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A randomised population-based intervention to examine the effects of the ultraviolet index on tanning behaviour

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Abstract

The aim of the following study was to examine the effects of the Ultraviolet (UV) Index and a personal ultraviolet radiation (UVR) intensity indicator on tanning behaviour compared with general, written information about sun protection. A population-based random sample in Sweden was randomly assigned to four groups receiving different information packages ($n = 3200$). Questionnaires were sent before and after the summer of 2001. Positive attitudes towards sunbathing as well as tanning and sunburn frequencies decreased. Knowledge about UV radiation and the use of sun protection increased for all groups. There were no between-group differences. Sun-related behaviours and beliefs changed, but information about the UV Index or a personal UVR intensity indicator did not decrease sunbathing and sunburn more than general, written information.
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Keywords: Sunbathing; Sun protection; Skin cancer; The Ultraviolet Index; Randomised population-based study

1. Introduction

The incidence of malignant melanoma and other types of skin cancer is increasing in Sweden [1]. Sun exposure is today the only known lifestyle factor of importance for the development of skin cancer and thus should be the main focus for prevention. Exposure to ultraviolet radiation (UVR) increases the risk of getting different forms of skin cancer including malignant melanoma [2,3]. In particular, the incidence seems to be connected to intensive sun exposure that leads to sunburn [4,5], but the total dose of UVR is also important [6]. Various preventive methods have been developed with the main goal being to decrease sun exposure by altering people's behaviour in the sun, i.e. limit sun-seeking behaviour and increase sun-protection behaviour. In Sweden, a number of campaigns have been conducted to change sun-related behaviour and attitudes towards tanning, in addition to increasing the awareness of skin cancer in the population [7]. Effects of information on changing sun-related behaviour have mainly been evaluated by self-reports. Earlier studies have found limited effects of information brochures and leaflets on sun habits [8,9]. More effective methods are therefore warranted in order to change sun-related behaviours. Swedish adolescents and young adults sunbathe more frequently compared with other age groups [10]. Consequently, they increase their risk of getting a high lifetime dose of UVR exposure, and they are also likely to transfer their risky sun habits onto their children, for whom they are role models.

The ozone layer in the atmosphere protects the earth from UVR. During the 1980s, it was recognized that the ozone layer was becoming thinner. In the beginning of the 1990s, a measure of the intensity of the ambient UVR was constructed, i.e. the Ultraviolet (UV) index. When calculating the UV index consideration is made for clouding and the thickness of the ozone layer. In Sweden, the Swedish Meteorological and Hydrological Institute has calculated the UV index since the summer of 1993. In 1994, the UV index was standardised internationally at a meeting organized by the World Meteorological Organization. The UV index has been used, e.g. in the US, for the purpose of increasing the proportion of people who protect themselves in the sun by giving guidance on how they should plan their

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outdoor activities [11, 2]. According to a survey in the US, the UV index made people realize that high UVR can be present even when the temperature is low and that sunburns could also occur on cloudy days [12]. Another attempt to change sun-related behaviour has been through the use of a simple form of UVR intensity indicator for private use. When exposed to the sun for a few seconds, it gives a rough indication, i.e. moderate, high or extreme, of the current amount of ambient UVR. To our knowledge, the behavioural effects of the UV index and/or the UVR intensity indicator on sunbathing behaviour have not been investigated in a controlled trial.

The aim of the present randomised study was to compare four different UVR information packages directed at young adults and their effects on a number of sun-related behaviours, including sunburn and variables derived from the Theory of Planned Behavior [13]. It was hypothesized that a UVR intensity indicator, together with a brochure on UV index and a brochure with advice on how to protect oneself in the sun, would have most effect on sun-related behaviours and beliefs, compared with information packages with less information. Another aim was to examine to what extent the different parts of the information packages were used.

2. Patients and methods

2.1. Subjects

A random population-based sample ($n = 3200$, 18–37 years of age) in the Stockholm County, Sweden, was selected from the Swedish census registry. In May 2001 (time 1), they were mailed a baseline questionnaire together with an invitation to participate in the study. Those who agreed to participate were randomly assigned to receive one of four different information packages. A second follow-up questionnaire was sent in the autumn of 2001 (time 2). No compensation for participation was given. There were no significant age differences in the response frequency when compared in age groups with five-year intervals ($\chi^2 = 0.47$, degrees of freedom (df) = 3, non-significant (N.S.)). The sample had a somewhat higher education (31% university degree) than the average in the Stockholm County (27% university degree, from Statistics Sweden; www.scb.se).

2.2. The information packages

Two information brochures and a personal UVR intensity indicator were used. The packages were sent by mail after randomisation. One of the brochures included general information about UVR and sun protection (Brochure 1). It was produced by a company with monopoly on drug-selling in Sweden, Apoteksbolaget AB. A brochure on the UV index was specially developed for this study (Brochure 2). It contained information about UVR and information about the UV index, as well as recommendations on how to protect oneself from the sun. A description of the daily UV forecast and illustrative descriptions of variations in UVR intensity, depending on the latitude and time of the year, was included. The two brochures were similar in size, shape and layout. The UVR intensity indicator is a credit-card sized, commercially available product (Teraco, Inc., USA). It gives a rough indication of the UVR intensity after a few seconds exposure to sunlight. The card indicates by a colour change if the UVR levels are moderate, high or extreme. Instructions for usage are printed on the card. After the return of the first questionnaire, the participants were randomised to four groups, Groups A–D. Group A received both brochures and the UVR intensity indicator, Group B received Brochure 1 and the UVR intensity indicator, Group C received both brochures, and Group D received Brochure 1 only.

2.3. Measures

The first questionnaire contained background questions about age, gender, occupation and level of education. Both questionnaires contained 47 items measuring frequency of sunbathing, the use of sunbeds, attitudes, beliefs and knowledge of tanning, and assessments of the dangers and benefits associated with sunbathing. Most of the items included in this study have previously been tested for reliability in an earlier study [14]. Some of the items on the frequency of sunbathing and sunburn have been validated against diary recordings [15]. The items used in the present paper were:

- Sun exposure: Three questions were asked about sun exposure: ''How often are you outside in the sun during the summer?'', ''How often do you sunbathe with the intention to tan during the summer?'', and the final question concerned the approximate amount of time spent in the sun on a typical work-free day during the summer. All questions had five response categories. The items were summarised and the scores ranged from 3 to 15.
- Sunburn: Two items on experiences of sunburn were used: ''How many times have you been sunburnt (redness) during the past year?'', with six response categories (''More than 10 times'', ''6–10 times'', ''3–5 times'', ''1–2 times'', ''I haven't been sunburnt'', and ''I haven't sunbathed'', and a second item on the severity of the sunburn: ''If you got sunburnt, how did your skin react?'', with five response categories (''Some redness without pain'', ''Severe redness

without pain'', ''Redness and pain'', ''Severe redness and pain'' and ''Redness, pain and blisters''). The variable was calculated by multiplying frequency of sunburn by severity of sunburn, the scale ranged from 1 to 25.

- Use of sun protection: Subjects responded on a four-point scale ranging from 1 (Not at all likely) to 4 (Very likely) regarding how likely it would be that they were to use each of six different precautions when sunbathing i.e. using sunscreen, using long-sleeved or short-sleeved shirt when in the sun, using hat, the shadow, or avoiding the sun at peak hours. An index was calculated using the sum of the items. Minimum score was 6 and maximum score 24.
- Intention to change: Three questions on intentions to change were used. The questions concerned intentions to stop sunbathing, to decrease the frequency of sunbathing and to decrease sunburn. The sum of the variables was used and the scale ranged from 3 to 18.
- Knowledge: A scale measuring knowledge about UV-radiation and sun protection with nine true-false items was used. The sum of the items ranged from 0 to 9.
- Beliefs and perception of risk related to sun exposure: Four variables about beliefs and risk perception were measured; positive attitudes towards having a tan, positive attitudes towards being in the sun, perception of risk with sun exposure, and perceived behavioural control. The subjects were asked to indicate on scales from 1 to 6 or 1 to 4, to what extent they agreed with different statements measuring these factors.
- Use of the information packages: Four questions in the second questionnaire assessed the use of the UV index and each of the three components in the intervention. Only the ones receiving the component was asked about their use of it, and only those informed about the UV index were asked if they had used it.

2.4. Statistical analyses

A number of univariate analyses of variance (ANOVA) were conducted with intervention groups, gender and age groups as independent variables. The dependent factor was the difference between time 1 and time 2 for sunbathing, sunburn, sun protection, intention to change, knowledge, positive attitudes towards being in the sun, positive attitudes towards having a tan, risk perceptions and behavioural control. All assumptions for the use of ANOVA were not met for all of the dependent variables. However, as the number of observations in each study group were considerable and equal, the ANOVA statistics were still used [16]. The assumption of homogeneity of variance was met for most variables according to Levene's Test of Equality of variances. As some heterogeneity was present for the frequency of sunburn, risk perception and perceived behavioural control, an α-value of 0.01 was set as the minimum criteria for significance as recommended in Tabachnick and Fidell [17]. An estimation of the explained variance was made through a calculation of η^2. η^2 is the percentages of the variation in the data that can be attributed to the independent variable [18]. χ^2-test and Student's t-test were used to analyse differences between responders and non-responders. The Wilcoxon Signed Ranks test was used to compare the respondent's judgement of the information packages. The Statistical Package for the Social Sciences (SPSS) statistical package was used (SPSS Inc., 1999).

2.5. Ethical considerations

All participants were informed that participation in the study was voluntary and that they were free to drop out of the study at any time. The study was approved by the Ethical Committee of the Karolinska Institute (No. 01-135).

3. Results

3.1. Effects of intervention

A total of 1743 persons (54%) returned the first questionnaire and agreed to participate in the study. Seventy-five percent ($n=1301$) returned the second questionnaire. More women (742; 57%) than men (559; 43%) participated in the study ($\chi^2=25.74$, $P<0.001$). The mean scores at time 1 and time 2 and the mean difference between time 1 and time 2 for sunbathing, sunburn, sun protection, intention to change, knowledge, positive attitudes towards being in the sun, positive attitudes towards having a tan, risk perception and behavioural control are presented in Tables 1 and 2. There was no Intervention group by Time interaction for any of the dependent variables, indicating that no information package was superior to the other. We found an overall significant decrease in sunbathing, frequency of sunburn, positive attitude towards being in the sun, positive attitude towards having a tan, and behavioural control for all groups between time 1 and time 2. Furthermore, there were overall significant increases in intention to change sun related behaviour, sun protection and knowledge. No significant change was found for risk perception.

We found no significant differences between the study groups at baseline for any of the variables (data not shown).

Table 1
Mean scores for frequency of sunbathing, sunburn, sun protection, and intention to change sunbathing behaviour before and after intervention, total difference for all groups, and partial η_p^2 for total difference[f]

		Group A		Group B		Group C		Group D		Total difference		
	Time	*n*	Mean	*n*	Mean	*n*	Mean	*n*	Mean	Mean[a]	S.E.	η_p^2
Sunbathing (min = 3, max = 15)	Pre	310	10.65	318	10.61	324	10.69	313	10.70	−0.76[b]	0.061	0.11
	Post		9.84		9.87		9.86		9.96			
Sunburn (min = 1, max = 25)	Pre	311	4.73	320	5.04	328	4.73	316	4.71	−1.37[c]	0.11	0.11
	Post		3.32		3.49		3.40		3.47			
Sun protection (min = 6, max = 24)	Pre	310	15.58	318	15.83	325	15.54	313	15.59	0.56[d]	0.079	0.04
	Post		15.99		16.34		16.21		16.13			
Intention to change (min = 3, max = 18)	Pre	310	8.67	319	8.69	320	8.68	315	8.66	0.34[e]	0.070	0.02
	Post		8.84		9.14		9.12		9.02			

η_p^2, partial eta-squared; S.E., Standard Error.
[a] Analysis of variance was calculated with the differences in sunbathing, sunburn, sun protection and intention to change before and after intervention as dependent variables and intervention group, gender and age group as independent variables.
[b] $F(1, 1264) = 158.59$, $P < 0.001$.
[c] $F(1, 1274) = 153.73$, $P < 0.001$.
[d] $F(1, 1265) = 50.19$, $P < 0.001$.
[e] $F(1, 1263) = 24.26$, $P < 0.001$.
[f] Only those respondents who answered the questions at both times are included in the analysis, and thus, some information is missing for some categories.

Table 2
Mean scores for knowledge, attitudes, risk perception and behavioural control before and after intervention, total difference for all groups, and partial η_p^2 for total difference[g]

		Group A		Group B		Group C		Group D		Total difference		
	Time	*n*	Mean	*n*	Mean	*n*	Mean	*n*	Mean	Mean[a]	S.E.	η_p^2
Knowledge (min = 0, max = 9)	Pre	313	7.05	319	6.95	318	6.89	311	6.96	0.46[b]	0.039	0.10
	Post		7.53		7.36		7.42		7.35			
Positive attitudes towards having a tan (min = 4, max = 16)	Pre	306	11.13	310	10.91	319	11.14	306	11.18	−0.33[c]	0.052	0.03
	Post		10.84		10.57		10.77		10.83			
Positive attitudes toward being in the sun (min = 8, max = 32)	Pre	307	23.04	309	22.87	313	23.25	305	23.03	−0.53[d]	0.091	0.03
	Post		22.72		22.30		22.50		22.49			
Risk perception (min = 3, max = 18)	Pre	303	10.02	315	10.19	323	10.16	306	10.11	−0.047[e]	0.046	–
	Post		9.96		10.09		10.18		10.06			
Behavioural control (min = 1, max = 6)	Pre	320	4.42	321	4.44	329	4.35	317	4.43	−0.075[f]	0.025	0.01
	Post		4.52		4.49		4.45		4.50			

η_p^2, partial eta-squared; S.E., Standard Error; N.S., non-significant.
[a] Analysis of variance was calculated with the differences in knowledge, attitudes, risk perception, and perceived behavioural control before and after intervention as dependent variables and intervention group, gender and age group as independent variables.
[b] $F(1, 1260) = 144.23$, $P < 0.001$.
[c] $F(1, 1240) = 41.27$, $P < 0.001$.
[d] $F(1, 1233) = 34.24$, $P < 0.001$.
[e] $F(1, 1246) = 1.05$, n.s.
[f] $F(1, 1286) = 9.22$, $P < 0.01$.
[g] Only those respondents who answered the questions at both times are included in the analysis, and thus, some information is missing for some categories.

The partial η^2 calculated for all ANOVAs are included in Tables 1 and 2. The η^2 values indicate that even though the F-tests for sun protection, intention to change, positive attitudes towards sunbathing and having a tan, and perceived behavioural control were significant, the explained variances were small. Larger effects were found for sunbathing, frequency of sunburn and knowledge.

A significant difference was found between the change in attitude towards being in the sun and gender ($P = 0.01$), and also between change in attitude towards being in the sun and age groups ($P = 0.001$). The subjects were categorised into four age groups (18–22, 23–27, 28–32 and 33–37 years of age). Females and the younger age groups changed their attitudes more than men and the older age groups did. There was also a

significant difference between risk perception and age group ($P<0.01$). Tukey's post-hoc test revealed that the difference in risk perception appeared between the age group 23–27 years and 28–32 years. The older age group had reduced their risk perception whereas the younger age group increased it.

The initial analysis was based on the 'intention to treat' approach. However, the same analyses were conducted with only the subjects that had used the information. Still no significant group differences were present for any of the variables. The difference before and after the intervention for intention to decrease sunbathing and perceived behavioural control was not significant. The η^2 for the increase in knowledge was higher when the analysis was conducted only for those using the information packages, i.e. 0.15 instead of 0.10 with the 'intention to treat' approach and the mean improvement in knowledge increased from 0.46 to 0.59.

3.2. Use of the information packages

More than 70% of all respondents had used some of the material received. The most well read brochure was the one with general information about sun protection. It was read by 70% of the respondents. 48% of the respondents had read the brochure with information about the UV index and 42% had used the UVR intensity indicator. One question was also asked about the use of the UV index as presented in the news media. 12% had used the prognosis. The respondents' judgements of the information packages are presented in Fig. 1. The brochure with general information about sun protection was more appreciated than both the brochure about the UV index ($Z=-5.25$, $P<0.001$) and the UVR intensity indicator ($Z=-6.93$, $P<0.001$).

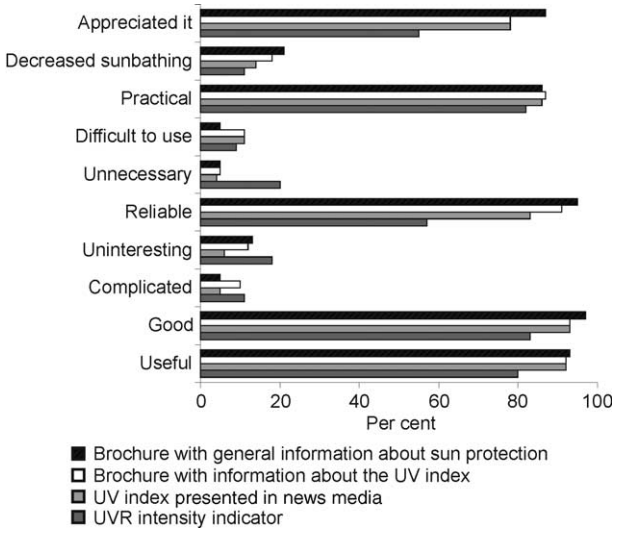

Fig. 1. The respondents' judgements of the elements in the information packages. Bars represent percentages of the respondents that agrees with the description. UV, ultraviolet; UVR, ultraviolet radiation.

According to the respondents, this brochure also decreased sunbathing more than the UV index presented in news media ($Z=-2.83$, $P<0.01$) and the UVR intensity indicator ($Z=-3.66$, $P<0.001$).

3.3. Analysis of non-responders

Baseline differences between responders at both time 1 and time 2 were compared with dropouts at time 2 concerning educational level, sunbathing, sunburn, knowledge, attitudes, risk perception, likelihood of using sun protection, social norms, intention to change and behavioural control. The non-responders were less educated ($\chi^2=0.118$, $P<0.001$), had less knowledge ($t=-5.787$, $P<0.001$), scored lower on risk perception ($t=-2.637$, $P<0.001$), were more likely to use sun protection ($t=1.967$, $P<0.001$), and reported a lower degree of behavioural control ($t=4.67$, $P<0.001$). There were no statistically significant differences in the frequency of sunbathing, sunburn, attitudes towards being in the sun, attitudes towards having a tan or intention to change sunbathing behaviour.

4. Discussion

The present study is the first randomised trial testing the UV index as a way to change sun habits and attitudes towards sunbathing and to increase knowledge of UVR. This study did not support the use of the UV index as a tool for altering behaviours, beliefs or attitudes concerning sunbathing. All information packages seemed to reduce sunbathing and sunburn, increased knowledge of UVR, and altered people's positive attitudes towards sunbathing and having a tan. This was a remarkable finding as sunbathing and related attitudes as well as other health-related behaviours have previously been found to be difficult to change by means of brochures and leaflets [9,19–21].

The UV index has been widely promoted throughout Europe, Australia, Canada and the USA [12]. Even though the findings from our study are disappointing to the advocates of the UV index, it does not tell us anything about the potential effects of widespread media broadcasting of the UV index. In Sweden today, the UV index is only available on the Internet and in a few daily newspapers. However, only 12% of the responders in this study used it. Furthermore, the low frequency by which the brochure about the UV index was read indicates a limited public interest for learning about an index in the planning of outdoor activities in the sun. One possible explanation of the low frequency of users, suggested by the overall judgements of the brochures, could be that the UV index brochure was considered more complicated and difficult to use than the brochure with general information. It is also possible that the UV index

is more appropriate for countries with a higher intensity of ambient UVR. In Sweden, the UVR is modest in comparison with countries at lower latitudes, e.g. the USA, Australia and the Mediterranean countries.

The individual UVR intensity indicator was also not used to a high extent. The reliability of the device has been questioned. However, it illustrates the fact that sunlight includes more than visible light and heat and it might therefore increase people's awareness of the importance to protect themselves against the sun. The results of this study, however, did not support the use of such a device in further public health campaigns. People's judgement of the device showed that they appreciated it less and considered it less reliable, interesting and necessary than the brochures.

It seemed as if the intervention, including completion of the questionnaires, had the greatest effect among younger persons and among females. This is promising as many studies have showed that younger girls are those who sunbathe the most [10,22]. However, it also suggests the necessity of developing information with a higher impact among older adults and men. The interaction effect of risk perception and age is very difficult to interpret. The intervention appears, contrary to the intention, to make the older age group less concerned about the risks of sunbathing. However, this effect, although significant, was very small. It is surprising that risk perception did not increase as a result of the interventions as all other variables were affected. However, the information was mostly concerned with increasing protective behaviour and decreasing sun exposure and not in inducing a fear of getting skin cancer.

The brochure with general information about sun protection (Brochure 1) was, contrary to our expectations, the most appreciated component in the intervention and also the one that obtained the highest score on changing sunbathing habits. The reason that we chose this brochure as a control intervention was that it's availability was already widespread and leaflets with general information have previously shown a limited effect on behaviour [21]. Brochure 1 was readily available, free of charge, in pharmacies all over Sweden during the study period and was especially promoted by the pharmacies at the beginning of summer. This widespread availability, and the fact that many people in Sweden consider information from pharmacies to be reliable, could probably explain the high percentages of subjects that used it. 70% had read the brochure and this is a high frequency compared with a study in the south of France that used three types of mailed information about sun exposure and skin cancer. In that study, only approximately 50% of the population-based sample had read the information provided [8].

The moderate response rate has to be considered when interpreting the results. It is possible that those who declined participation were less interested in heath issues, or at least in sun-related questions. Therefore, it is possible that the results are difficult to generalise to the general public as a whole. However, in addition to our own analysis of non-respondents, a recent Swedish study of non-response bias showed a great similarity between responders and non-responders in the frequency of sunbathing and sunbed use [10]. It is also possible that the respondents might have given answers that they thought the researchers would like to receive. However, the risk of this is lower due to the use of mailed questionnaires.

5. Conclusion

Positive attitudes towards being in the sun, knowledge of UVR as well as tanning and sunburn frequencies, and the use of sun protection changed during the study period. Information about the UV Index or a personal UVR intensity indicator did not decrease sunbathing and sunburn more than general, written information about sun-protection. These are important conclusions for future preventive efforts.

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