Validity of the Fitzpatrick Skin Phototype Classification in Ecuador

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ABSTRACT

BACKGROUND: The Fitzpatrick Skin Phototype Classification (FSPC) is the most common tool used to assess skin phototype in White populations according to the amount of pigment the skin has and its reaction to sun exposure. Scientific evidence about the use of this scale for persons with darker skin is limited.

OBJECTIVE: To assess the internal consistency, reliability, and construct validity of the FSPC for Ecuadorians.

METHODS: This observational cross-sectional study recruited participants of both sexes between 40 and 90 years of age living in a rural area of Quito, Ecuador. Cronbach α values were used to assess the internal consistency of the scale. Construct validity was assessed with confirmatory factor analysis.

RESULTS: The internal consistency coefficients indicated that the reliability of the responses to the scale was fair. Total α value was .515, whereas the α values of the two factors were .42 and .67. Most item-to-factor correlations had a low to moderate magnitude, ranging from $r = 0.30$ to 0.37. Confirmatory factor analysis supported a two-factor solution and achieved good overall fit as indicated by root mean square error of approximation = 0.08, and nonnormed fit index = 0.88 was mediocre. Goodness-of-fit $\chi^2 = 177.10$, $P < .001$. The factor loads were greater than 0.30, ranging from 0.30 to 0.99.

CONCLUSIONS: The FSPC showed an acceptable construct validity and a fair internal consistency. The five-item scale could potentially be used as an effective instrument for assessing skin phototype in non-White people.

KEYWORDS: cancer risk, Fitzpatrick Skin Phototype Classification, internal consistency, skin phototype, sun exposure, validity

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INTRODUCTION

The general geographic patterns of skin pigmentation show a strong correlation with latitude and UV radiation (UVR) intensity. Skin pigmentation tends to be darker in equatorial and tropical regions (Sub-Saharan Africa, South Asia, Australia, and Melanesia), where UVR levels are higher than those in regions distant to the equator.[1] Skin color is correlated with the amount of melanin in skin. The more melanin, the better protection against UVR, and the less likely skin is to burn.

The Fitzpatrick Skin Phototype Classification (FSPC) was developed in 1975 by Dr Thomas Fitzpatrick, a Harvard University dermatologist. This system classifies skin type according to the amount of pigment the skin has and its reaction to sun exposure.[2] This scale could help predict a person's overall risk of sun damage and skin cancer. The validity and reliability of this well-known scale are widely accepted and it has been applied in many research studies. However, most of the studies have been performed with White participants.[3–5]

That said, the FSPC is not a very good predictor of UV sensitivity but still plays an important role in epidemiology for estimating the risk of skin cancer.[6] The FSPC is the criterion standard for the classification of skin types.[7] This self-reported scale is determined with a questionnaire the participant uses to grade his/her tendency to burn 24 hours and tan 7 days after his/her first unprotected sun exposure in early summer.[8] The FSPC has three subscales: genetic disposition, sun exposure, and tanning habits. The first two subscales have four items each, and the other subscale consists of only two items, giving 10 items in total.

The FSPC faces all the typical challenges of skin typing, especially as human beings are becoming increasingly multiracial and multiethnic. Skin color alone cannot determine reactivity to the sun. Although very fair, thin, delicate skin is usually associated with sensitive skin, darker skin can be very sensitive too. It is even more

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challenging to correctly predict how multiracial skin will react to the sun.[7] Regardless, the FSPC may be a useful tool for predicting how skin will respond to the sun.

Ecuador, and specifically its cities located in the Andean region, experiences high degrees of daily sun exposure and its UVR. This is primarily because of its height above sea level (2,850 m) and the perpendicular fall of the sun rays. Accordingly, the Ecuadorian Foundation of Psoriasis and the Institute of Physics in Rosario, Argentina, proposed a modification (the FEPSO-IFIR criterion[9]) to the World Health Organization UV Index (UVI) classification, which classifies a UVI equal to or greater than 11.0 as extreme, taking into account both the skin types and the UVI levels in South America. The modified scale classifies an extreme UVI as equal to or greater than 16.0. Statistical analysis of weather records from 2010 to 2017 indicates that UVIs greater than or equal to 11.0 are common in Quito (between 40.5% and 70.0% of days per month). Between 0.4% and 19.1% of days per month had a UVI greater than 16.0.[9]

The daily exposure to UVR, especially during the summer months, means that about 90% of nonmelanoma skin cancers and 65% of melanoma cases are associated with exposure to UVR.[10] According to the latest data published in 2017, skin cancer deaths in Ecuador reached 0.37% of total deaths. The age-adjusted mortality is 1.93 per 100,000 of population.[11]

Persons of Mestizo descent make up 72% of the population of Ecuador, followed by persons of Montubio, African Ecuadorian, and Native South American descent, which together make up 7%. Most of these individuals have dark skin, but they are still at risk of skin cancer because of the extreme UVR. Skin cancers are less prevalent in people with deeply pigmented skin than in White individuals, although their prognosis is worse.[12] There is also limited knowledge of the effects of UVR exposure on skin of color.[13]

According to Sharma et al,[14] the response choices for certain questions on genetic disposition from the FSPC may not adequately capture the spectrum of color variations in dark-skinned populations. In addition, questions such as those on tanning habits may not be relevant for such populations.[14] Given this knowledge, and the increased skin cancer rates in Educador, high UVI, average skin tone, and the lack of studies measuring the validity of FSPC in non-White populations, the study authors posed the following research question: is the FSPC useful for use in Ecuador? Can it be adapted to populations with darker skin? The objective of this observational cross-sectional study was to explore the internal consistency and construct validity of the self-rated FSPC in Ecuadorian participants living in la Ruta Escondida de la Mitad del Mundo, which has a very high UVI and a majority Mestizo population with very dark skin tones.

METHODS

Data were collected from May to July 2017. The inclusion criterion was any participant 40 years or older living in the study region. A sample of 254 Ecuadorian adults living in La Ruta Escondida de la Mitad del Mundo was evaluated to assess the construct validity of the FSPC. The sample size for factor analysis was influenced by the ratio of individuals who completed the questionnaire to the number of items in the questionnaire (approximately 40:1). Participants were chosen by simple random sampling from lists provided by the authorities of each of seven towns visited by the researchers.

This was a one-time self-rating activity. Participants' skin types were self-assessed using the FSPC questionnaire, which has a six-point categorical scale. In this study, response options for four items on genetic disposition (items 1-4, "What is the color of your skin [nonexposed areas]?" "What is the natural color of your hair?" "What is the color of your eyes?" and "Do you have freckles on unexposed areas?") and two items on sun exposure (item 5, "Do you turn brown within several hours of sun exposure?" and item 6, "To what degree do you turn brown?") were studied. The authors excluded two items for sun exposure and the tanning questions, as these were thought to be irrelevant for individuals living in Ecuador. Other authors also have proposed to eliminate the tanning subscale from the FSPC.[5]

Ethics

Participants signed an informed consent after being informed about the aims, content, and duration of the study by the research team. They were told that participation was voluntary, and their participation would be anonymous.

This study was approved by the ethics committee of la Universidad de Las Americas. Researchers followed the STROBE guidelines in reporting this study. There was no involvement from patients or members of the public in the design, conduct, reporting, or dissemination of this research.

Statistical Analysis

For descriptive analyses, mean and variability (SD) for quantitative variables and number and percentages for qualitative variables were computed. To estimate the internal consistency of the items of FSPC, the Cronbach α coefficient was calculated. Acceptable values for Cronbach α coefficient for a scale with a small number of items are between .50 and .90. For each of the subscales of FSPC, values greater than 0.5 were considered acceptable. Item correlation less than 0.30 was considered weak with poor clinical applicability; between 0.30 and 0.50 was considered moderate; and greater than 0.50 was considered strong.

Confirmatory factor analysis was performed to assess the construct validity of FSPC. Confirmatory factor analysis was performed using principal axis factoring and varimax rotation with Kaiser normalization. The principal components method was used to estimate the model. Factors with an eigenvalue greater than 1 (total variance explained for each factor) were evaluated to determine the number of factors to retain. Factor loading greater than 0.40 was considered acceptable.

The Kaiser-Meyer-Olkin index and Bartlett sphericity test were used to assess the adequacy of the sample size and the factor analysis. The values expected for the Kaiser-Meyer-Olkin test were between 0.5 and 1 and $P < .5$ for the Bartlett sphericity test.

χ^2 was used to verify the model's goodness of fit ($P > .05$). Investigators also calculated the root mean square error of approximation (RMSEA), with acceptable values equal to or less than 0.08, and Bentler and Bonett's nonnormed fit index (NNFI), with acceptable values equal to or greater than 0.90.

The Statistical Package for the Social Sciences version 24.0 (IBM Corp, Armonk, New York) was used to perform data analysis. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

RESULTS

Participants were aged 40 to 90 years (mean, 60.7 ± 13.30 years). Females comprised the majority (71.3%) of the sample. All participants were classified into one of six skin types (I–VI) based on their total FSPC score. Types VI and I were not represented in the sample. Of participants, 61.0% reported skin type IV, and 32.3% reported skin type III (Table 1).

Internal Reliability Consistency

The corrected item-total correlation was low (<0.30) for items 3 and 4 in the genetic disposition domain, considered weak with poor clinical applicability; for the rest of the items, values ranged from 0.30 to 0.37 (moderate correlation; Table 2). Total Cronbach α was .51. The sun exposure subscale had the highest α value, .67, which revealed satisfactory internal consistency. The removal of item 4 would lead to the best Cronbach α improvement (.55). The α value and item-to-factor correlation coefficients of the genetic disposition items were nonsatisfactory (Table 2).

Table 1. SKIN PHOTOTYPE

Fitzpatrick Phototype	Baseline, n (%)
II	6 (2.4)
III	82 (32.3)
IV	155 (61)
V	11 (4.3)
Total	254 (100)

Table 2. ITEM ANALYSIS OF TOTAL SAMPLE (N = 254)

Subscale	Cronbach α for Subscale	Item	Corrected Item-Total Correlation	Cronbach α if Item Deleted[a]
Genetic disposition	.42	1 What is the color of your skin (nonexposed areas)?	0.37	.40
		2 What is the natural color of your hair?	0.30	.44
		3 What is the color of your eyes?	0.24	.48
		4 Do you have freckles on unexposed areas?	0.00	.55
Sun exposure	.67	5 Do you turn brown within several hours of sun exposure?	0.31	.44
		6 To what degree do you turn brown?	0.35	.44

[a]Total α = .51.

Construct Validity of FSPC

Confirmatory factor analyses were performed, and the number of factors to retain was set at two. The Kaiser-Meyer-Olkin index, or the measure of sampling adequacy for the factor analysis, was 0.53 within the established limits. The Bartlett test of sphericity revealed a significant χ^2 value of 181.15 ($P = .00$). The χ^2 test for goodness of fit was of 9.08 ($P = .05$); the RMSEA was 0.07 (95% confidence interval, 0.056-0.081; acceptable), and the NNFI was 0.88 (mediocre). Confirmatory factor analysis was performed on six items and showed that most of the items were distinctively and significantly loaded into the respective two factors. The explained variance was 52.67%, and the factor loadings ranged from 0.30 to 0.99. Three of the genetic disposition subscale items loaded on the second factor and the sun exposure subscale had its two items loading strongly on the first factor. The findings revealed that all the items under the subscales showed a distribution according to the original form. Item 4, "Do you have freckles on unexposed areas?" should be disregarded because of its low load (Table 3).

DISCUSSION

This is a validation study for the FSPC in a sample of Ecuadorians. To the best of the authors' knowledge, this is the first study of the FSPC with a representative sample in this rural area of Ecuador. The Ruta Escondida is

Table 3. LOADING FACTORS IN CONFIRMATORY FACTOR ANALYSIS (ROTATED), COMMUNALITY (H2), EIGENVALUES, AND VARIANCES FOR THE TOTAL AND EACH FACTOR OF THE FITZPATRICK SKIN PHOTOTYPE CLASSIFICATION (N = 254)

Subscale	Items	Factor 1	Factor 2	h^2
Genetic disposition	1 What is the color of your skin (nonexposed areas)?	0.131	0.67	0.49
	2 What is the natural color of your hair?	0.25	0.30	0.17
	3 What is the color of your eyes?	–0.12	0.53	0.29
	4. Do you have freckles on unexposed areas?	0.00	0.05	0.00
Sun exposure	5 Do you turn brown within several hours of sun exposure?	0.99	–0.10	0.33
	6 To what degree do you turn brown?	0.56	0.10	0.99
Eigenvalues		1.86	1.29	
Variance, %		31.07	21.59	

Note: Total variance explained, 52.67%. Extraction method: main components analysis; rotation method: varimax with Kaiser normalization; rotation A converged in three interactions.

located 60 km from Ecuador's capital, Quito. Its population is dedicated to agriculture, livestock, and poultry production, which results in prolonged time outdoors exposed to the sun.

These participants' skin characteristics differ from those of the participants in the original study performed by Dr Fitzpatrick,[2] which may explain the differences. That said, considering the importance of skin type and how frequently the FSPC is used, these findings have merit.

Most of the participants classified themselves as skin phototype III or IV. In a study performed in Brazil, the most common Fitzpatrick skin phototypes were also III (49.02%) and IV (33.33%).[15]

The Cronbach α for the general instrument was .51; .50 is considered acceptable for scales with few items.[16] Typically, the more items in a scale, the greater the estimated internal consistency. This coefficient could be affected by the instrument length; that is why the investigators estimated the internal consistency for each of the two subscales individually. Investigators found that the internal reliability consistency was lower than expected for one subscale (genetic disposition), indicating an inability to measure the same construct and a lack of item homogeneity.

Fasugba et al[5] reported internal consistency values of .505 and .829 for the genetic disposition and sun exposure items, respectively, in a study of women undergoing radiation therapy for breast cancer. These results are similar to those reported in this article. Because of this heterogeneity, it is possible that this subscale requires adaptation before it can be used in Ecuador.

Most correlations among the items of each of the two factors were of low to moderate magnitude (r = 0.30-0.37) according to the classification of Ajzen and Fishbein.[17]

The RMSEA value was acceptable.[18] The RMSEA was the primary indicator for goodness of fit in this study because it is less sensitive to sample size; Rigdon[19] recommended RMSEA for confirmatory factor analysis. The NNFI was mediocre (0.88) and did not meet the prespecified criteria for goodness of fit (>0.90).

The construct validity was fair; all items loaded on the same factor and had factor loadings greater than 0.3 (considered acceptable). The FSPC factors ranged from 0.30 to 0.99. In general, factor loadings should be equal to or greater than 0.70 for good validity.[20] Accordingly, the authors propose that item 6, "Do you have freckles on unexposed areas?" be eliminated. This item had a very low load, and its elimination would improve the Cronbach α value. In terms of subscale internal consistency, the authors found that an effort to change the number of items met their expectations.

This study documents a scale structure that, after removing some elements from the original scale, obtained a reasonable goodness-of-fit index. The results of this study showed that a 5-item scale is appropriate for use in this sample. Similar results were reported by Fasugba et al.[5]

Low reproducibility and the limited number of classes are some of the problems associated with the skin type evaluation. In a study of non-Hispanic White, Hispanic, Black, and Asian/Pacific Islander participants, self-reported responses to tanning questions could not be classified using standard FSPC concepts.[21] In Whites, the Fitzpatrick scale is not predictive of sun sensitivity and ability to tan but still plays an important role in epidemiology for the estimation of risk of skin cancer.[22]

Limitations

The FSPC is a self-assessment scale, and the authors gave participants instructions the way the instrument recommends, but it still has limitations. In a previous study performed in the same group of participants, the authors concluded that self-reported race and pigment phenotypes are inaccurate predictors of sun sensitivity as defined by the FSPC. Further, there are limitations to

using patient-reported race and appearance in predicting individual sunburn risk.[23] Other investigators also have found limitations such as using self-reported skin appearance.[24–26] Other methods to measure sun sensitivity objectively such as spectrographic readings of melanin index or spectrophotometry to determine constitutive (untanned) skin color have been proposed.[26]

Limitations of the study design include the age range of participants. Further, the composition of the study population was not representative of the general population of Ecuador. The studied population was homogenous, and therefore almost all participants belonged to one of two skin types, which can affect the discriminatory capacity of the FSPC. Finally, most of the participants were women, also limiting the generalizability of the findings.

CONCLUSIONS

To date, an Ecuadorian instrument to assess skin phototype has not been created, and thus the adaptation of the FSPC would provide South American researchers with the first instrument capable of investigating this concept. The observed low internal consistency of the FSPC scale could be explained by the nature of the items of the scale and the small number of items. Therefore, these results should not necessarily be interpreted as a lack of reliability of the scale. Ultimately, these results also indicated that the correlated two-factor model developed and validated using samples from White individuals could be appropriately generalized to the Ecuadorian population with some limitations.

Analyses of correlation and reliability of the factor structure of the scale were fair. There are very few published studies examining the internal consistency and construct validity of the Fitzpatrick scale, so comparing results with other studies is difficult. The construct validity assessed through confirmatory factor analysis presents satisfactory results for the goodness-of-fit indexes (RMSEA and NNFI). The scale showed an acceptable construct validity and a fair internal consistency. The modified 5-item scale could potentially be used as an effective instrument for assessing skin phototype in non-White populations. Further investigations of the psychometric properties of the FSPC including different age groups, populations, and skin tones are needed. ●

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