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The Fitzpatrick Skin Type Scale: A reliability and validity study in women undergoing radiation therapy for breast cancer

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TITLE

The Fitzpatrick Skin Type Scale: A reliability and validity study in women undergoing radiation therapy for breast cancer

ABSTRACT

Objectives: This study aimed to evaluate the internal consistency reliability and construct validity of the Fitzpatrick Skin Type Scale during radiation therapy in a cohort of women receiving treatment for breast cancer.

Method: The assessment of the Scale was performed as a nested study within a randomised control trial of two creams used for radiation therapy skin care for breast cancer patients. The sample consisted of 244 female patients undergoing radiation therapy for breast cancer. Participants completed a modified version of the Fitzpatrick Skin Type Scale.

Results: Internal consistency as measured by the Cronbach's alpha was 0.505, 0.829 and 0.339 for the Genetic Disposition, Sun Exposure and Tanning Habits subscales respectively. Only the Sun Exposure subscale surpassed the 0.70 cut off indicating good internal consistency. Maximum Likelihood factor analysis with promax rotation method confirmed the *a priori* factor structure for the Sun Exposure subscale as well as providing evidence of construct validity for this subscale. Analysis for the other two subscales highlighted issues with internal reliability and construct validity suggesting that not all items on each subscale truly measure the intended trait.

Conclusion: The study findings support reliability and validity of the Sun Exposure subscale of the Fitzpatrick Skin Type Scale in a convenience sample of women receiving radiation therapy for cancer. Despite limitations with two of the three subscales, this tool continues to be used in clinical practice.

Key words

Fitzpatrick Skin Type Scale, Reliability, Validity

INTRODUCTION

Radiation therapy treatment for breast cancer has the potential to cause skin reactions such as moist desquamation which adds to the distress associated with the patient's cancer diagnosis and treatment.[1] Standardised grading tools, such as the Common Terminology Criteria for Adverse Events (CTCAE) Version 4.0 [2] are often used when assessing the skin condition of patients undergoing radiation therapy. The skin reaction is graded from faint erythema or dry desquamation (grade 1), to skin necrosis or ulceration of full thickness dermis (grade 4) on the CTCAE. To minimise the severity of radiation-induced skin reactions, patients are often advised to use various skin care products, such as a basic moisturising cream (100% sorbolene) but the effectiveness of any topical products in a tropical environment is yet to be identified[3] necessitating the need for further research. A randomised control trial (RCT) investigating the effectiveness and acceptability of two skin care creams for patients undergoing radiation therapy in a tropical region was therefore conducted. This RCT formed the basis for the present nested study to assess the reliability and validity of the Fitzpatrick Skin Type Scale (referred to in this paper as the Fitzpatrick Scale) in this group of patients.

BACKGROUND

In 1975, the Fitzpatrick Scale was developed to estimate the skin's response to ultraviolet (UV) light based on a person's sunburn and tanning experience.[4] This scale has since been used widely to determine sun-reactive skin type and is currently the most commonly used tool or measure. It is recognised as the gold standard for classifying skin types.[5] It consists of 3 subscales derived from a total of 10 items. Based on a total skin type score, respondents are

classified into 1 of 6 types (Skin type I-VI).[4] The validity and reliability of this widely utilised and accepted instrument is crucial as health and government agencies provide sun protection and tanning advice based on this tool[6-8] and because it has been applied in many research studies.[9-15]

The Fitzpatrick Scale has been used mainly for assessing skin type as a potential confounder in clinical studies. Magin et al., [16] carried out a cohort study that examined the psychological complications of acne and used this scale to assess skin phenotype as a potential confounder in their study. Other dermatological studies have also utilised this classification system in determining the ability of an individual's skin type to act as a potential confounder when other outcomes are being assessed.[16-17]

Despite this widespread use, there are a limited number of studies that have examined the reliability and validity of the Fitzpatrick Scale. The studies have examined the stability and test-retest reliability of modifications of the scale with good results noted.[7, 16, 18] The wide use and acceptability of this instrument with no published studies on the internal consistency of the items in the scale led to the current study reported in this paper. Magin et al., [16] recently highlighted the lack of studies assessing the validity of this scale hence further necessitating research in this area. We decided, therefore, to determine the internal reliability and validity of the Fitzpatrick Scale in assessing skin type in patients receiving radiation therapy for breast cancer in the tropics.

OBJECTIVE

To assess the internal consistency and construct validity of the Fitzpatrick Scale as a valid and reliable tool for assessing skin type in women receiving radiation therapy for breast cancer in the tropics.

MATERIALS AND METHODS

Setting: The assessment of the reliability and validity of the Fitzpatrick Scale was performed as a nested study within a randomised control trial of two creams used in the skin care of patients receiving radiation therapy for breast cancer in the tropics.

Sample: The data were collected from participants at the time of recruitment to the trial by a nurse between June 2010 and July 2012. As there were very few male participants the sample was restricted to the 245 female patients who provided informed consent to participate in the randomised control trial and completed the Fitzpatrick Scale. Data collection was completed by the recruiting nurse asking the questions and circling the boxes which best represented the participants' responses after showing them the scale. One woman was excluded from data analysis due to incomplete data hence the results are based on 244 women.

Instruments: The Fitzpatrick Scale is based on 3 concepts: genetic disposition or ancestry, reaction to sun exposure and tanning habits. The Genetic Disposition and Sun Exposure subscales consist of four items each and the Tanning Habits subscale consists of only two items, giving a total of 10 items. Participants are classified into 1 of 6 skin types based on their total skin type score (Table 1). This study used a version of the Fitzpatrick Scale similar to that available from the New South Wales Government website.[19]

INSERT TABLE 1

Ethics approval: Approval for the RCT from which this data were obtained was granted by the XXXX (name to be provided) health service's human research ethics committee.

Data analysis: To estimate the internal consistency of the scores, the Cronbach's alpha coefficient was calculated for each of the three subscales (Genetic Disposition, Sun Exposure and Tanning Habits) based on the sample of 244 women. The aim was to determine if the estimated coefficient values were acceptable according to the general convention in research prescribed by Nunnally and Bernstein, [20] who state that one should strive for reliability values

of 0.70 or higher. Classical item analysis was also conducted on the Fitzpatrick Scale to determine whether any items were negatively affecting the reliability of the subscales. The next step was to conduct an exploratory factor analysis to identify the dimensions of the test and more importantly to determine if multiple factors or traits underlie the items on each subscale. The Kaiser-Meyer-Olkin measure (KMO-test) was first conducted to determine sampling adequacy with a value of >0.5 signifying adequacy. The Bartlett test of sphericity was used to check for underlying structure to the data. This test has to be significant. Maximum Likelihood (ML) was chosen as the method of extraction for the factor analysis and the Scree test was used to determine the number of factors to retain for rotation. To simplify and clarify the data structure, the promax rotation method was applied.

The relationship between skin type and two possible influencing variables, ancestry and dermatological history, were assessed for significance using the Chi square test of Independence. The significance level was chosen as 0.05 and p values below this level were regarded as statistically significant. The data were analysed using SPSS IBM statistics version 19.

RESULTS

All participants were female with the majority being of Australian descent. The mean age was 55.5 years. About a quarter of respondents had a pre-existing dermatological condition ranging from allergies, psoriasis, eczema and other fungal skin diseases (Table 2).

INSERT TABLE 2

Almost half of the women reported having Skin type III with the minority having Skin Types I and V. In our study, Skin type VI was not represented in the sample and so is not included in the Table (Table 3).

INSERT TABLE 3

The Cronbach's alpha values for the three subscales of the Fitzpatrick Scale are presented in Table 4. The Sun Exposure subscale has the highest alpha value of 0.829. The table also features the Corrected Item-Total Correlation, Squared Multiple Correlation values and the Cronbach's alpha if the weakest item is deleted from its subscale. The Corrected Item-Total Correlation was low (<0.3) for three items in the Fitzpatrick Scale. In column six, for example, removal of any item in the Genetic Disposition subscale except item "F1-Do you have freckles on unexposed areas?" would result in a lower Cronbach's alpha. Conversely removal of this latter item would lead to an improvement in Cronbach's alpha. It is also noted that the corresponding Corrected Item-Total Correlation value was low (0.126) for this item.

INSERT TABLE 4

The KMO measure had a value of 0.783 signifying adequate sampling and the Bartlett test of sphericity was significant ($p<0.05$). Exploratory factor analyses were performed and the number of factors to retain was set manually at 2, 3 and 4 factors based on the Scree plot (Figure 1) and the *a priori* factor structure. It is noteworthy to report that the general picture of the factor analysis for each of the analyses was similar with respect to the item loading pattern but retaining four factors had the best fit to the data in this study and this was selected for the results (Table 5). The Sun Exposure subscale had all 4 items loading strongly on the first factor while the 2 items for the Tanning Habits subscale loaded on the third factor. For the Genetic Disposition subscale, the first 3 items loaded highly on the second factor except item 4, "F1-Do you have freckles on unexposed areas?" which was the only freestanding item in the Fitzpatrick Scale in this study loading on the fourth factor.

INSERT FIGURE 1

INSERT TABLE 5

The Chi square test for Independence showed no association between the Fitzpatrick Skin Type and presence of a dermatological history in women ($\chi^2=7.38$, $p=0.12$). There was a

statistically significant association between the Fitzpatrick Skin Type and the women's ancestry (χ^2=32.30, p=0.02).

DISCUSSION

Prior to administering an instrument such as the Fitzpatrick Scale for research purposes, the validity and reliability should be assessed to facilitate the accuracy of the results obtained from the study. Assessment of the internal consistency of the Fitzpatrick Scale in this study showed Cronbach's alpha values below that expected for two of the three subscales with only the Sun Exposure subscale having the highest alpha value of 0.829 thereby satisfying the criterion for reliability.

Various reasons can be postulated for these results. There are a number of factors that can affect the Cronbach's alpha value of a test, including how well the items in a test correlate to each other and also the length of the test.[21] Correlation in a test refers to extent to which all items measure the same thing.[22] It is not certain for the Fitzpatrick Scale whether each test item truly measures the same trait on the same subscale as observed by the low item-total correlation values. Therefore to determine how well the items on the test correlate, an exploratory factor analysis was applied.[21] The exploratory factor analysis also provides an assessment of the correctness or incorrectness of the factor structure.[23] We performed a series of exploratory factor analyses based on the method described by Costello & Osborne.[23] They described a clean factor structure as one with item loadings above 0.30, no or few item crossloading and no factors with fewer than three items. Retaining 4 factors showed that all items on the Sun Exposure subscale loaded together on a single factor and factor loadings were high. This can be considered to be a good factor structure. This subscale appears to correspond to the above criteria and also has a Cronbach's alpha value suggestive of good reliability. For the Tanning Habits subscale, both items loaded together on a single factor but

as the number of items in this subscale is only two, this should be interpreted with caution as both the alpha values and item-total correlations are below that accepted. This factor is therefore considered weak and unstable.[23] We suggest including more items to this subscale to strengthen reliability of the Fitzpatrick Scale in a similar population. Also in response to the two items on this subscale which ask "When did you last expose your body to the sun (or artificial sunlamp/tanning cream)?" and "Did you expose the area to be treated to the sun?" it is likely that a considerable number of women had exposed their breasts to the sun in the past. Since many of the respondents were 'Baby Boomers', (that is, born between 1946 and 1964), they grew up in a time when experimenting with topless sunbathing and swimming was common in sunny climates such as North Queensland. The questions refer to exposure to the sun or artificial tanning and it is difficult to classify exposure, for example, in participants who swam in their own pools topless, but only in the shade. It is important to note also that in a place like North Queensland, parts of the bodies are exposed to the sun every day incidental to other activities, so the first item on this subscale is also problematic in that way. The term "tanning cream" also created some confusion as to its meaning. Respondents asked whether this included spray tans or even solariums.

The Genetic Disposition subscale appears to have one of the four items loading on a different factor. This item "Do you have freckles on unexposed areas?" is not well loaded onto the factor representing its subscale. This item is also the weakest on the subscale with a low item-total correlation and does not appear to correlate with the other items that are well loaded on this subscale. The other 3 items on this subscale relate to measurement of eye, hair and skin colour which appear to measure a single construct as they are constant traits. Although freckles are an inherited trait and therefore classify as a genetic factor, they can also be non-inherited arising following sun exposure making them an acquired trait.[24] This item was also noted by the recruiting nurse as problematic for women who gave other responses such as

200 "few" and "incidental". These responses may explain the inability of this item to load on the
201 same factor with other items in the *a priori* factor structure. We suggest removing this item
202 from the subscale due to its free standing nature or adding items measuring similar traits to
203 form a new subscale to be examined in future studies.[23]
204 As stated earlier in this section, the measured alpha value also depends on the test length,
205 with shorter tests generally having a lower alpha value.[25] The Fitzpatrick Scale has 10 items
206 in total and can be considered a short test. Hence the alpha values should be interpreted with
207 some degree of caution. Tests with 20 items or more will have acceptable Cronbach's alpha
208 values even though they may be measuring multiple characteristics. Close examination of the
209 item-total correlations is recommended with values ranging from 0.15 to 0.20 for scales
210 measuring broad characteristics and 0.40 to 0.50 for those measuring less widespread traits.[25]
211 According to Nunnally & Bernstein,[20] acceptable item-total correlation is >0.30 for all items
212 with most being >0.5. Items with values less than 0.3 should be examined closely as they
213 may have little to do with the subscale. The item "Do you have freckles on unexposed
214 areas?" has the lowest item-total correlation along with the two items in the Tanning Habits
215 subscale.
216 The Cronbach's alpha results and the exploratory factor analysis provide some evidence of
217 construct validity for the Fitzpatrick Scale mainly in regards to the Sun Exposure subscale
218 which we rate as good. For the Genetic Disposition subscale, the construct validity can be
219 rated as fair because all items except one load on the same factor and have factor loadings
220 >0.3 considered acceptable for the minimum loading of an item.[23] The results suggest that the
221 Tanning Habits subscale should be removed from the Fitzpatrick Scale as it is very difficult
222 to interpret results with only two items in this subscale; hence one item may not necessarily
223 provide more information than the other when trying to elicit patients' tanning habits.

In this study there was a statistically significant association between the Fitzpatrick Skin Type of women and their ancestry. Other evidence available also suggests a relationship between a person's skin type and country of ancestry.[26] People with skin types I, II and III tend to be of English, Scottish or Scandinavian descent as compared to people with skin types V and VI who originate mainly from middle eastern, Indian and African countries. There was no association between the Fitzpatrick Skin Type and presence of dermatological history although studies have shown a relationship between skin type and some dermatological conditions. People with skin types IV-VI are more prone to developing acne vulgaris compared to the other skin types.[27] Various studies have shown that people with fair skin are at risk for developing basal cell carcinoma as well as those with Fitzpatrick Skin Type II.[28] The relationship between the Fitzpatrick Skin Type and skin reactions such as moist desquamation following radiation therapy in cancer patients were reported in two previous studies.[29,30] The findings of the RCT within which this study was nested have recently been published.[31]

LIMITATIONS

The results of this study provide some evidence to support the reliability and validity of the Fitzpatrick Scale although there were a number of limitations. All participants are females limiting the generalisability of the findings. A further limitation is the utilisation of a version of the scale which has a risk of modifying the original content but this version is from a credible source utilised in Australia and cited in other publications. As noted earlier, the few studies that have evaluated reliability and validity of modifications of the Fitzpatrick Scale have reported good results. Although these results are based on the test retest reliability of the Scale, estimation of this was not feasible in the RCT because of heavy respondent burden for completion of other surveys. There is also a potential for information bias occurring as a

result of the way in which the Fitzpatrick Scale was administered due to the use of several data collectors. However the inter-rater reliability among data collectors was assessed prior to the study commencement and was high (95% concordance).

CONCLUSIONS

Considering the importance of skin type and how frequently the Fitzpatrick Scale is used, the findings from the study hold merit because the Sun Exposure subscale has been rated specifically to have a good internal consistency and construct validity. Overall, the tool is easy and quick to administer in the clinical environment with practical application for patient education and information sessions. If the Fitzpatrick Scale is included as part of the routine assessments associated with planning for radiation therapy, clinical staff can inform patients prior to commencement of radiation therapy that they may be more or less likely to develop acute skin reactions if they fall into a particular Fitzpatrick Skin Type.

As the alpha value from a test is dependent on the specific sample of respondents, [21] replication of the analysis is recommended on other samples. Also, because there are no published studies examining the internal consistency and construct validity of the Fitzpatrick Scale, we are unable to compare our findings but suggest that further research is imperative to enhance the accuracy of assessments using this scale.

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DECLARATION OF INTEREST

None.

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TABLES

Table 1 Fitzpatrick Skin Type Classification

Skin Type	Score	Overall skin type descriptor
I	0-6	Always burns, never tans (pale white skin)
II	7-13	Always burns easily, tans minimally (white skin)
III	14-20	Burns moderately, tans uniformly (light brown skin)
IV	21-27	Burns minimally, always tans well (moderate brown skin)
V	28-34	Rarely burns, tans profusely (dark brown skin)
VI	35+	Never burns (deeply pigmented dark brown to black skin)

Source: Australian Government, 2012. Australian Radiation Protection and Nuclear Safety Agency

Table 2 Demographics and smoking patterns of sample (N=244)

Variable	Results: n (%)
Age in years: mean (SD)	55.5 (11.7)
Indigenous status	13 (5.3)
Place of birth/Ancestry	
Australia	203 (83.2)
Europe	20 (8.3)
Asia	8 (3.3)
NZ	4 (1.6)
USA	1 (0.4)
Not specified	8 (3.3)
Presence of dermatological condition	59 (24.4)

SD: Standard Deviation; NZ: New Zealand; USA: United States of America

Table 3 Skin type by Ancestry and Age group (in years) n (%)*

	Type I	Type II	Type III	Type IV	Type V	Total
Ancestry						
Australia	7 (2.9)	65 (26.6)	83 (34.0)	41 (16.8)	7 (2.9)	203 (83.2)
NZ	0 (0)	0 (0)	3 (1.2)	1 (0.4)	0 (0)	4 (1.6)
Europe	0 (0)	2 (0.8)	12 (4.9)	4 (1.6)	2 (0.8)	20 (8.3)
USA	0 (0)	0 (0)	1 (0.4)	0 (0)	0 (0)	1 (0.4)
Asia	0 (0)	1 (0.4)	1 (0.4)	6 (2.5)	0 (0)	8 (3.3)
Not specified	0 (0)	0 (0)	3 (1.2)	5 (2.0)	0 (0)	8 (3.3)
Total	7 (2.9)	68 (27.9)	103 (42.2)	57 (23.4)	9 (3.7)	244 (100)
Age group						
27-34	0 (0)	0 (0)	1 (0.4)	2 (0.8)	2 (0.8)	5 (2.1)
35-44	2 (0.8)	9 (3.7)	9 (3.7)	9 (3.7)	0 (0)	29 (12.0)
45-54	3 (1.2)	21 (8.7)	32 (13.1)	23 (9.5)	4 (1.7)	83 (34.0)
55-64	0 (0)	22 (9.1)	29 (12.0)	10 (4.1)	2 (0.8)	63 (25.8)
65-74	2 (0.8)	12 (5.0)	27 (11.2)	12 (5.0)	1 (0.4)	54 (22.3)
75-84	0 (0)	4 (1.7)	5 (2.1)	1 (0.4)	0 (0)	10 (4.1)
Total	7 (2.9)	68 (27.9)	103 (42.2)	57 (23.4)	9 (3.7)	244 (100)

NZ: New Zealand; USA: United States of America

*Note Skin Type VI is not represented in the sample

Table 4 Classical Item Analysis

Subscale	Cronbach's Alpha value for subscale	Items	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item deleted*
Genetic Disposition	0.505	F1-What is the colour of your eyes?	0.399	0.207	0.325
		F1-What is the natural colour of your hair?	0.341	0.146	0.402
		F1-What is the colour of your skin (non exposed areas)?	0.382	0.191	0.375
		F1-Do you have freckles on unexposed areas?	0.126	0.017	0.601
Sun Exposure	0.829	F2-What happens when you stay in the sun too long?	0.646	0.438	0.791
		F2-To what degree do you turn brown?	0.763	0.636	0.731

		F2-Do you turn brown within several hours of sun exposure?	0.704	0.580	0.764
		F2-How does your face react to the sun?	0.536	0.306	0.833
Tanning Habits	0.339	F3-When did you last expose your body to sun (or artificial sunlamp/tanning cream)?	0.218	0.047	Not Applicable
		F3-Did you expose the area to be treated to the sun?	0.218	0.047	Not Applicable

*when weakest item is removed from each subscale

Table 5 Exploratory Factor Analysis Pattern Matrix: Four Factor Solution

Items	Factor			
	1	2	3	4
F1-What is the colour of your eyes?	-0.144	0.755	-0.007	0.102
F1-What is the natural colour of your hair?	0.057	0.479	0.005	0.184
F1-What is the colour of your skin (non-exposed areas)?	0.302	0.496	-0.028	-0.070
F1-Do you have freckles on unexposed areas?	0.105	0.133	0.065	0.362
F2-What happens when you stay in the sun too long?	0.819	-0.048	-0.038	0.303
F2-To what degree do you turn brown?	0.844	-0.003	0.063	-0.110
F2-Do you turn brown within several hours of sun exposure?	0.764	0.025	0.028	-0.218

F2-How does your face react to the sun?	0.663	-0.046	-0.053	0.255
F3-When did you last expose your body to sun (or artificial sunlamp/tanning cream)?	-0.018	0.006	1.007	0.089
F3-Did you expose the area to be treated to the sun?	0.099	-0.071	0.202	-0.229

FIGURES

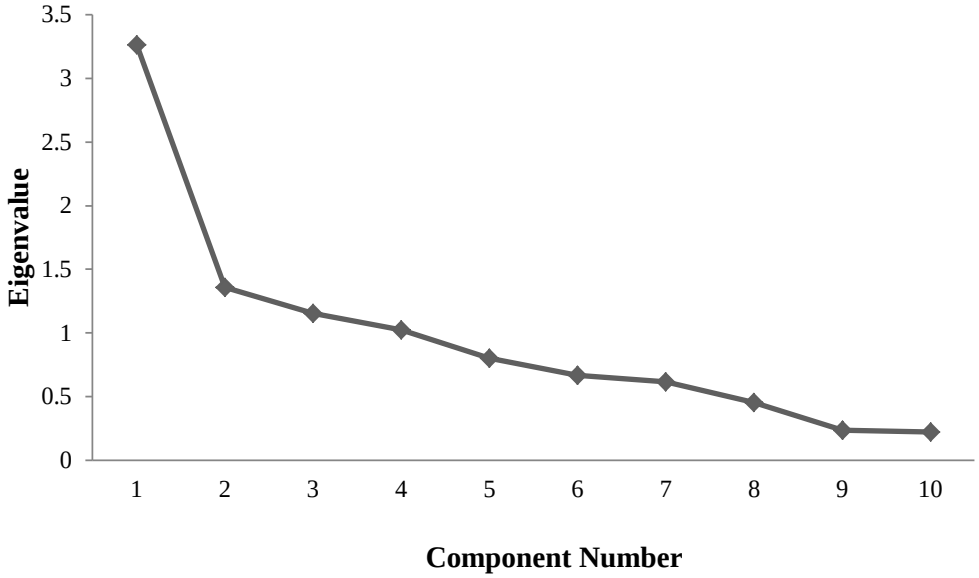

Figure 1 Scree plot for determination of number of factors retained for rotation