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Validation of sun exposure and protection index (SEPI) for estimation of sun habits

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ABSTRACT

Background: In both Sweden and Australia high incidence rates of skin cancer have become a major health problem. In prevention and risk communication, it is important to have reliable ways for identifying people with risky sun habits. In this study the validity and reliability of the questionnaire Sun Exposure Protection Index (SEPI), developed to assess individual's sun habits and their propensity to increase sun protection during routine, often brief, clinical encounters, has been evaluated. The aim of our study was to evaluate validity and reliability of the proposed SEPI scoring instrument, in two countries with markedly different ultraviolet radiation environments (Sweden and Australia).

Method: Two subpopulations in Sweden and Australia respectively were asked to fill out the SEPI together with the previously evaluated Readiness to Alter Sun Protective Behaviour questionnaire (RASP-B) and the associated Sun-protective Behaviours Questionnaire. To test reliability, the SEPI was again filled out by the subjects one month later.

Results: Comparison between SEPI and the questions in the Sun-protective Behaviours Questionnaire, analyzed with Spearman's Rho, showed good correlations regarding sun habits. Comparison between SEPI and RASP-B regarding propensity to increase sun protection showed concurrently lower SEPI mean scores for *action stage*, but no difference between *precontemplation* and *contemplation* stages. The SEPI test-retest analysis indicated stability over time. Internal consistency of the SEPI, assessed with Cronbach's alpha estimation showed values marginally lower than the desired >0.70 coefficient value generally recommended, and was somewhat negatively affected by the question on sunscreen use, likely related to the classic "sunscreen paradox". There were some differences in the performance of the SEPI between the Swedish and Australian samples, possibly due to the influence of "available" sunlight and differing attitudes to behaviour and protection "at home" and on vacation.

Conclusions: SEPI appears to be a stable instrument with an overall acceptable validity and reliability, applicable for use in populations exposed to different UVR environments, in order to evaluate individual sun exposure and protection.

1. Introduction

For many years, the incidence of skin cancer has been increasing in western societies, not least northern Europe [1,2]. In Sweden, for example, malignant melanoma (MM), the most lethal skin cancer form, has become the most rapidly increasing malignancy during recent decades and was in 2013 the fifth most common type of cancer among women and the sixth most common type among men. Additionally, non melanoma skin cancer (NMSC), included in the cancer registry in Sweden, has become the second most

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frequent cancer form for both women and men [1]. In Australia, which has the world's highest incidence rates for all skin cancers, MM is the third most common cancer form diagnosed for both women and men, and during the years 1991–2009 the age standardised incidence of MM, in men, increased with 42 percent, and with 18 percent in women [3]. NMSC is not generally recorded in cancer registers in Australia but is nevertheless by far the most frequently diagnosed cancer for both men and women [4].

From a preventive perspective, the increasing incidence has turned the focus towards sun exposure habits, and how to modify people's behaviour in the sun, since ultraviolet radiation (UVR) is not only the main known cause of skin cancer development [5,6], but also the one that is most amenable to change [7]. Other important risk factors in the development of skin cancer are pigmentation phenotype [8], genetic background [5], common nevi count and atypical nevi count [9,10]. While the high skin cancer rates in Australia are entirely consistent with its sunny climate and location close to the equator, the high incidence rates in Sweden are remarkable given the high latitude and markedly lower number of average daily sunshine hours. The probable explanation for this is the fact that the Swedish population has one of the world's most pronounced sun-seeking behaviour, whereas the Australian population has been educated for decades to try to protect itself from the sun [11]. Prevention of excessive UVR exposure is important throughout life, not only since frequent sun exposure and sunburns (especially in early life) has been found to increase the risk for development of MM and basal cell carcinoma (BCC) [12,13], but also since populations in western societies are in general getting older, with increased levels of accumulated sun exposure during life. Preventive measures need therefore to focus both on minimizing numbers of sunburns and also the cumulative rate of sun exposure in all age groups [14–16]. The most frequently used sun protection, both in Australia and worldwide, is to apply a sunscreen, whereas the recommended ways of protection are covering up with clothes, staying in the shade, wearing a broad-brimmed hat and avoiding the sun between 11am and 3pm [11,17–20].

Not least when it comes to prevention, reliable mapping of individual sun exposure as well as attitudes to and practice of sun protection is highly desirable. Despite much activity, no gold standard for measurement of sun exposure habits exists. Furthermore, many questionnaires are extensive and time consuming, hindering broad clinical uptake. Some studies have looked at objective methods for assessing exposure such as observations or UV-indicators [20,21]. Despite an inevitable element of uncertainty and recall bias, however, self-reported measures of ultraviolet exposure have been found to be surprisingly reliable when compared with actual exposure assessed by observational methods [21]. Examples of sun-related questionnaires are the Sun protection behaviour scale (SPBS) [22], and Readiness to Alter Sun Protective Behaviour RASP-B [23], both based on the transtheoretical model of behaviour change (TTM). We previously presented a scoring model based on a combination of Likert scale scores for mapping sun exposure and protection practices, and TTM for mapping readiness to increase sun protection [24]. Based on the model, we have now developed a combined scoring instrument named Sun Exposure and Protection Index SEPI, intended for use in patient-doctor interactions in clinical practice [25,26], as well as for evaluating preventive interventions [24].

The aim of the present study was to evaluate the validity and reliability of the SEPI scoring instrument, in two countries with different UVR environments. In addition, we tested the utility of the SEPI to explore possible differences in sun exposure habits between populations—in this paper Sweden and Australia.

2. Material and methods

2.1. Study populations

The study was performed in Brisbane, Australia, and in Linkoping, Sweden, in September to December 2013. In each country, participants were sampled from two subpopulations, namely primary health care (PHC) patients and university students. The initial aim was to recruit 150 participants in each subpopulation respectively, a sample size based on the outcome of the previously performed pilot study describing the model [24], comprising approximately 100 subjects in each group, with a margin for possible drop-outs.

2.1.1. Primary health care patients

The samples of PHC patients were recruited from two typical PHC practices in Brisbane and Linköping, respectively. At registration in the reception, the SEPI questionnaire was handed to the patients, together with a written information sheet about the study, and a request to voluntarily participate. Patients willing to do so signed a written consent form which was enclosed with the questionnaire, and then filled-out the questionnaire, either while sitting in the waiting room, or later at home. In addition to SEPI, the participants also completed a previously validated questionnaire, by means of the RASP-B and the associated Sun-protective Behaviours Questionnaire used in the validation process of the latter [23]. After four weeks, participants were sent a repeated SEPI questionnaire to be filled-out, together with a prepaid envelope and an information letter with a reminder of the study and a request to return the completed questionnaire by mail.

2.1.2. Students

The student sample in Australia consisted of third year psychology students and first year engineering mathematic students at Queensland University of Technology (QUT). In Sweden the population consisted of second and third year psychology students and second year engineering applied physics students at Linköping University (LiU).

The student samples were recruited by visiting two lectures in Brisbane and three lectures in Linköping where, after a brief verbal introduction and information, the students received the information sheet, consent form with contact details and the SEPI and RASP-B/Sun-protective Behaviours Questionnaire, which they thereafter handed in. The test-retest procedure after four weeks was the same as for the group of PHC patients.

2.1.3. Inclusion and exclusion criteria

In all four study subpopulations, age $\geq$18 years was an inclusion criterion. Exclusion criteria were individuals with limited autonomy or impaired cognitive abilities. We did not impose any exclusion criteria relating to conditions that might affect sun exposure habits (e.g. photodarmatoses etc) as we sought to recruit samples that reflected unselected populations, namely PHC patients and students. No remuneration for participation was offered.

2.2. Questionnaire

2.2.1. SEPI

The SEPI scoring instrument consists of two sections; one including eight questions appraising sun habits and sun protection behaviour, and one including five questions assessing readiness to increase sun protection (see appendix). The contents of the two sections were developed from previous studies [27–29] and the question items used in these, and were then, in a first step, selected and processed among a group of experts within the field,

comprising dermatology, epidemiology, public health and primary healthcare, to cover the different areas of the score. In a second step, the suggested instrument was forward translated from the original Swedish version into the English language, and the consistency of the produced English version re-compared with the original by a native English speaker skilled in both languages. In a third step, the two language versions of the instruments were then presented, further discussed and evaluated in two seminar sessions with two groups of primary healthcare clinicians; one in Australia and one in Sweden, respectively. The process resulted in equivalent question formulations for both country questionnaire versions, except for the question on vacational sun exposure (in the Australian version: "How often do you take a holiday with the intention of spending more time in the sun?"), for which travel to sunny resorts abroad were referred to in the Swedish version ("How often do you travel abroad to countries with strong sun light (for example to sunny resorts)?"), since the latter constitutes an important source of UV exposure especially during the winter season in Sweden. Subsequent backward translation prior to a later study gave an essentially identical Swedish version.

Each part of the SEPI results in a score. Part I, mapping sun exposure/protection habits, includes eight questions based on five-grade Likert scale scores (0–4 points), resulting in a total score of 0–32 points, reflecting an increasing risk exposure. Part II, mapping readiness to increase sun protection, includes five questions scored from 0 to 4 points based on the defined stages of change according to the TTM (*maintenance, action, preparation, contemplation* and *precontemplation* stage), resulting in a total score of 0–20 points, reflecting a decreasing propensity to increase sun protection. Thus, in summary, a high score in both parts reflects a high level of sun exposure, and a low propensity to change it.

2.2.2. RASP-B/Sun-protective Behaviours Questionnaire

The RASP-B questionnaire consists of twelve questions assessing propensity to increase sun protection, according to the TTM. Unlike part II in SEPI, however, each question refers to a specific stage of change (*precontemplation*,*preparation* or *action* stage), distributed as four questions for each stage, instead of each question assessing stage of change for specific aspects of UV exposure/protection. Completing the RASP-B results in one single dominant stage of change for each individual, not referring to a specific behaviour (e.g. sunscreen use). In the validation process of RASP-B, the complementary Sun-protective Behaviours Questionnaire was used, consisting of 14 questions exploring current sun exposure habits/sun protection behaviour, based on five-grade Likert scale responses [23].

For demographic information, age and gender were recorded in the questionnaire.

2.3. Testing of validity

For part I of SEPI, mapping current sun exposure habits, we calculated Spearman's rho to estimate the correlation between the eight questions in SEPI and each of the one or more questions in the Sun protective behaviours questionnaire of RASP-B. A correlation coefficient value of 0.10-0-29 was seen as poor correlation, between 0.30–0.49 as medium correlation and 0.50–1.00 as good correlation [30]. A level of $P < 0.05$ was set as statistically significant.

For part II of SEPI, assessing propensity to increase sun protection, correlation with each of the questions in the Sun protective behaviours questionnaire was also explored using Spearman's Rho, following the same principles as described for part I. Furthermore, to compare the staging of propensity to increase sun protection between SEPI and RASP-B, the median score of SEPI part II was assessed for each of the three stages of change (*precontemplation, contemplation*and*action*stage) based on which was the dominant stage according to the subjects' responses in RASP-B and statistical differences in response distribution between the stages tested with Kruskall–Wallis analysis.

2.4. Testing of reliability

2.4.1. Internal consistency

Internal consistency of each of the two parts of SEPI was tested by estimation of Cronbach's alpha. A Cronbach's alpha coefficient value above 0.70 was interpreted as an expression of good internal consistency.

2.4.2. Stability over time

Stability over time was assessed by a test-retest procedure, whereby the participants filled-out the SEPI twice; at baseline and after four weeks. Correlation of individual responses between the two response occasions was investigated using Spearman's rho. We used the same levels for correlation and statistical significance as described for the validity testing to interpret agreement.

The same analyses were made in all subpopulations (student population Australia/Sweden, PHC population Australia/Sweden) as well as in the overall populations (Australia, Sweden).

2.5. Exploring differences in SEPI outcome between Australia and Sweden

Differences in SEPI outcome between the Australian and Swedish total populations were investigated by means of median scores, for part I (0–32 points) and part II (0–20 points) of the instrument. Also, the median scores for each of the individual questions in both parts were calculated. Statistical differences in median values were investigated using independent samples median test.

2.6. Ethical approval

In Australia, ethical approval was received by the ethical committee of QIMR Berghofer and QUT (QUT approval number:1300000520/Queensland Institute of Medical Research HREC approval number: P1539) and in Sweden by the Regional Ethical Review Board in Linköping (Dnr 2013/146-13).

3. Results

3.1. Australian samples

In the Australian PHC sample, 46 patients completed the questionnaires. Of these, one was excluded due to a missing written consent form. Of the remaining 45 subjects, 29 (64.4%) were female and 16 (35.6%) were male. The ages were between 26 and 83 with a mean age of 49 years. The Australian student sample comprised 210 students who completed the questionnaires. Of these, 46 (22%) were excluded due to lack of contact details, incomplete questionnaires, age <18 years or lack of written consent. Of the remaining 164 subjects 70 (42.7%) were female and 93 (56.7%) were male. Gender information was missing in one subject (0.6%). The ages ranged between 18 and 50 with a mean age of 21 years.

3.2. Swedish samples

In the Swedish PHC sample 76 participants were recruited. Of these, ten were excluded due to lack of contact details or incomplete questionnaires. Of the remaining 66 participants, 42 (63.6%) were female and 24 (36.4%) were male. The ages ranged

between 30 and 87 with a mean age of 64 years. The Swedish student sample yielded 132 completed questionnaires. Of these, ten were excluded due to lack of contact details, incomplete questionnaires or lack of consent. Of the remaining 122 subjects 69 (56.6%) were female and 53 (43.4%) were male. The ages ranged between 19 and 41 with a mean age of 23 years.

3.3. Validity of SEPI

3.3.1. SEPI part I

The correlation between each separate question in SEPI part I and the corresponding questions in the Sun protective behaviour questionnaire is shown in Table 1. Spearman's Rho was calculated in all four subpopulations (student population in Australia/Sweden, PHC population in Australia/Sweden) as well as in the total population in each country (Australia, Sweden). Correlation coefficients showed satisfactory correlation for most of the questions, with the exception of the SEPI question concerning sun exposure on vacations, for which there was a negative correlation with sunscreen use during vacation. The highest coefficient values were seen for*Intentional tanning*, *Occasions with sunburn*and *Hat or cap for sun protection.*

3.3.2. SEPI part II

In Table 2, the correlation between the questions in SEPI part II and the related questions in the Sun protective behaviour questionnaire, is displayed in the same manner as described above for SEPI part I. Table 3 shows the median scores of SEPI part II for each of the three stages of change (*precontemplation, contemplation*and*action*stage), respectively, based on which was the dominant stage according to the responses in RASP-B. As seen in the table, the median SEPI score was generally lower in the action stage compared to the two other stages, whereas there was no marked difference between the median scores in the contemplation and precontemplation stages.

3.4. Reliability of SEPI

3.4.1. Internal consistency

In Tables 4a and 4b, the results of the Cronbach's alpha analysis for assessment of internal consistency, is presented. For SEPI part I, the Cronbach's alpha coefficient in the total populations ofAustralia and Sweden were 0.69 and 0.61 respectively. For SEPI part II, the corresponding outcomes were 0.67 in Australia and 0.57 in Sweden. With deletion of the question on *Sunscreen use*in SEPI part I, the Cronbach's alpha increased to 0.71 in the Australian population, and 0.73 in the Swedish population.

3.5. Test stability

3.5.1. Test stability

A test-retest analysed with Spearman's Rho was also made between both SEPI by matching the answers at baseline and at one month's follow-up, in order to evaluate test stability over time. The

Table 1
Correlation between the responses to the eight questions in SEPI part I and the one or more related question responses in the Sun-protective behaviours questionnaire (in italics), assessed with Spearman's Rho. Asterisks indicate statistical significance (* = $P < 0.05$, ** = $P < 0.01$).

SEPI part I—Questions	Correlation coefficient (Spearman's rho)					
	Aus stud.	Aus PHC	Aus tot	Swe stud.	Swe PHC	Swe tot
1. Intentional tanning						
How often do you sunbathe with the intention to get tanned?						
How often do you sunbathe?	0.76**	0.55**	0.73**	0.88**	0.83**	0.88**
2. Occasions with sunburn						
How many times have you been sunburnt (redness and smarting pain) during the last 12 months?						
Think about the time from last summer until now. How often did you get that sunburnt that was sore or tender the next day?	0.70**	0.78**	0.75**	0.76**	0.68**	0.82**
Think about the time from last summer until now. How often have you had sunburn that has blistered?	0.35**	0.18	0.39**	0.09	0.38**	0.20**
3. Duration of stay in the sun						
How long do you usually stay in the sun (in average), between 11 am and 3 pm, on a typical day-off?						
When on holidays, how much time do you typically spend outdoors during 11 am – 2 pm?	0.61**	0.63**	0.61**	0.44**	0.49**	0.42**
4. Vacational sun exposure						
How often do you take a holiday with the intention of spending more time in the sun?						
When I am on holidays, I use sunscreen when going outdoors	−0.01	−0.51**	−0.10	−0.22*	−0.22*	−0.40**
When I am on holidays, I re-apply sunscreen when outdoors	−0.03	−0.21	−0.13	−0.22*	−0.02	−0.42**
5. Sunscreen use						
When in the sun, how often do you use sunscreens?						
When I am on holidays, I use sunscreen when going outdoors	0.68**	0.64**	0.68**	0.54**	0.84**	0.67**
When I am at home, I use sunscreen when going outdoors	0.42**	0.72**	0.48**	0.48**	0.76**	0.58**
When I am on holidays, I re-apply sunscreen when outdoors	0.50**	0.53**	0.51**	0.54**	0.78**	0.64**
When I am at home, I re-apply sunscreen when outdoors	0.36**	0.40**	0.37**	0.43**	0.78**	0.54**
6. Clothes for sun protection						
When in the sun, how often do you use covering clothes for						
How often would you wear clothes covering most of your body (including arms and legs) to avoid the sun?	0.56**	0.66**	0.58**	0.67**	0.78**	0.74**
How often would you deliberately wear less clothing so as to get some sun on your skin?	0.26**	0.24**	0.26**	0.31**	0.32**	0.36**
Covering up with clothes	0.57**	0.69**	0.62**	0.69**	0.64**	0.72**
7. Hat or cap for sun protection						
When in the sun, how often do you use a sun hat or cap for sun protection?						
How often would you wear a hat?	0.68**	0.53**	0.72**	0.76**	0.80**	0.78**
Wearing a hat outside	0.60**	0.46**	0.65**	0.65**	0.75**	0.71**
8. Staying indoors or in the shade						
How often do you stay indoors or in the shade in order to protect yourself from the sun?						
How often would you stay mainly in the shade to avoid the sun?	0.52**	0.79**	0.59**	0.68**	0.70**	0.71**
How often would you spend most of the time inside?	0.46**	0.51**	0.49**	0.30**	0.54**	0.38**
Staying inside	0.41**	0.57**	0.48**	0.37**	0.45**	0.38**
Staying under shade	0.49**	0.58**	0.51**	0.64**	0.78**	0.71**
Keeping out of the sun between 11am and 3pm	0.55**	0.58**	0.60**	0.50**	0.55**	0.54**

Table 2
Correlation between the responses to the five question items in SEPI part II, addressing propensity to increase sun protection, and the one or more related question responses in the Sun-protective behaviours questionnaire (in italics), assessed with Spearman's Rho. Asterisks indicate statistical significance (* = $P < 0.05$, ** = $P < 0.01$).

SEPI part II—Questions	Correlation coefficient (Spearman's rho)					
	Aus stud	Aus PHC	Aus tot	Swe students	Swe PHC	Swe tot
Sunbathing						
The amount of time I spend in the sun is a problem sometimes	0.17*	−0.09	0.11	−0.49	0.03*	−0.04
How often do you sunbathe?	0.68**	0.48**	0.66**	0.40**	0.63**	0.51**
Sunscreens						
When I am at home, I use sunscreen when going outdoors	0.43**	0.57**	0.47**	0.53**	0.79**	0.61**
When I am on holidays, I re-apply sunscreen when outdoors	0.42	0.50	0.44	0.61	0.72	0.65
When I am at home, I re-apply sunscreen when outdoors	0.30	0.24	0.29	0.49	0.72	0.56
Covering clothes						
How often would you wear clothes covering most of your body (including arms and legs) to avoid the sun?	0.59**	0.62**	0.60**	0.61**	0.65**	0.63**
How often would you deliberately wear less clothing so as to get some sun on your skin?	0.25**	0.35*	0.28**	0.25**	0.12	0.24**
Covering up with clothes	0.60**	0.71**	0.64**	0.61**	0.50**	0.58**
Sun hat or cap						
Wearing a hat outside	0.56**	0.53**	0.62**	0.58**	0.82**	0.68**
How often would you wear a hat?	0.63**	0.51**	0.68**	0.62**	0.79**	0.71**
The shade						
How often would you stay mainly in the shade to avoid the sun?	0.61**	0.51**	0.61**	0.61**	0.74**	0.68**
How often would you spend most of the time inside?	0.41**	0.29	0.42**	0.33**	0.48**	0.38**
Staying inside	0.38**	0.33**	0.41**	0.29**	0.34**	0.29**
Staying under shade	0.56**	0.49**	0.56**	0.58**	0.75**	0.65**
Keeping out of the sun between 11am and 3pm	0.50**	0.56**	0.54**	0.47**	0.47**	0.49**

results are presented in Table 5, showing in general high correlation coefficient values for all questions, in both parts of SEPI.

3.6. Differences in SEPI outcome between Australia and Sweden

Table 6 compares sun exposure habits between the Australian and Swedish samples, showing the median SEPI scores for each of the two parts of the instrument (part I: 0–32 points, part II: 0–20 points). Overall, the Swedish sample had generally lower levels of sun protective behaviours, and a markedly lower propensity to increase sun protection than the Australian sample, illustrated by significantly higher total scores for both parts of the SEPI ($p < 0.001$). Assessing individual items, it was notable that all items in SEPI part II assessing readiness to increase sun protection were significantly higher in the Swedish than Australian samples. Similarly, all items in part I (assessing current sun exposure habits) were higher in the Swedish than Australian samples, except for *Occasions with sun burn*and*Vacational sun exposure,*for which the

Table 3
Median score of SEPI part II for each of the three stages of change (*precontemplation*,*contemplation* and *action* stage) based on the responses in RASP-B.

Stage of change according to RASP-B	SEPI part II median score			SEPI part II median score		
	Australian population			Swedish population		
	Students	Patients	Total	Students	Patients	Total
Precontemplation stage	6	4	5	12	11	11
Contemplation stage	7	3	6	12	12	12
Action stage	4	1.5	3	7	8	7
Sign. (Kruskall–Wallis)	0.11	0.32	0.009	0.048	0.33	0.01

Table 4a
Internal consistency of SEPI part I, in terms of Cronbach's alpha, displayed for the full score, and with deletion of each of the ingoing questions.

	Australian population			Swedish population		
	(Cronbach's alpha)			(Cronbach's alpha)		
	Students	Patients	Total	Students	Patients	Total
Value for SEPI as a whole	0.66	0.43	0.69	0.63	0.50	0.61
Value after deletion of single questions, as follows:						
1. Intentional tanning	0.62	0.41	0.65	0.53	0.39	0.50
2. Occasions with sunburn	0.63	0.43	0.66	0.62	0.47	0.57
3. Duration of stay in the sun	0.61	0.37	0.64	0.55	0.41	0.54
4. Vacational sun exposure	0.61	0.50	0.65	0.62	0.48	0.59
5. Sunscreen use	0.67	0.53	0.71	0.69	0.65	0.73
6. Clothes for sun protection	0.64	0.29	0.67	0.58	0.39	0.54
7. Hat or cap for sun protection	0.67	0.29	0.67	0.63	0.48	0.60
8. Seeking the shade	0.60	0.25	0.64	0.54	0.34	0.49

Table 4b
Internal consistency of SEPI part I, in terms of Cronbach's alpha, displayed for the full score, and with deletion of each of the ingoing questions.

	Australian population (Cronbach's alpha)			Swedish population (Cronbach's alpha)		
	Students	Patients	Total	Students	Patients	Total
Value for SEPI as a whole	0.67	0.55	0.67	0.60	0.59	0.57
Value after deletion of single questions, as follows:						
1. Intentional tanning	0.65	0.43	0.64	0.62	0.51	0.53
2. Sunscreen use	0.62	0.62	0.65	0.64	0.70	0.68
3. Clothes for sun protection	0.61	0.47	0.62	0.46	0.37	0.38
4. Hat or cap for sun protection	0.62	0.56	0.63	0.56	0.55	0.52
5. Seeking the shade	0.57	0.34	0.57	0.43	0.46	0.40

Table 5
Stability over time of the SEPI, expresses as correlation between the subjects' responses at baseline and after one month, assessed with Spearman's Rho. Asterisks indicate statistical significance (* = $P<0.05$, ** = $P<0.01$).

	Correlation coefficient (Spearman's Rho)					
SEPI Part I—Questions	Aus stud	Aus PHC	Aus tot	Swe stud	Swe PHC	Swe tot
Intentional tanning	0.84**	0.65**	0.83**	0.84**	0.79**	0.83**
Occasions with sunburn	0.68**	0.88**	0.79**	0.57**	0.65**	0.75**
Duration of stay in the sun	0.80**	0.56**	0.74**	0.58**	0.67**	0.64**
Vacational sun exposure	0.69**	0.42**	0.68**	0.91**	0.84**	0.89**
Sunscreen use	0.70**	0.80**	0.74**	0.74**	0.74**	0.74**
Clothes for sun protection	0.61**	0.72**	0.64**	0.71**	0.72**	0.75**
Hat or cap for sun protection	0.59**	0.74**	0.73**	0.61**	0.70**	0.67**
Staying indoors or in the shade	0.63**	0.52**	0.63**	0.63**	0.69**	0.69**
SEPI Part II—Questions						
Sunbathing	0.84**	0.69**	0.82**	0.65**	0.83**	0.76**
Sunscreens	0.40**	0.93**	0.57**	0.83**	0.86**	0.87**
Covering clothes	0.75**	0.88**	0.80**	0.66**	0.70**	0.69**
Sun hat or cap	0.69**	0.27	0.72**	0.59**	0.81**	0.72**
The shade	0.68**	0.68**	0.68**	0.79**	0.65**	0.71**
Sunbathing	0.84**	0.69**	0.82**	0.65**	0.83**	0.76**

Table 6
Comparison in SEPI outcome between the Australian and Swedish total populations, expressed as median scores, also showing the subscore for each of the individual questions included. Statistical significance values refer to differences in median score between the two populations assessed with independent samples median test.

	Median score		
SEPI Part I—Questions	Australian population	Swedish population	Sign. (Median test)
Intentional tanning	0	2	<0.001
Occasions with sunburn	1	1	0.03
Duration of stay in the sun	1	2	<0.001
Vacational sun exposure	1	1	0.003
Sunscreen use	1	1	0.081
Clothes for sun protection	2	3	<0.001
Hat or cap for sun protection	2	3	<0.001
Staying indoors or in the shade	2	2	<0.001
Total score	11	14	<0.001
SEPI Part II—Questions			
Sunbathing	0	3	<0.001
Sunscreens	0	1	<0.001
Covering clothes	1	3	<0.001
Sun hat or cap	1	3	<0.001
The shade	1	2	<0.001
Total Score	5	11	<0.001

Australian sample scored higher, and*Sunscreen use*, for which the difference in response distribution was not statistically significant.

4. Discussion

The Sun Exposure and Protection Index (SEPI) is a novel instrument for grading sun exposure habits, intended to be usable both as a platform to communicate tailored sun protection advice on an individual level, and to measure sun exposure and protection on a group level, e.g. as a tool to evaluate the effect of an intervention. In this study, the SEPI was shown to be stable and reproducible, and to have in general acceptable validity when compared with the questions in the somewhat more extensive sun protective behaviour questionnaire of RASP-B. Overall, internal consistency between the items was also shown to be acceptable.

The level of correlation between the separate questions in SEPI and the control questions varied, as shown in Table 1 and 2. The reasons behind the occasions of lower correlation values are probably various. For example, the correlation between *"How many times have you been sunburnt (redness and smarting pain) during the last 12 months?"* and *"Think about the time from last summer until now. How often have you had sunburn that has blistered?"* might depend on the fact that blisters develop less frequently than typical sunburn. Furthermore, in Sweden blisters probably develop less commonly than in Australia due to the generally less intense UV radiation. In the case of sunscreen use, the SEPI question correlated best with the questions addressing vacational application, and less with everyday use when at home, possibly reflecting differences in risk perception between the two samples associated with "at home" UV-exposure.

Internal consistency reflected by Cronbach's alpha turned out to be slightly lower than the desired >0.70 coefficient value generally recommended. In part, this was probably due to the limited number of questions, and relatively small study samples. Perhaps more importantly, we found that the questions concerning sunscreen use were the least consistent internally and that, for both parts I and II, deletion of these would increase the value of the Cronbach's alpha coefficient considerably (in part I >0.70). The main reason behind this is probably the sunscreen paradox, as mentioned earlier [18,19], since people who are using sunscreens also are the ones spending more time in the sun, making these specific questions operate in opposite directions. Although the results might indicate that the sunscreen questions should be excluded from the score, this would, however, be less beneficial for identifying those individuals with the highest risk behaviour (individuals with intense sun exposure and rarely using sunscreens). Thus, with regard to the sunscreen paradox, the usefulness of the SEPI is likely to be assisted by leaving the questions in place.

As might be expected, the median score of SEPI part II was generally lower in the action stage compared to the two other stages, reflecting a higher propensity to increase sun protection, whereas there was no difference between the median scores in the precontemplation and contemplation stages. The reason for the latter might be the basic difference between SEPI and RASP-B, namely SEPI assessing readiness to increase sun protection (or reduce sun exposure) within different behavioural aspects (seeking the shade, using sunscreens etc), resulting in a cumulated score, while all questions in RASP-B are restricted to the general aspect of "spending less time in the sun", resulting in a dominant stage instead of a score. This makes RASP-B a somewhat coarser instrument.

A possibly expected finding was that the Swedish samples showed a significantly higher level of sun seeking behaviour, coupled with a lower propensity to increase sun protection, compared with the Australian samples. This was true for all items except for measures of sunburn and vacational sun exposure, which were higher for Australian subjects. This most likely reflects a natural consequence of the markedly sunnier Australian climate. It might also reflect, in part, that the question on vacational sun exposure by intention differed somewhat in content between the two UVR environments. With this exception, the remaining questions did not differ between the two language versions, a circumstance that may be discussed. For example, in Australia a broad brimmed hat is the generally recommended protection for the face and head, whereas in Sweden this is a very uncommon headdress, a reason for choosing the more neutral terminology "sun hat or cap" in the score. Although the term "sun hat" aims to include a wider range of alternate sun protective headwear, such as bucket or legionnaires hats, future revisions of the instrument may benefit from specifying these types of headwear in the question. In doing so, they would capture those types of headwear that offer the greatest protection to the face, neck and ears, as opposed to "cap", from which the sun protective effect in many cases is likely to be insufficient. Despite an inevitable element of language and environmental disparities in the present version, as a whole the SEPI appears to be useful in exploring differences in individuals over time, between groups of individuals or between populations.

Although the number of study participants was lower than originally intended, especially in the two PHC samples, the fact that the study was performed in two highly different UVR environments represents an important strength of the study, the results indicating that the SEPI instrument can reliably be used in the populations of both environments. Moreover, the different study subpopulations cover a broad age spectra, albeit with a somewhat more sparse representation in lower middle age. The lower than intended number of participants, mainly in the PHC subpopulations, was mostly due to limitation of the time frames of the study, and that the recruitment of PHC patients took somewhat longer than expected. Also, difference in the recruitment procedure between the student and PHC samples is likely to have contributed to the lower sample size achieved in the two PHC samples, students receiving a short oral information presentation in connection with a lecture, whereas the PHC patients only received a written information at registration in the reception. Ideally, a more active recruitment strategy, incorporating both oral and written information may have been beneficial for this group. Unfortunately, for practical reasons, extending the recruitment period was not possible. An additional study limitation is that the seasons for filling-out the questionnaires differed between the two countries. The Australian population filled-out the questionnaires in their spring whereas the Swedish population filled-out the questionnaires during the autumn. This could have affected the results by means of possible recall bias; ideally, an additional half-year follow-up or would potentially have overcome this limitation. However, the winter climate in Brisbane is similar to the summer climate in Sweden, by means of ambient UV radiation [31,32], and in contrary to Sweden there is an all-year-round need for sun protection, also in the winter. This may have been contributory in diminishing this disparity.

Besides age and gender, no other demographic properties were asked for from the participants. Other factors known to determine sun exposure habits include ethnicity, skin colour and self-perceived UV skin sensitivity. However, no mapping of these factors was made in the present study, but remains to be explored in future studies addressing the applicability of SEPI in different settings and with regard to varying responder characteristics. Finally, we had no information about non-responders, and so it remains possible that our survey is biased due to self-selection of participants.

An advantage of the SEPI is that it is short and quick to complete which increases its attractiveness for clinical use. In practice, SEPI

takes only a few minutes to complete, and could easily be filled-out prior to the doctor's visit. Although this shortness entails a subsequent lack of detailed information, the information loss from low response rates commonly associated with extensive questionnaires should not be underestimated. Also, the combination of the two parts of SEPI, addressing not only the present behaviour but also the propensity to change it, in the same instrument, gives the user a comprehensive picture of whether the responder needs to increase sun protection, as well as the likelihood to successfully promote such a change. Finally, the possibility to look at SEPI both as a global score or to focus on individual questions/behaviours may be useful for constructive risk communication, a clear advantage in comparison with previous instruments [22,23,27].

In conclusion, the SEPI appears to be a stable instrument with overall acceptable validity and reliability, and is applicable to evaluate individual sun exposure and protection in populations exposed to different UVR environments. The question on sunscreen use affected internal consistency somewhat negatively, but there are reasonable grounds for retaining this item. With its short format SEPI is likely to be easily used in clinical practice and could contribute to higher response frequencies in surveys. This new instrument constitutes a useful and novel contribution to the field of skin cancer prevention. For future studies, replication in a larger population would be desirable, and possibly also in different populations or settings, as well as translation into additional languages.

Conflicts of interest

None.

Author contribution

Hedvig Detert: Data collection and analysis, manuscript writing.

Sara Hedlund: Data collection and analysis, manuscript writing.

Chris Anderson: Project planning, development of SEPI instrument, manuscript writing, expertise in dermatology/skin cancer.

Ylva Rodvall: Development of SEPI instrument, manuscript writing, expertise in skin cancer prevention and public health.

Karin Festin: Statistical expertise/analyses, also contributing to the re-writing of the revised version of the manuscript.

David Whiteman: Project management in Australia, development of SEPI instrument, manuscript writing, expertise in epidemiology and prevention of skin cancer.

Magnus Falk: Project planning, data analysis, development of SEPI instrument, manuscript writing, project manager, expertise in general practice and skin cancer prevention.

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