Journal of Photochemistry and Photobiology B: Biology xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Journal of Photochemistry and Photobiology B: Biology

journal homepage: www.elsevier.com/locate/jphotobiol

A randomised trial to demonstrate the effectiveness of electronic messages on sun protection behaviours

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ARTICLE INFO

Article history:
Received 20 March 2015
Received in revised form 4 June 2015
Accepted 6 June 2015
Available online xxxx

Keywords:
Cancer prevention
Health communication
Sun exposure
Clinical trial

ABSTRACT

Message exposure is effective at changing a variety of health behaviours. Our aim was to improve sun protection habits of a volunteer sample. We conducted a randomised, non-blinded, investigator-initiated trial (from 1st June to 31st August in 2011) on the effect of an electronic text-message system on sun protection behaviours. The assessments of 149 healthy volunteer participants took place at the Clinical Department of Dermatology and Allergology at the University of Szeged in Hungary. Psychological and medical assessments were also made. Total motivation scores for adherence to sunscreen use improved at a nearly significant level ($t = -1.954$, $p = 0.054$). The intervention group used sunscreens more often than the other groups according to their sun exposure diaries ($F = 8.173$, $p < 0.05$) and their interview results ($F = 3.44$, $p < 0.05$). Using electronic messages offers an effective method to improve sun protection behaviours. Our intervention is a cost-effective method and it can easily be implemented at worksites.

1. Introduction

There is an association between exposure to sunlight and the development of skin cancer [1]. Skin cancer is one of the most preventable groups of malignancies and therefore, it is important to induce behavioural changes regarding the major avoidable causative factor: sun exposure [2,3]. Optimal use of routine sunscreen is strongly associated with decreased melanoma risk [4]. Irich et al. [5] found that regular use of sunscreens, being part of a consequent UV-protection strategy, may prevent the development of further actinic keratoses and invasive squamous cell carcinomas and, to a lesser degree, basal cell carcinomas in immune-compromised organ transplant recipients. Sun safety behaviours are an important determinant of skin cancer risk [6,7], these protective behaviours include such as aforementioned sun avoidance or increased use of protective clothing and sunscreen [3]. One's personal behaviour is a result of knowledge, attitudes and beliefs; therefore, lack of knowledge and inaccurate beliefs can lead to inappropriate behaviour [8]. Identifying the most important determinants of both skin cancer risk behaviours and sun protection behaviours is essential for the development of effective health education interventions that focus on changing the most appropriate beliefs [9,10]. For example, few studies have examined the psychosocial correlates of sunburn [11]. Theory-driven health communication is needed to motivate people to engage in sun safety behaviours and avoid sunburn [12]. Tailored, mailed communications are promising methods for skin cancer prevention and detection among individuals at increased risk, but these interventions have not been widely tested [13]. Message exposure has been shown to be associated with improvements in several sun protection behaviours, including increased use of sunscreen, lip balm, and face covering [12]. The Internet represents a promising channel for widespread dissemination of public health-oriented skin cancer risk and prevention information [14]. Using e-mails to induce changes in behaviour is a widely used method [15–17]. The telephone also can serve as an effective tool in the delivery of health care education messages [18]. Promoting both phone and Web-based components of an integrated program achieves the best results in its effectiveness [15]. A possible strategy for promoting positive health actions might be to create specific narrative messages [19]. Additional information about several beneficial contents of sun protection messages is provided in Supplementary Material 1. Personalizing the risks of unprotected sun exposure, combined with education about sun protection,

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http://dx.doi.org/10.1016/j.jphotobiol.2015.06.006
1011-1344/

can facilitate healthy changes in behaviour and motivation [20]. Personalization (a form of tailoring mechanism) can be defined by the inclusion of specific and personally identifiable information within the content (e.g. names, age, or specific behaviours) gathered during the assessment phase [21]. Even such minimally tailored approaches have been found to be more effective than generic prompts [22]. Besides sending specific sun protection messages, delivering brief patient-centred counselling by primary care practitioners, could be an efficient and cost-effective approach for delivering multiple behaviour change interventions [23]. Being counselled by a physician regarding sun safety is associated with high adherence to sun-protective behaviours [6,24].

2. Aim

Our aim was to improve sun protection habits of a volunteer sample: to facilitate frequency of sunscreen use, to decrease sun exposure, to explore factors influencing adherence to sun protection counselling and psychological dimensions related to sun protection. We intended to explore possible relations between adherence to sunscreen use, psychological and medical variables.

3. Methods

3.1. Sample population

We conducted a randomised, non-blinded, investigator-initiated trial of the effect of an electronic text-message system on sun protection behaviours (Fig. 1). 149 participants constituted a volunteer sample from the staff members of the Clinical Department of Dermatology and Allergology at the University of Szeged in Hungary and the members' relatives (Table 1). There were no significant differences between the three groups in dimensions of sex, age and level of education. The inclusion criteria required participants to be 18 years or older, to own a cellular telephone with text-message features, and to know how to retrieve text messages. No exclusion criteria were specified. The randomisation method was carried out with sealed envelopes which contained group numbers, the individuals opened the envelopes, and the group numbers were revealed. The participants were randomised into three intervention groups. All three groups were given sun protection advice orally by a dermatologist at the beginning of the study. The dermatologist gave advice to the participants about how to use sunscreen properly and how to reduce sun

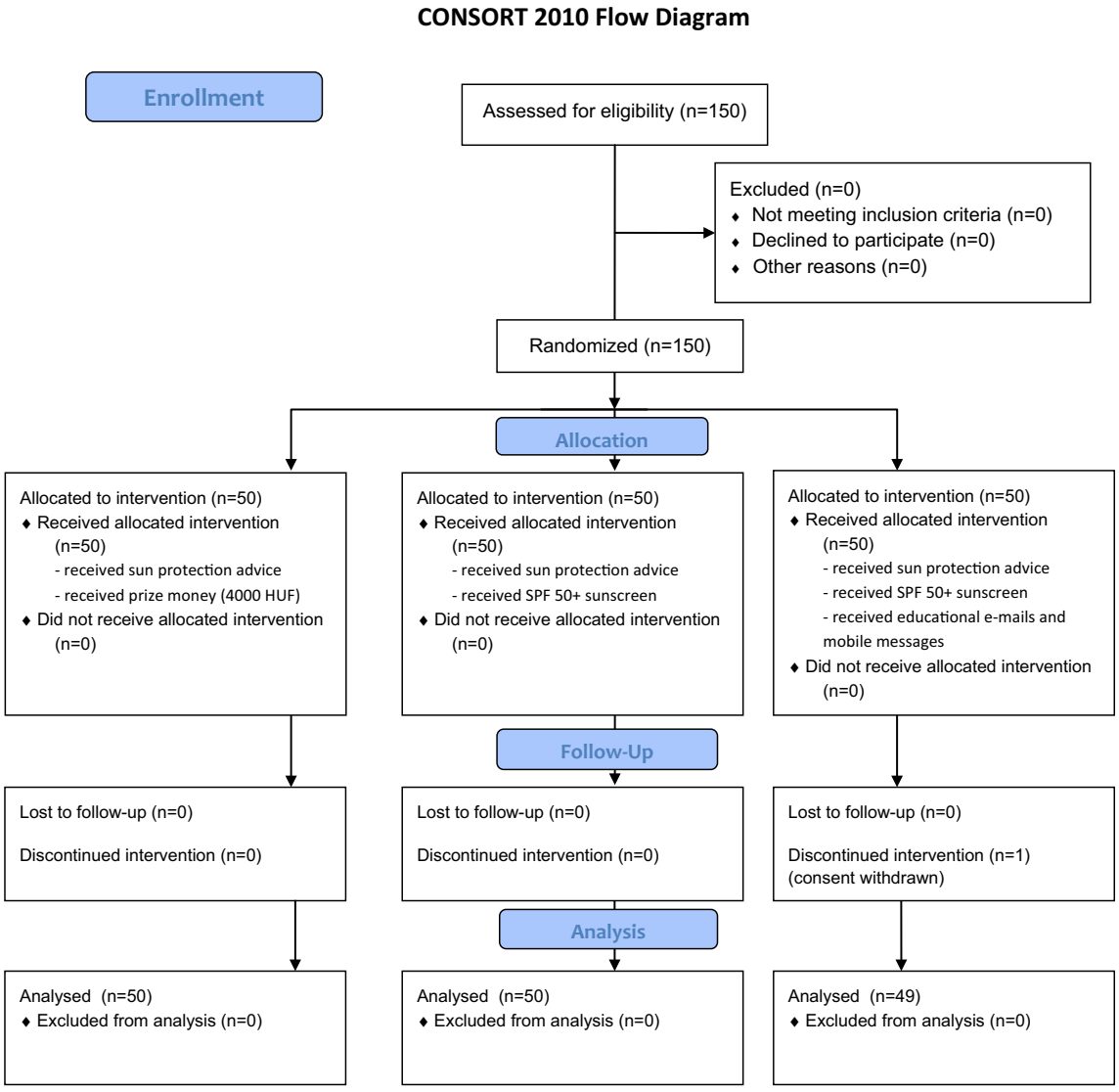

Fig. 1. Flow of participants through each stage of the trial.

Please cite this article in press as: C. Szabó et al., A randomised trial to demonstrate the effectiveness of electronic messages on sun protection behaviours, J. Photochem. Photobiol. B: Biol. (2015), http://dx.doi.org/10.1016/j.jphotobiol.2015.06.006

Table 1
Descriptive characteristics of the participants ($N = 149$).

		Group 1 ($N = 50$) N (%)	Group 2 ($N = 50$) N (%)	Group 3 ($N = 49$) N (%)	All participants ($N = 149$) N (%)
Gender	Male	12 (24%)	11 (22%)	20 (40,8%)	43 (28.9%)
	Female	38 (76%)	39 (78%)	29 (59,2%)	106 (71.1%)
Age	Mean ± SD	35.98 ± 11.29	39.73 ± 9.35	35.07 ± 9.59	36.94 ± 10.25
Education	Primary school	1 (2%)	1 (2%)	1 (2%)	3 (2%)
	Secondary school	6 (12%)	4 (8%)	3 (6.1%)	13 (8.7%)
	High school	24 (48%)	23 (46%)	16 (32.7%)	63 (42.3%)
	University	19 (38%)	22 (44%)	29 (59.2%)	70 (47%)

exposure. A psychologist made adherence-related and psychological assessments, and the dermatologist made medical examinations throughout the study. Assessments were made at 0, 6 and 12 weeks. The trial was carried out from 1st June to 31st August in 2011. Group 1 ($N = 50$) received prize money (4000 HUF) at 12 weeks. Volunteers in Group 2 ($N = 50$) were given free, broad-spectrum, sun protection factor (SPF) 50+ sunscreen and asked to apply it to themselves when they were in the sun for more than 15 min. Volunteers in Group 3 ($N = 49$) were also given SPF 50+ sunscreen, and they were sent minimally personalized educational e-mails and mobile messages every week of the study. All three groups received the same amount of property in the form of the prize money and sunscreens, this was in order to avoid participants' vulnerability as mentioned by Good Clinical Practice [25]. In our study, a dermatologist and a psychologist ensured the professional informing of the participants. The research protocol was approved by the Regional and Institutional Human Medical Biological Research Ethics Committee of the University of Szeged in Hungary. Our study was supported by La Roche-Posay Laboratoire Dermatologique/L'Oréal Magyarország Kozmetikai Kft. by providing sunscreens.

3.2. Electronic messages

In this study, we used cellular telephone text messaging and e-mails as tools to facilitate participants' frequency of sunscreen use and to reduce sun exposure. All of the messages were tailored to the individuals, in the form of personalizing [26], which meant greeting the participant by their full names at the beginning of each message. Group 3 ($N = 49$) received weekly electronic messages, and Group 1 ($N = 50$) and Group 2 ($N = 50$) did not receive these messages. In summary, the members of Group 3 were sent 9 e-mail packages and 3 SMS messages in our study. In order to create the contents of our own electronic messages to improve the sun protection behaviour of the participants we used professional sources, for example sun protection tips given by the Le Tan Company [27], prevention strategies suggested by the Go Sun Smart Program [28] or good habits to take proper care of our skin provided by La Roche-Posay [29] (examples of our messages can be seen in Table 3). See Supplementary Material 2 for a list of the contents of our educational electronic messages. Our e-mail message packs consisted of 2 e-mails: a text containing tips about sun protection and a text detailing the level of the UV-radiation in Hungary on the day following the message, based on the online database of the Hungarian Meteorological Service [30].

3.3. Psychological dimensions related to sun protection

3.3.1. Behavioural change

The Stages of Change model shows that, for most individuals, a change in behaviour occurs gradually [31]. Stage effects are also related to the amount of time spent in the sun [32] and the amount of sunscreen use [33]. A technique useful in determining the stage of change of an individual is the Readiness to Change Ruler, which is a simple, straight line drawn on a paper that represents a continuum ranging from 0 ("not prepared to change") to 10 ("ready to change"). Patients are asked to mark on the line their current position in the behaviour change process. Physicians can enhance stages of change [31]. To determine the stage of behavioural change we used the Readiness to Change Ruler [34] modified to measure the readiness to regularly use sunscreen at 0 and 12 weeks.

3.3.2. Health locus of control

"Health locus of control refers to a person's beliefs regarding where control over his/her health lies" [35, pp. 534]. Perceived behavioural control is associated with sun protection behaviour [11,36–38]. Individuals may be resigned to their unhealthy behaviour because of previous failed efforts and no longer believe that they have control [31]. Health locus of control was measured with Form C of the Multidimensional Health Locus Control (MHLC) scales [35] at the beginning of the study. Volunteers of the three study groups were asked to mark the degree of their agreement on a 6-point rating scale ranging from 1 (strongly disagree) to 6 (strongly agree). The MHLC scales have three subscales: internal (the extent to which a person believes his/her health is a function of his/her own behaviour), powerful others (belief that one's own health status is due to the actions of "powerful" people, such as one's doctors, family members, or friends) and chance (the belief that chance, fate or luck influences one's health) [35]. Each subscale is composed of six items and the scores range from 6 to 36 for each of the three subscales.

3.3.3. Self-efficacy

Perceived Self-efficacy is the belief that one can perform a novel or difficult task, or cope with adversity in various domains of human functioning [39]. Self-efficacy is related to performing sun protection behaviours [9,36,37,40,41]. Individuals have varying levels of self-efficacy about being able to do all the behaviours necessary to protect their skin [36]. Self-efficacy was measured with the General self-efficacy scale [42] at 0 and 12 weeks. Scoring is done by adding the responses made to the 10 items of the scale, yielding a cumulative score between 10 and 40.

3.4. Adherence to sun protection counselling

3.4.1. Interview questions

The more that people understand and agree with the underlying rationale for the expected behaviour, the greater the adherence [43]. Intention to adhere to a certain behaviour has both motivational and knowledge aspects. Forgetfulness and carelessness are considered to be indicative of motivation, and understanding the long-term benefits of a particular health behaviour may be indicative of the knowledge aspect [34]. Observing changes in motivation may be substantial and provide additional information about the impact of an intervention [20]. Adherence to sunscreen use was

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Table 2
The Modified Morisky Scale [27] with modified questions for assessing adherence to sunscreen use.

1. Do you ever forget to use your sunscreen when sunbathing?	Yes	No
2. Do you ever forget to use your sunscreen when staying in the sun for more than 15 min?	Yes	No
3. Are you careless at times about using your sunscreen when sunbathing?	Yes	No
4. Are you careless at times about using your sunscreen when staying in the sun for more than 15 min?	Yes	No
5. When you feel the positive effects of the sunscreen, do you sometimes stop using it?	Yes	No
6. Sometimes if you feel that the sunscreen is ineffective, do you stop using it?	Yes	No
7. Do you know the long-term benefit of using your sunscreen?	Yes	No
8. Do you sometimes forget to get new sunscreen if you are out of sunscreen?	Yes	No

measured with the Modified Morisky Scale (MMS) [34]. The scale's motivation and knowledge domains' (both domains' scores range from 0 to 3) questions were modified for assessing adherence to sunscreen use (Table 2). By adding two extra questions we could assess adherence motivation domains of sunscreen use for both sunbathing and sun exposure for more than 15 min, and a total motivation score could also be calculated. Adherence results for 12 weeks were evaluated by calculating the mean scores of adherence results of week 6 and week 12. The rate of adherence with sunscreen use was assessed using two interview questions ("In what percentage of the cases have you used sunscreen when you were sunbathing in the last 12 weeks?" "In what percentage of the cases have you used sunscreen when you were in the sun for more than 15 min in the last 12 weeks?") at 12 weeks.

3.4.2. Sun exposure diary

A sun exposure diary was also used in this study, which was a record of frequency of daily sun exposure, sunbathing, use of sunscreen, fish consumption and consumption of milk and eggs. Participants were instructed to complete the diary for the 12 weeks of the study. Participants were asked to report whether they were exposed to sun for more than 15 min for each day of the study, and if they were, how many minutes they were exposed to sun on that day. The participants were instructed to cross "yes" or "no" to questions about whether they were sunbathing (and for how many minutes), whether they used sunscreen, whether they consumed fish or milk and eggs (and the amount of the consumption) for each day of the study.

3.4.3. Melanin and erythema measurement

The Mexameter® MX 18 (Courage and Khazaka, Germany) is a very easy, quick and economical tool to measure the two components, mainly responsible for the colour of the skin: melanin and haemoglobin (erythema) [44]. We used this device to assess changes in melanin and erythema levels which could strengthen the validity of the self-reported interview results of our adherence with sunscreen use. The analysed area was the volar forearm. The measurements of skin parameters were performed at 0 and 12 weeks.

3.5. Statistical analysis

Descriptive statistics, one-sample *t*-test, paired *t*-tests, chi-square tests, Pearson correlation coefficients and one-way ANOVA were calculated with SPSS 17.0 software.

4. Results

4.1. Electronic messages

The participants of Group 3 ($N = 49$) were sent three minimally personalized educational e-mails and mobile messages every week of the study, and their sun protection habits differed in certain dimensions. According to their sun exposure diary, members of Group 3 (3.21 ± 2.37) used sunscreens on more days per week ($F = 8.173$, $p < 0.05$) than participants of Group 1 (1.47 ± 1.91) and Group 2 (2.09 ± 1.85). Compared to Group 1 and 2, only Group 3 members' knowledge scores improved significantly ($t = -2.206$, $p = 0.033$) between week 6 (2.17 ± 0.62) and week 12 (2.33 ± 0.53) in the adherence to sunscreen use domain. We found a significant difference ($F = 3.44$, $p = 0.035$) in the rates of adherence to sunscreen use (given to the interview question "In what

Table 3
Examples of the contents of our personalized educational e-mails and mobile messages sent to participants of Group 3 ($N = 49$) every week of the study to improve sun protection behaviours.

E-mail 1 (examples of texts containing tips about sun protection)	E-mail 2 (an example of texts detailing the level of the UV-radiation in Hungary)	Mobile messages
Sunscreen should be applied in a thick layer before sunbathing. Reapply sunscreen often, particularly after swimming, toweling off (because it is easy to remove the sunscreen while toweling off)	"Dear (full name of participant), The expected UV index for tomorrow in Hungary (2011.06.15.) will be 7.3, which is a very high UV radiation level. Expected sunburn time will be 17 min.	"Dear (abbreviated full name of participant), the use of sunscreen can easily become part of your daily routine by keeping it next to your other personal hygiene products. Yours sincerely, Ócsai H., Szabó Cs."
Apply your sunscreen 30 min before going outside so that it can be absorbed by the skin, creating a protective barrier		
Apply a sufficient amount of sunscreen on all sun-exposed skin (most people do not use enough sunscreen, therefore they do not get enough protection)! Do not forget your ears, the nape of your neck and your feet	You can protect yourself from UV radiation when staying outdoors for long time: wear a sunhat, UV blocking sunglasses, long-sleeved and loose-fitting clothing, and use sunscreen lotion! Stay in the shade between 11 h and 15 h! Expected sunburn time between 11 h and 15 h: approximately 15–20 min, less than 20 min for children, and approximately 30–40 min before 11 h and after 15 h. Yours sincerely, Henriette Ócsai, Csanád Szabó, research associates"	"Dear (abbreviated full name of participant), Reapply sunscreen every 2 h, and even more often when sweating, getting wet or if its windy. Yours sincerely, Ócsai H., Szabó Cs."

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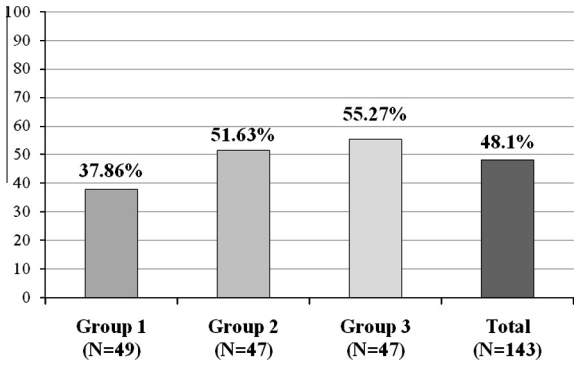

Fig. 2. Rates of adherence to sunscreen use given by the three groups at week 12 to the interview question "In what percentage of the cases have you used sunscreen when you were in the sun for more than 15 min in the last 12 weeks?".

percentage of the cases have you used sunscreen when you were in the sun for more than 15 min in the last 12 weeks?"): Group 3 gave the highest rates (55.27 ± 33.59), which were followed by Group 2 (51.63 ± 34.11), and Group 1 answered with the lowest rates (37.86 ± 35.41) of sunscreen use (Fig. 2).

4.2. Psychological dimensions related to sun protection

4.2.1. Behavioural change

The results of the Readiness to Change Ruler (with possible scores ranging from 0 ("not prepared to change") to 10 ("ready to change")) modified to measure the readiness to regularly use sunscreen did not differ significantly at 0 (8.22 ± 2.26) and 12 weeks (8.025 ± 2.42).

4.2.2. Health locus of control

The results of the MHLC scales show that the participants' internal health locus of control (25.54 ± 5.01) are the most responsible for their health or illness according to their own beliefs. This was followed by the importance of powerful others health locus of control (22.67 ± 4.65), and they ranked the role of chance health locus of control (13.59 ± 5.51) in the last place. Participants of our volunteer sample believed that their own behaviour influenced their health status mostly of the three mentioned factors. We compared our results to means of normative MHLC data of a healthy adult sample ($n = 1287$) [45]. There were no significant differences between participants' (25.54) and healthy adults' (25.55) internal health locus of control scores. Participants' (22.67) powerful others health locus of control scores were significantly higher ($t = 8.942$, $p < 0.01$) than healthy adults' scores (19.16). Participants' (13.59) powerful others health locus of control scores were significantly lower ($t = -5.619$, $p < 0.01$) than healthy adults' scores (16.21).

4.2.3. Self-efficacy

The point scores of the General Self-efficacy scale did not differ significantly at 0 (30.65 ± 4.53) and 12 weeks (30.73 ± 4.25). We compared our results to means of normative General Self-efficacy data of a Hungarian sample ($n = 158$) [46]. Participants' (30.65) scores measured at 0 weeks were significantly higher ($t = 5.357$, $p < 0.01$) than members' scores of the Hungarian sample (28.59). Participants' (30.73) scores measured at 12 weeks were significantly higher ($t = 6.025$, $p < 0.01$) than members' scores of the Hungarian sample (28.59). These results suggest that the volunteers of our study had stronger beliefs that they can perform a novel or difficult task than the Hungarian sample.

4.3. Adherence to sun protection counselling

4.3.1. Interview questions

The results of the MMS scales calculating adherence to sunscreen use showed that the knowledge scores (2.23 ± 0.51) were significantly higher ($t = -5.173$, $p < 0.05$) than total motivation scores (1.8 ± 0.8) for the 12 weeks of the study. In the motivation dimension, scores for adherence to sunscreen use when sunbathing (2.16 ± 0.91) were significantly higher ($t = 8.544$, $p < 0.01$) than adherence to sunscreen use when being in the sun for more than 15 min (1.44 ± 0.92) for the 12 weeks of the study. Many participants were not sunbathing during the study, this reduced the number of participants whose adherence to sunscreen use when sunbathing ($N = 92$) and total motivation adherence ($N = 90$) could be calculated for 12 weeks. Unanswered items on the questionnaires reduced the number of participants whose adherence to sunscreen use when being in the sun for more than 15 min ($N = 127$) and knowledge scores ($N = 122$) could be calculated for 12 weeks.

An adherence intention quadrant can be identified with the MMS scales, by the classification of participants into four domains: low motivation score ($N = 18$), high motivation score ($N = 72$), low knowledge score ($N = 2$) and high knowledge score ($N = 120$). There was a significant difference ($\chi^2 = 14.951$, $p < 0.01$) in the results of women and men in the motivation domain. In the women's results 60 of them had high scores and 7 of them had low scores, while in the men's results 11 of them had low scores and 12 of them had high scores in the motivation domain. Total motivation scores for adherence to sunscreen use improved at a nearly significant level ($t = -1.954$, $p = 0.054$) between week 6 (1.75 ± 0.89) and week 12 (1.9 ± 0.9). Adherence to sunscreen use when sunbathing did not differ significantly at week 6 (2.12 ± 1) and at week 12 (2.21 ± 0.99). However, motivation scores for adherence to sunscreen use when being in the sun for more than 15 min improved from week 6 (1.36 ± 1.07) to week 12 (1.52 ± 1.02) at a nearly significant level ($t = -1.783$, $p = 0.077$).

4.3.2. Sun exposure diary

According to results of the sun exposure diary participants were exposed to sun for more than 15 min on 65.55 ± 16.01 days of the 84 days of the study. They spent 64.34 ± 59.4 min per day exposed to sun. Participants were sunbathing on 8.94 ± 10.01 days of the 84 days of the study. They were sunbathing for 8.55 ± 10.11 min per day. Participants used sunscreen on 2.22 ± 2.16 days per week. They consumed fish on 0.75 ± 0.86 days per week and consumed milk and eggs on 12.05 ± 10.6 days per week. There were no significant differences between the three groups in their results of the sun exposure diary, except for the difference in frequency of sunscreen use, which is discussed in the 4.1. Electronic messages paragraph of the Results section.

4.3.3. Melanin and erythema measurement

Melanin values measured on the volar forearm were higher at week 12 (238.47 ± 64.39) than at week 0 (227.25 ± 62.39) at a nearly significant level ($t = -1.893$, $p = 0.061$). Erythema values measured on the volar forearm were significantly lower ($t = 2.13$, $p < 0.05$) at week 12 (280 ± 54.97) than at week 0 (290.87 ± 69.08). There were no significant differences between the three groups in changes of melanin levels and erythema levels in the 12 weeks of the study (Table 4).

4.4. Correlations

To determine whether a statistically significant relationship was present between participants' results for the Readiness to Change Ruler (modified to measure the readiness to regularly use

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Table 4
Melanin and erythema values measured on the volar forearm at week 0 and week 12.

	Melanin values at week 0 mean ± SD	Melanin values at week 12 mean ± SD	Erythema values at week 0 mean ± SD	Erythema values at week 12 mean ± SD
Group 1 ($N = 50$)	237.69 ± 58.19	250.27 ± 55.65	292.75 ± 65.44	288.83 ± 54.39
Group 2 ($N = 50$)	223.45 ± 49.42	229.24 ± 43.28	290.69 ± 63.67	279.73 ± 51.86
Group 3 ($N = 49$)	220.48 ± 76.68	234.17 ± 89.9	289.13 ± 78.77	268.17 ± 58.12
All participants ($N = 149$)	227.25 ± 62.39	238.47 ± 64.39	290.87 ± 69.08	280 ± 54.97

Table 5
Significant correlations between results of the Readiness to Change Ruler [27] (modified to measure the readiness to regularly use sunscreen) at week 0 and week 12 and other variables (Pearson correlation coefficients $^{*}p < 0.05$, $^{**}p < 0.01$).

	Readiness to regularly use sunscreen at week 0	Readiness to regularly use sunscreen at week 12
Rate of adherence to sunscreen use – sunbathing (interview)	0.274**	0.546**
Rate of adherence to sunscreen use – sun exposure for more than 15 min (interview)		0.420**
Frequency of sunscreen use (sun exposure diary)	0.210*	0.292**
Frequency of daily sun exposure (sun exposure diary)		−0.230**
Total motivation scores for adherence to sunscreen use	0.277*	0.450**
Internal health locus of control	0.195*	

Table 6
Significant correlations between total motivation and knowledge scores of adherence to sunscreen use for 12 weeks and other variables (Pearson correlation coefficients $^{*}p < 0.05$, $^{**}p < 0.01$).

	Motivation scores for adherence to sunscreen use during sunbathing (12 weeks)	Motivation scores for adherence to sunscreen use during sun exposure for more than 15 min (12 weeks)	Total motivation scores for adherence to sunscreen use (12 weeks)	Knowledge scores for adherence to sunscreen use (12 weeks)
Melanin values at week 0	−0.341**	−0.216*	−0.352**	
Melanin values at week 12	−0.225*	−0.225*	−0.261*	
Erythema values at week 0	−0.341**	−0.224*	−0.294**	
Erythema values at week 12	−0.363**	−0.311**	−0.362**	
Readiness to regularly use sunscreen (week 0)	0.273*	0.284**	0.277*	
Readiness to regularly use sunscreen (week 12)	0.467**	0.384**	0.450**	
Rate of adherence to sunscreen use – sunbathing (interview)	0.777**	0.467**	0.718**	0.436**
Rate of adherence to sunscreen use – sun exposure for more than 15 min (interview)	0.382**	0.564**	0.507**	0.240**
Powerful others health locus of control				−0.223*
Frequency of sunscreen use (sun exposure diary)	0.303**	0.444**	0.374**	0.187*
Frequency of fish consumption (sun exposure diary)				0.191*
Knowledge scores of adherence to sunscreen use (12 weeks)	0.520**	0.273**	0.466**	

sunscreen) at 0 and 12 weeks and their other results, Pearson's correlation coefficients (r) were calculated (Table 5).

We summarized statistically significant relationships between motivation and knowledge scores for adherence to sunscreen use for 12 weeks and other variables in Table 6. (In Table 6 these correlations are also indicated with sunbathing and sun exposure for 15 min dimensions of motivation scores for adherence, besides the total motivation scores.) Here we would like to highlight the following: there were significant negative correlations between results of total motivation scores for adherence to sunscreen use and both melanin and erythema values at week 0 at week 12.

5. Discussion

Participants found internal health locus of control factors (e.g. their own behaviour) the most responsible for their health or illness, which is in line with conclusions of Pertl et al. [9], who suggest that people are aware that it is up to them to use sunscreen and believe that doing so is easily within their control. This may also be explained by the fact that all of the participants were volunteers from the staff members of the Clinical Department and their relatives, which gives them knowledge about and insight into the advantages of sunscreen use. Nevertheless, controllability did not predict intention to use sunscreen, and this result is similar to the conclusions of Myers and Horswill [38].

In contrast to the results of Jackson and Aiken [47], general self-efficacy (the belief that one can cope with adversity in various domains of human functioning) did not emerge as a significant predictor of intention to use sunscreen. Though professionals' results differ in this area of research, for example the Go Sun Smart project arranged by Andersen et al. [12] had no effect on the participants' self-efficacy beliefs. Also, improving knowledge of a certain subject related to one's health does not necessarily improve self-efficacy to use that newly achieved knowledge [43].

Investigation of stages of change can be advantageous in studies, because even if a behavioural change is not observable, intention might be influenced [48]. According to results of the modified version of The Readiness to Change Ruler, the readiness of the participants to regularly use sunscreen was high at both the first and the last week of the study. This suggests that all three groups' members already had efficient sun protection habits or they were ready to change those to even more frequent sunscreen use. These results are very favourable for the participants, because individuals who are in a higher stage for one behaviour are more likely to be in a higher stage for another health-promoting behaviour as well [49].

Please cite this article in press as: C. Szabó et al., A randomised trial to demonstrate the effectiveness of electronic messages on sun protection behaviours, J. Photochem. Photobiol. B: Biol. (2015), http://dx.doi.org/10.1016/j.jphotobiol.2015.06.006

Results of adherence to sunscreen use revealed that participants' knowledge scores were higher than their motivation scores, which is in line with the results of Thomas-Gavelan et al. [50], because having an acceptable degree of awareness does not guarantee the use of sufficient photoprotection measures in daily life.

Our educational messages had two main goals: to facilitate participants' frequency of sunscreen use and to reduce sun exposure. Total motivation scores to use sunscreen were higher at the end of the study than at 6 weeks, this may be the positive effect of our intervention. Measurements of melanin and erythema scores might have also confirmed the positive impact of our messages, because the higher the motivation scores for adherence, the lower the erythema- and melanin- index, indicating less time staying in the sun. We found greater improvement in motivation scores for adherence to sunscreen use during sun exposure for more than 15 min than during sunbathing. In women's results, there was a higher rate of belonging in the high motivation adherence domain than in men's results.

Readiness to change and adherence to sunscreen use (both in the motivation and knowledge domains) results showed significant correlations with many aspects of sun protection behaviours, thus they proved to be essential variables of sun protection habits.

Participants who received our personalized e-mails and text messages used sunscreens more often (according to sun exposure diaries and interview results) and their knowledge score improved significantly in the adherence to sunscreen use domain as compared to participants who did not receive messages. When comparing adherence results to the degree of sun protection, it is important to mention that although there is no gold standard for measuring sun protective behaviour, self-reports, prospective diaries, and observation techniques show small positive correlations [2]. Based on the interview answers, Group 3 (the intervention group) reported overall 3.64% more sunscreen use (when they were in the sun for more than 15 min) than Group 2, and 17.41% more sunscreen use than Group 1. These results are in line with a meta-analysis of studies on interventions to improve medication adherence, which revealed an increase in adherence of 4–11% [51]. Using electronic messages offers an effective method for improving adherence to sunscreen application. These tools may also be effective in helping individuals adhere to medication regimens, as well as promoting preventive health behaviours [24]. According to Armstrong et al. [24], the introduction of a program that incorporates text-message reminders to a large population may be an innovative preventive health measure against the development of skin cancer.

6. Limitations

The use of a volunteer group working within the Clinical Department of Dermatology and Allergology allows potential for systematic bias. The target group of the present study may not be a representative sample of the general population. However, there were no significant differences between the three groups in dimensions of sex, age and level of education, which may enhance the scientific strength of our study. In future research examining the effect of our intervention to enhance adherence to sunscreen use with patients who have dermatologic conditions is recommended.

7. Conclusion

The advantages of our intervention are that it is a cost-effective method and it can easily be implemented at worksites (particularly the use of the Readiness to Change Ruler's modified version to measure the readiness to regularly use sunscreen, which takes a very brief time, but its scores correlated with many aspects of sun protection behaviour). Successful modification of one behavioural domain can affect changes in the other domain, possibly by transfer [49,52], and in our study, improving sun protection behaviour may have effected other examined habits, for example paying more attention to healthy food consumption.

Funding

All of the fundings were provided by the Clinical Department of Dermatology and Allergology at the University of Szeged in Hungary.

Conflict of interest statement

The authors declare that there are no conflicts of interest. The trial was partly supported by La Roche-Posay Laboratoire Dermat ologique/L'Oréal Magyarország Kozmetikai Kft.

Acknowledgements

We would like to thank Mónika Széllné Andóczi Balogh and Ildikó Kószó, who assisted with contacting the participants between the assessments. We would like to thank Zoltán Behány for his advices about analysing results of measurements of skin parameters. We would also like to thank Gergely Kulinyi for typing in data.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jphotobiol.2015.06.006.

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