Self-estimation or Phototest Measurement of Skin UV Sensitivity and its Association with People's Attitudes Towards Sun Exposure

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Abstract. *Background: Fitzpatrick's classification is the most common way of assessing skin UV sensitivity. The study aim was to investigate how self-estimated and actual UV sensitivity, as measured by phototest, are associated with attitudes towards sunbathing and the propensity to increase sun protection, as well as the correlation between self-estimated and actual UV sensitivity. Patients and Methods: A total of 166 primary healthcare patients filled-out a questionnaire investigating attitudes towards sunbathing and the propensity to increase sun protection. They reported their skin type according to Fitzpatrick, and a UV sensitivity phototest was performed. Results: Self-rated low UV sensitivity (skin type III-VI) was associated with a more positive attitude towards sunbathing and a lower propensity to increase sun protection, compared to high UV sensitivity. The correlation between the two methods was weak. Conclusion: The findings might indicate that individuals with a perceived low but in reality high UV sensitivity do not seek adequate sun protection with regard to skin cancer risk. Furthermore, the poor correlation between self-reported and actual UV sensitivity, measured by phototest, makes the clinical use of Fitzpatrick's classification questionable.*

Sensitivity and reactivity to ultraviolet (UV) radiation differs greatly between individuals and is mainly dependent on several phenotypic factors. In general, individuals with fair skin, red hair and freckles burn more easily in the sun than those with browner pigmented skin and dark hair, and are at greater risk for skin cancer from UV exposure (1-5). This variation in UV sensitivity is partly reflected in how people behave in the sun, and appropriately, in general, individuals with high self-estimated skin UV sensitivity and those with blonde or red hair tend to be more cautious in the sun than those with low self-estimated skin UV sensitivity and dark hair (6). Furthermore, several other important factors, such as gender, age and perceived barriers to undertaking sun protection also seem to affect the degree of UV exposure (7-12). In general, females report sunbathing more frequently than men, whereas men usually report exposing themselves to the sun more often in other outdoor situations. Furthermore, young people tend to take fewer precautions in the sun than older people (7, 8).

The traditional and most common way of classifying skin reactivity is Fitzpatrick's classification of tendency to burn and tan (13, 14). The method is based on self-estimation of how the skin reacts to sun exposure, is easy to use and understand, and has been widely-accepted in a variety of situations both for preventative purposes and in research studies, as well as in clinical practice (*e.g.* to support dose decisions before phototherapy). However, the method is inevitably subjective in nature, and has been shown to correlate poorly with actual UV sensitivity as assessed by phototesting (15-19). In contrast to Fitzpatrick's classification, phototesting is an objective method for determining skin UV sensitivity, although it only takes the tendency to burn into account and not the ability to tan. Although easy to perform (provided one has the necessary equipment), phototesting is relatively rarely used and the fields of use are quite limited. The most common phototest applications are for dosimetry purposes in phototherapy and in the investigation of suspected photodermatoses (20, 21), but the method has also been assessed more recently for prevention of skin cancer (22, 23) and as a tool to identify individuals especially at-risk for skin cancer due to high UV sensitivity.

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Because individuals with a pronounced tendency to sunburn are especially susceptible to skin cancer from UV exposure, avoidance of excessive sun exposure and adequate sun protection are appropriate. In a previous study, however, it was demonstrated that self-perceived sensitivity to sunlight by means of Fitzpatrick's classification had a clear impact on sun exposure habits and sun protection behaviour, whereas the actual UV sensitivity assessed by phototest did not (24). In practice, this means that some individuals with a perceived low UV sensitivity but who biologically have a high UV sensitivity, subsequently expose themselves to considerably more UV radiation than is appropriate for their individual skin cancer risk. Thus, information and demonstration of individual UV sensitivity are necessary to enlighten at-risk individuals and to promote sun protection. In addition to this, it would also be of interest to examine the possible associations between attitudes towards sun bathing, as well as the individual's propensity to increase sun protection, and self-perceived UV sensitivity *versus* actual UV sensitivity, which was the aim of the present study. In addition, the association between self-estimated UV sensitivity, in terms of Fitzpatrick's classification, and actual UV sensitivity, determined by phototest, was investigated.

Patients and Methods

The data from a previous intervention study, assessed in primary healthcare (PHC) and investigating the effect of using a phototest for skin cancer prevention, was used as study material, and constitutes the same population as the one referred earlier (24). The two PHC Centres engaged for the study were located in a medium-sized city in southern Sweden, together having a mixed population of suburban and rural/outer metropolitan habitants of varying socioeconomic status, totalling 18,000 individuals. The study was approved by the Regional Ethics Review Board in Linköping (Dnr M193-08). From January 2009 to December 2010, 331 patients visiting their general practitioner (GP) for nevi/skin tumour inspection were recruited voluntarily for the study, and were equally randomized into two intervention groups. The patients in both groups were given sun protection advice by their GP. In one of the groups (n=166), the patients also underwent a phototest assessing individual skin UV sensitivity. Since the patients in this group provided information on both self-estimated and actual UV sensitivity, this group was selected for the present study.

Mapping of attitudes towards sun bathing and propensity to increase sun protection was gained from a questionnaire filled out by the patients before their visit with the GP. The questions addressing attitudes (Figure 1) were based on 5-point Likert scales, for all of which the reliability has previously been confirmed (25), except for question 5, which was based on a 4-point Likert scale and added as a complementary question not previously reliability-tested. The propensity to increase sun protection was estimated using the Transtheoretical Model of Behaviour Change (TTM) (26, 27). The TTM was developed by Prochaska *et al*. in the early 1990s and has since then gained wide acceptance in studies on different health behaviours, including sun protection behaviour (28-31). By use of grading statements, the model attempts to classify the individual into one of five stages, representing increasing readiness to change behaviour: pre-contemplation stage (never thought of changing behaviour); contemplation stage (could consider changing behaviour); preparation stage (decided to change behaviour); action stage (taken action to change behaviour); or maintenance stage (performing the changed behaviour and trying to avoid relapse). The TTM items included in the questionnaire were giving up sunbathing, sunscreen use, use of clothes for sun protection, and seeking the shade.

In addition, the patients also reported their self-estimated skin type according to Fitzpatrick's classification (13, 14), by responding to the following question: "Which of the following skin types do you consider corresponds the best to how your own skin reacts in the sun?". Skin type I: always burns, never tans; Skin type II: always burns, sometimes tans; Skin type III: sometimes burns, always tans; Skin type IV: rarely burns, always tans; Skin type V: ethnic groups with moderately pigmented brown skin; Skin type VI: ethnic groups with markedly pigmented dark or black skin.

The phototest (Dermalight 80 MED-tester, A.L.T Lichtterapietechnik, Germany) performed at the end of the doctor's consultation consisted of six 12×12 mm provocation fields emitting separate increasing doses of UV light, produced by a broadband fluorescent UV lamp (Philips PL 9W/12). The test was applied to the lower arm of the patient, on its palmar side. The illumination time was 25 s, giving the following UV doses: 18, 35, 51, 63, 82 and 105 mJ/cm^2. The participants read the phototests themselves after 24 h, by simply counting the number of erythematous reactions within the provocation area. They then reported the results by mail, using a designated test protocol. The reading instruction made it clear that each visible reaction, including a barely perceptible erythema, was to be classified as a reaction, a procedure supported by the previous findings of Lock-Anderson *et al*. (32) of this criterion for minimal erythema dose (MED) to be more reliable in terms of interobserver variability than that relating to sharp-bordered reactions. The self-reading procedure has been proven reliable both in a student population (33), as well as in patients (34), well comparable to the interobserver variability that is known to be present even among trained physicians (32).

Statistical analysis. IBM SPSS Statistics 20 (IBM Corporation, Armonk, New York, USA), was used for all statistical analyses. The five-point Likert scales were dichotomized to reflect a positive or a negative attitude towards sunbathing; the five stages of change according to the TTM were dichotomized to reflect a high (preparation, action and maintenance stage) or a low (pre-contemplation and contemplation stage) propensity to increase sun protection. Similarly, self-estimated and actual skin UV sensitivity results were dichotomized so that Fitzpatrick's skin types I and II and 3-5 erythemal reactions on the phototest represented high UV sensitivity; Fitzpatrick's skin types IV-VI and 0-2 erythemal reactions on the phototest represented low UV sensitivity. Binary logistic regression analysis was used to investigate the odds ratios (OR) for having a positive attitude towards sunbathing and a low propensity to increase sun protection, depending on whether the participants had high or low UV sensitivity, assessed either by self-estimation or by phototest. Age and sex were used as covariates in all analyses to adjust for possible differences related to these.

Correlation between self-estimated skin UV sensitivity by Fitzpatrick's classification, and actual skin UV sensitivity by phototest was carried out in two steps. In the first step, correlation

Q1. How do you like sunbathing?
(I dislike it very much, I rather dislike it, I neither like nor dislike it, ↔I rather like it, I like it very much)
Q2. Do you think that the advantages of sunbathing outweigh the disadvantages?
(there are many more disadvantages, there are a few more disadvantages, advantages and disadvantages are equal, ↔ there are a few more advantages, there are many more advantages)
Q3. How extensive do you consider the health risks of sunbathing to be?
(very high, rather high, not very high, ↔ very low, no risk at all)
Q4. How extensive do you consider the risk for you to develop skin cancer?
(very high, rather high, not very high, ↔ very low, no risk at all)
Q5. How important is it for you to get tanned during the summer?
(very important, rather important, ↔ not very important, not important at all)

Figure 1. *Questions on attitudes towards sunbathing. The two-headed arrow (↔) shows the point of dichotomisation of response alternatives used in the analyses.*

between the six skin types according to Fitzpatrick and the seven possible UV sensitivity levels from the phototest (0-6 erythemal reactions) was investigated using Spearman's correlation. In the second step, agreement between the two methods in terms of high and low UV sensitivity using the dichotomized outcomes as described above was investigated using kappa analysis.

Results

Of the 166 eligible participants, 70 were male (42%) and 96 were female (58%). Age ranged from 18 to 90 years, and the mean age was 48 years. Skin type IV was the highest skin type reported by the subjects. For six individuals, information on skin type was left out in their responses, leaving 160 eligible for further analyses. On the phototest, no participant reacted with more than five erythemas, *i.e.* no reaction from the lowest UV dose was observed. Table I shows the response distributions for the dichotomized parameters regarding attitudes towards sunbathing and propensity to increase sun protection according to gender and UV sensitivity (self-estimated or by phototest), as well as the mean age for each subgroup of respondents.

The ORs (unadjusted and adjusted for gender and age) for having a positive attitude towards sunbathing and having low skin UV sensitivity are shown in Table II. A low self-perceived UV sensitivity was associated with a tendency to enjoy sunbathing and to consider tanned skin to be important, whereas actual UV sensitivity, determined by phototest, did not show any significant association with any of the attitude items investigated.

Table III shows the ORs (unadjusted and when adjusted for gender and age) for having a high propensity to increase sun protection according to the TTM and having low skin UV sensitivity. Self-estimated low UV sensitivity was also associated with having a lower propensity to give up sunbathing and to start using clothes for sun protection compared with self-estimated high UV sensitivity. However, no relationship between the actual UV sensitivity by phototest and propensity to increase sun protection was found for any of the items investigated.

When comparing the two methods for assessment of skin UV sensitivity, Spearman's correlation coefficient was low (0.22), indicating a low, although significant degree ($p<0.05$) of correlation between the two methods. Similarly, when investigating the level of agreement between the two methods when dichotomized to reflect high and low UV sensitivity, this was found to be poor (kappa=0.15).

Discussion

As previously shown for sun exposure habits (24), people's own perceptions of how they react in the sun, rather than their actual UV sensitivity, seems to be what determines their attitude towards sun exposure and protection, as well as propensity to increase sun protection. An individual's self-estimated UV sensitivity may diverge markedly from their actual sensitivity; this means that individuals with high UV sensitivity, but who perceive themselves to have low UV sensitivity [which is not so uncommon, as reported by both Harrison *et al.* (19) and Reeder *et al.* (35)], are at high risk of exposing themselves to considerably more sunlight than appropriate with regard to the risk for skin cancer development. Because individual attitude, together with subjective norms and normative beliefs, are important predictors of sun exposure habits (36), this knowledge is important for considering preventative measures and in designing and modifying sun protection advice, and supports the idea of targeting individuals with both high UV

Table I. *Response distributions for the dichotomized parameters regarding attitudes towards sunbathing and propensity to increase sun protection, according to gender and UV sensitivity (self-estimated and by phototest), with the mean age for each subgroup of respondents.*

Attitude towards sunbathing		Respondents (n)	Gender (n)		Self-estimated UV sensitivity		UV sensitivity by phototest		Mean age (years)
			Male	Female	High	Low	High	Low	
Preference for sunbathing	Yes	79	25	54	15	64	45	34	46.2
	No	79	40	39	30	49	47	32	50.4
Advantages of sunbathing	Yes	41	16	25	9	32	25	16	45.5
outweigh disadvantages	No	113	48	65	34	79	65	48	49.0
Sunbathing is healthy	Yes	37	20	17	8	29	16	21	56.4
	No	120	74	46	35	85	75	45	46.3
The risk of getting	Yes	27	14	13	4	23	15	12	50.5
skin cancer is low	No	155	47	78	36	89	73	52	47.8
Getting a tan is important	Yes	62	15	47	11	51	31	31	43.1
	No	97	50	47	34	63	62	35	51.8
Propensity to increase sun protection									
Giving-up sunbathing	Low	99	34	65	21	78	57	42	44.0
	High	60	31	29	24	36	37	23	55.8
Sunscreen use	Low	106	65	41	23	83	63	43	46.1
	High	54	29	25	22	32	31	23	43.1
Use of clothes for	Low	52	26	25	11	40	28	23	56.0
sun protection	High	109	68	41	34	75	66	43	45.0
Seeking the shade	Low	80	47	33	20	60	44	36	46.7
	High	80	47	33	25	55	50	30	50.2

sensitivity and excessive sun exposure habits. Informing people about their actual UV sensitivity and how it affects their constitutional risk profile may motivate people to take better precautions in the sun, and it has been suggested that a phototest might enhance the effect of preventative initiatives for individuals with high UV sensitivity (37). A probable mechanism behind this might be increased awareness of individual UV sensitivity, stimulating people to reconsider their behaviour in the sun.

Somewhat surprisingly, the consideration of risk and whether or not sunbathing is healthy were not significantly associated with differences in self-estimated UV sensitivity. Although not statistically significant, the OR for individuals with low UV sensitivity indicates that individuals in this category were more concerned about the risk of getting skin cancer than individuals with high UV sensitivity, even though the opposite might be expected. A probable explanation for this might be that people who perceive themselves to be sensitive to the sun choose to avoid it to a greater extent and thus reduce their personal risk.

In agreement with previous studies, there was no correlation between Fitzpatrick skin types and actual UV sensitivity measured by phototest (15-19). This raises the question whether assessment of Fitzpatrick's classification actually has any place in clinical practice or in other situations for determining UV sensitivity. Its unquestionable advantages in terms of being easy and quick to perform (as well as cheap) have probably contributed to its substantial and widespread use, but do not make it legitimate, correct and reliable. In its defence, however, and probably as a partial explanation for the lack of correlation with UV sensitivity measured by phototest, Fitzpatrick's classification takes tendency to burn and tan into account, whereas phototesting does not consider the latter. Nevertheless, the assessment is inevitably based on subjective criteria, and in theory in order to obtain objective data, it is possible to assess both these components with complementary bioengineering techniques, such as photospectroscopy (37), which has the ability to evaluate a range of different colours and individual intensities (such as redness or browning of the skin). In practice, this could generate objective data on skin reactivity, which would be more informative. However, further studies are needed to explore and develop this field before it can be used in clinical practice and in research or preventative situations.

The relatively small sample size is an important limitation of this study, especially because differences in response patterns for the kind of questions used in the questionnaire may be difficult to detect, due to a general considerable natural variance in responses (8, 36). The small number of

Table II. *The odds ratios (ORs), confidence intervals (CIs) and p-values for having a positive attitude towards sunbathing and having a low skin UV sensitivity, determined either by self-estimation, in terms of skin type according to Fitzpatrick's classification, or by phototest, showing non-adjusted values and when adjusted for gender and gender + age.*

Attitude towards sunbathing	Low UV sensitivity					
	Self-estimated			By phototest		
	OR (OR1) OR2	95% CI*	*p*-Value	OR (OR1) OR2	95% CI*	*p*-Value
Preference for sunbathing	2.61		0.009	1.11		0.75
	(3.15)		(0.003)	(1.06)		(0.85)
	3.70	1.65-8.33	0.002	1.14	0.59-2.21	0.73
Advantages of sunbathing outweigh disadvantages	1.53		0.32	0.87		0.70
	(1.57)		(0.30)	(0.86)		(0.68)
	1.71	00.69-4.22	0.25	0.86	0.40-1.83	0.67
Sunbathing is healthy	1.49		0.37	2.19		0.06
	(1.43)		(0.43)	(2.23)		(0.06)
	1.69	0.66-4.38	0.28	2.00	0.92-4.37	0.07
The risk of getting skin cancer is low	2.33		0.14	1.12		0.79
	(2.14)		(0.19)	(1.16)		(0.74)
	2.14	0.66-6.89	0.20	1.17	0.49-2.76	0.71
Getting a tan is important	2.50		0.02	1.77		0.08
	(3.26)		(0.005)	(1.74)		(0.12)
	3.87	1.60-9.40	0.003	2.01	0.99-4.09	0.06

(OR1)=OR adjusted for gender, OR2=OR adjusted for gender an age. *The 95% CI is only displayed for ORs adjusted for both gender and age.

Table III. *Odds ratios (ORs), confidence intervals (CIs) and p-values for having a high propensity to increase sun protection according to the TTM, and having low skin UV sensitivity, determined either by self-estimation, in terms of skin type according to Fitzpatrick's classification, or by phototest, showing non-adjusted values and when adjusted for gender and gender + age.*

Propensity to increase sun protection	Low UV sensitivity					
	Self-estimated			By phototest		
	OR (OR) OR	95% CI*	*p*-Value	OR (OR) OR	95% CI*	*p*-Value
Giving up sunbathing	0.40		0.01	(0.88)		0.61
	(0.34)		(0.04)	0.71		(0.71)
	0.26	0.11-0.60	0.002	0.84	0.34-1.46	0.58
Sunscreen use	0.61		0.21	0.79		0.50
	(0.77)		(0.27)	(0.77)		(0.45)
	0.55	0.23-1.32	0.18	0.91	0.44-1.87	0.39
Use of clothes for sun protection	0.40		0.01	1.09		0.81
	(0.37)		(0.008)	(1.11)		(0.76)
	0.35	0.16-0.76	0.008	1.01	0.51-2.00	0.75
Seeking the shade	0.73		0.38	0.73		0.37
	(0.64)		(0.30)	(0.73)		(0.34)
	0.62	0.30-1.30	0.21	0.74	0.39-1.42	0.34

(OR1)=OR adjusted for gender, OR2=OR adjusted for gender an age. *The 95% CI is only displayed for ORs adjusted for both gender and age.

questions might also be viewed as a limitation, and it is possible that there are areas of potential interest not covered by the questionnaire. For example, attitudes towards using a sunbed have not been investigated. However, because the data were derived from a previous intervention study, originally focusing on research aspects other than those of the present study, the results presented here are what could be found with regard to these limitations. Ultimately, a somewhat larger study sample and an extended questionnaire would be valuable elements in a possible future study on this subject.

In conclusion, self-estimated UV sensitivity of the skin seems to be associated with differences in attitudes towards sun bathing and propensity to increase sun protection, whereas actual skin UV sensitivity does not. This might indicate that individuals with a perceived low but in reality high UV sensitivity do not seek adequate sun protection with regard to skin cancer risk. A strikingly low degree of correlation and agreement between self-estimated UV sensitivity, using Fitzpatrick's classification and actual UV sensitivity measured by phototest was found, which makes the clinical use of Fitzpatrick's classification questionable.

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