for tailored behavioural interventions. Evidence from studies conducted in Egypt and Tanzania demonstrates that even when multicomponent health education initiatives are implemented, such as the distribution of sunscreens or efforts led by government and non-governmental organizations to improve accessibility, adherence remains sub-optimal.[25,31] This persistent gap may be attributed to individual-level barriers, inadequately tailored public health messaging and entrenched perceptions of low personal risk. These findings highlight the imperative for complementary behaviour change strategies that are culturally sensitive, contextually relevant and grounded in behavioural science.

Public awareness campaigns should emphasize the risk of cumulative UV exposure, including indirect exposure through windows and reflective surfaces. In addition, workplace polices that promote routine sunscreen use, alongside employer-led educational initiatives may further improve adherence among PWAs especially those engaged in informal occupations.

Although cosmetic concerns and frequent application requirements did not significantly impact adherence in this cohort, addressing user preferences remains essential. The development of non-greasy, low residue and cosmetically acceptable formulations tailored to the needs of individuals with albinism can enhance user satisfaction and promote sustained use.[22,32] Policymakers should collaborate with dermatologists and cosmetic scientists to develop sunscreen products suited to regional climatic conditions and cultural preferences.

Importantly, our findings show that increased awareness alone does not necessarily translate to optimal adherence. This highlights the need for sustained community-based education programs that incorporate peer advocacy and role modelling by high adherence individuals to support long term behavioural change. Drawing lessons from successful interventions in other African and rural Asian contexts can inform the design of culturally grounded, resource-sensitive interventions that are more likely to succeed in improving sunscreen adherence and overall photo-protection among this vulnerable population.

**Study limitations**

While this study provides valuable insights into specific adherence barriers to sunscreen use as well as the impact of health-education intervention on sunscreen awareness and adoption, the small sample size (43 participants) restricts the applicability of findings to broader populations. Although the use of total population sampling without formal sample size calculation ensured full inclusion of eligible participants this may have limited statistical power, particularly for subgroup analyses. As such, non-significant findings should be interpreted with caution. Larger, more diverse studies are needed to strengthen external validity.

Furthermore, the dependence on self-reported data for assessment of sunscreen use and barriers makes the findings prone to recall and social desirability bias. Potential confounders such as sunburn history, healthcare access and pre-existing skin condition which may have influenced adherence were also not addressed in this research. Moreover, the short post-intervention assessment period limits insights into sustained adherence.

Despite these limitations, the findings of this study offer actionable data for policy and intervention development. Future research should employ a larger sample, objective adherence tracking, extended follow-up periods and qualitative methods to better understand and improve sunscreen adherence among PWAs.

## Conclusion

This study highlights the complex interplay between awareness, structural barriers and behavioural determinants of sunscreen adherence. While health education effectively improved awareness, adherence remained constrained by cost, availability and personal convenience factors. Addressing these barriers through multifaced policy interventions, financial support systems and tailored behavioural strategies are critical for improving long-term photoprotection among vulnerable populations particularly PWAs. Further research should explore innovative intervention models, such as mobile health (mHealth) solutions, policy-based sunscreen provision and longitudinal adherence studies to enhance photoprotective practices sustainably.

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