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Effects of smartphone diaries and personal dosimeters on behavior in a randomized study of methods to document sunlight exposure

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ABSTRACT

Dosimeters and diaries have previously been used to evaluate sun-related behavior and UV exposure in local samples. However, wearing a dosimeter or filling in a diary may cause a behavioral change. The aim of this study was to examine possible confounding factors for a questionnaire validation study. We examined the effects of wearing dosimeters and filling out diaries, measurement period and recall effect on the sun-related behavior in Denmark in 2012.

Our sample included 240 participants eligible by smartphone status and who took a vacation during weeks 26–32 in 2012, randomized by gender, age, education and skin type to six groups: 1) Control + diary, 2) Control, 3) 1-week dosimetry measurement, 4) 1-week dosimetry measurement + diary, 5) 3-week dosimetry measurement and 6) 1-week dosimetry measurement with 4 week delayed questionnaire.

Correlation coefficients between reported outdoor time and registered outdoor time for groups 3–6 were 0.39, 0.45, 0.43 and 0.09, respectively. Group 6 was the only group not significantly correlated. Questionnaire reported outdoor exposure time was shorter in the dosimeter measurement groups (3–6) than in their respective controls. We showed that using a dosimeter or keeping a diary seems to increase attention towards the behavior examined and therefore may influence this behavior. Receiving the questionnaire with 4 week delay had a significant negative influence on correlation and recall of sunburn. When planning future UV behavior questionnaire validations, we suggest to use a 1-week interval for dosimetry measurements, no diary, and to minimize the time from end of measurement to filling out questionnaires.

1. Introduction

Exposure to ultraviolet radiation (UVR) is the strongest risk factor for skin cancers of all types, including malignant melanoma (IARC, 2011). The incidence of melanoma (world standardized incidence rate per 100,000) for men and women in Denmark increased from 1.4 and 1.9 in 1949–53 (Engholm et al., 2008) to 20.5 and 25.5 in 2008–12 (Engholm et al., 2012) respectively and is still increasing (Ferlay et al., 2012). Most Danes are fair-skinned and have a high UVR exposure and thus a high risk of skin cancer (Koster et al., 2011a; Koster et al., 2010). Recent surveys (2007–2009) showed that 35% of the population had experienced sunburn in Denmark during the summer (Koster et al., 2010), 29% had used a sunbed (Koster et al., 2009) and 45% had traveled to a sunny destination within the past 12 months (Koster et al., 2011b).

In 2007, a national skin cancer prevention campaign was launched with three primary foci of reducing the UVR exposure of the population; 1) The summer in Denmark, 2) vacationing in sunny countries, and 3) using sunbeds (Koster et al., 2010; Koster et al., 2009; Koster et al., 2011b). The traditional monitoring and evaluation of sun-related behavior is carried out by questionnaires (IARC, 2011). However, these questionnaires are not validated against objective measurements. Monitoring of other health behaviors is validated by objective measurements, e.g. smoking by cotinine measurements, diet by biomarkers, and physical activity by accelerometers and GPS (Kvalvik et al., 2012; McGarty et al., 2014). We currently use annual population-based surveys, where participants have been asked in the beginning of September each year to recall and summarize their behavior in the sun for the past summer or for the past 12 months.

Several kinds of bias could influence this data collection method, and even though this traditional instrument to monitor sun-related behavior is widely used (IARC, 2011), there have been concerns with recall bias (English et al., 1998; Kwok et al., 2009) and selection bias (Boniol

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et al., 2012). Intensive campaign pressure has increased awareness, but could also lead to social desirability bias (Paulhus, 1991). These considerations led to the initiative of a questionnaire validation project, with the overall aim to optimize the campaign, to more effectively prevent skin cancer. The rationale being that an evaluation, which has been proven significantly associated with a population's actual behavior, is more qualified to be the base of interventions. For example, we may gain new knowledge on the efficiency of specific types of protection behavior, which can be prioritized accordingly.

Correlation between sun-related behavior by a self-reported questionnaire and objective measures of UVR exposure e.g. the use of personal electronic UV dosimeters, was previously shown in local samples. However, wearing a dosimeter is an intervention that could cause a behavioral change. In addition, most studies used diaries to assess the sun-related behavior of their participants (Thieden, 2008; Dwyer et al., 1996; Glanz et al., 2010). Diaries, however, may not be suitable for population-based assessment of UVR exposure. For instance using a diary could influence the participants and induce a change of behavior. Effects of using a diary or wearing a dosimeter were to our knowledge not previously described. Glanz et al. made an indirect questionnaire validation of outdoor exposure, by comparing first dosimeters and diaries and then diaries with questionnaires in a study of children and lifeguards (Glanz et al., 2010). Recently, a small study validated a brief questionnaire of sun exposure directly against objective measures of UVR exposure including UVR dosimeters (Cargill et al., 2012). Cargill et al. reported a significant association between outdoor times reported in a questionnaire and registered on a UV dosimeter.

The overall aim of this study was to develop the best conditions for a questionnaire validation study. Here we describe possible intervention effects; feasibility was previously described (Koster et al., 2015). We examined smartphones as a new media for monitoring sun-related behavior and we examined measures of outdoor time from questionnaires and actual outdoor time exposure registered by personal electronic UV dosimeters. We tested effects of wearing dosimeters in studies of sun-related behavior including intervention effects of dosimeters and diaries, measurement period and recall effects.

2. Method

2.1. Study design and participants

Participants were recruited in May 2012 through the Facebook site and the newsletter of the Danish Cancer Society, and were eligible to this study, if they were living in Denmark and vacationing in Denmark during the week 26, 28, 30 or 32 (late June to mid-August). Participants were randomly assigned to a dosimeter group (which were instructed to wear a dosimeter, complete a short daily sun diary and a questionnaire at the end of the measurement period) or control group (which received the diary and questionnaire, but not a UV dosimeter) by vacation week. Participants for groups using a diary were recruited among regular smartphone users and received their diary to fill in on the smartphone. Participants for 3 week measurement were restricted to persons volunteering for and having 3 weeks of vacation. The study sample was randomized by gender, age (15–34, 35–54, 55+), education (3 levels) and skin type into six groups as shown in Table 1: 1) Control + diary, 2) Control, 3) 1 week dosimetry measurement, 4) 1-week dosimetry measurement + diary, 5) 3 week dosimetry measurement and 6) 1 week dosimetry measurement with 4 week delayed questionnaire. The randomization procedure aimed to produce six equal groups and to achieve the best representation i.e. groups least represented in recruitment e.g. males and young people were randomized first and then subsequent groups in surplus were randomized. BK

Table 1
Distribution of background variables by groups and distribution of group interventions in Denmark in 2012.

Characteristic (%) Total (n = 240)	Total	Group 1 (n = 33)	Group 2 (n = 41)	Group 3 (n = 66)	Group 4 (n = 41)	Group 5 (n = 35)	Group 6 (n = 24)
Used diary		Yes	No	No	Yes	No	No
Used dosimeter		No	No	Yes	Yes	Yes	Yes
Weeks of participation		1	1	1	1	3	1
Questionnaire recall time		<2 weeks	<2 weeks	<2 weeks	<2 weeks	<2 weeks	4–6 weeks
Gender	p = 0.036						
Male	20	12	17	21	15	40	13
Female	80	88	83	79	85	60	88
Age group	p = 0.325						
15–24	15	12	12	11	20	17	21
25–34	17	15	10	11	24	26	21
35–44	16	27	15	15	15	14	8
45–54	22	21	24	23	29	20	8
55–64	19	18	24	27	7	9	25
65+	12	6	15	14	5	14	17
Skin type	p = 0.393						
I	15	12	10	12	20	11	29
II	58	70	66	55	49	63	46
III/IV	28	18	24	33	32	26	25
Region	p = 0.544						
Capital	33	45	29	24	49	29	21
Zealand	15	9	15	20	10	11	25
Northern Jutland	10	9	17	8	7	11	8
Central Jutland	20	12	20	26	15	26	21
Southern Denmark	22	24	20	23	20	23	25
Education	p = 0.056						
Primary school	10	6	17	6	5	17	13
Secondary school	14	0	12	8	24	20	25
Vocational	13	12	10	14	12	23	4
Higher education (<2 years)	15	18	17	21	5	9	13
Higher education (2–4½ years)	38	42	34	42	44	23	38
Higher education (>4½ years)	11	21	10	9	10	9	8