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Risk attitudes and sun protection behaviour: Can behaviour be altered by using a melanoma genomic risk intervention?

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ABSTRACT

Background: Exposure to ultraviolet radiation from sunlight is directly associated with melanoma skin cancer, however reducing sun-exposure can be difficult to achieve at a population level.

Methods: Using a genomic risk information behaviour change trial for melanoma prevention, we classified participants as risk-seeking, risk-neutral or risk-averse for domain-specific risk taking (DOSPERT). One-way ANOVA determined the association between socio-demographic characteristics and risk-taking score, and multivariable linear regression ascertained impact of an individual's underlying risk propensity on an objective measure of sun-exposure, standard erythemal dose (SED), at 3-months follow-up.

Results: Of 119 participants, mean age 53 years; 50% males, 87% had a personal/family history of cancer; 19% were classified risk-seeking, 57% risk-neutral. The mean risk-taking score was significantly higher in younger participants (≤50 years: 13.86 vs. > 50 years: 11.11, $p = 0.003$); and lower in those with a personal/family history of skin cancer versus without (10.55 vs 13.33, $p = 0.009$). Risk averse individuals had lower weekly mean SEDs at 3-months than risk neutral and risk seeking individuals (2.56, 5.81, 4.81 respectively, $p = 0.01$). Risk seekers showed fewer sun protective habits ($p < 0.001$); and higher intentional tanning, ($p = 0.01$). At 3-months, risk seekers attained 16%–54% lower SEDs in the genomic information group compared with controls, however this was not significantly different across risk groups (interaction $p = 0.13$).

Conclusion: An individual's underlying risk attitude is likely associated with sun-exposure behaviours, and may modify the effect of a genomic risk information behaviour change intervention. Young people and risk seekers may benefit most from being given information on their genetic risk of melanoma.

1. Introduction

Health-related behaviours may be affected by an individual's underlying propensity to take health-related risks. Prospect theory [1,2], maintainsthat an individual's risk propensity or risk attitude can be derived from observing an individual's risky choices. Risk attitude, which is defined as a person's position on the continuum from risk aversion to risk seeking, has been shown to differ across different life decisions and contexts such as health decisions versus financial decisions [3–6].

The Domain-Specific Risk-Taking (DOSPERT) scale measures three risk constructs: risk-taking, risk perception and perceived risk attitude [3,7]. The DOSPERT is a validated instrument, recommended for measuring risk propensity in healthcare decisions, including preventive

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behaviours [8,9]. It has been successfully used to classify risk attitudes to inform shared decision making in patients with multiple sclerosis [10]; and as a prediction tool for risky motor vehicle drivers [11]. In the later study, greater frequency of phone text messaging while driving was strongly associated with risk taking, enabling risk propensity measures to target effective prevention and intervention programs.

Genomic risk profiling involves the analysis of genetic variations linked through statistical associations to a range of disease states [12]. Provision of genomic risk information may stimulate positive behaviour change [13,14], or possibly negative behaviour change if individuals think their behaviour will have little effect on their health outcomes if a lower than average genetic risk result is received. However it is not clear whether an individual's underlying propensity to take risks will mediate subsequent behaviour. Other factors such as an individual's age, sex, personal or family medical history may encourage preventive behaviours to avoid poor health [7]. Although risk attitude has been examined for a variety of health conditions, such as smoking and alcohol, there is a real lack of evidence in many other health areas which require urgent attention. For example, risk attitudes towards sun exposure and melanoma is an under researched area. Australia has particularly high rates of melanoma with more than 15,000 new cases diagnosed each year; melanoma is the 3rd most common cancer, and the most common in young adults aged 15–24 years [15]. It is therefore a useful population to examine.

We conducted a pilot randomised trial of melanoma genomic risk information provision to participants without a personal history of melanoma residing in New South Wales, Australia. In addition to examining feasibility and acceptability of communicating personalised genomic risk of melanoma to the public, the main outcome of interest in the trial was sun-related behaviours including sun protection, skin examinations and objectively-measured sun exposure. Within the trial, we aimed to assess: (i) the personal characteristics that correlate with risk-taking using the DOSPERT scale; (ii) the association between an individual's risk-taking scores and sun-related behaviours; and (iii) the association between provision of genomic information and sun exposure, sun protection and skin examination behaviours at 3-months by risk-taking classification.

2. Material and methods

2.1. Study design and participants

This prospective study was undertaken in participants randomized into the melanoma genomic risk information provision pilot trial [14]. In brief, participants were randomised to receive the intervention: a personalised genomic risk of melanoma (based on variants in 21 genes from DNA saliva samples), in the form of an educational booklet on melanoma prevention and early detection and a genetic counselling phone call; versus the control group which consisted of a generic non-personalised melanoma education booklet and no genomic risk information [14]. Personalised genomic risk information classified participants into those at low risk, average risk and high risk of melanoma. Participants were adults aged 18–69 years from the general population residing in New South Wales, Australia without a personal history of melanoma, recruited through the Cancer Council NSW 'volunteer for a study' program. This database comprises of people with cancer, their relatives, friends and the broader public who have agreed to be contacted by researchers conducting approved, cancer-related research studies. (https://www.cancercouncil.com.au/65932/forms/join-a-research-study-thankyou/). Further details about the trial are reported elsewhere [14]. The trial was registered at the Australia and New Zealand Clinical Trials Registry (ACTRN12615000356561).

2.2. Outcomes

Sun-related behaviours were measured by self-report using validated questionnaire items at baseline prior to randomisation, and again at 3 months [16,17]. The behaviours included sun exposure (time spent outdoors); sun protection index (6 items including staying in the shade, limiting midday sun exposure hours, wearing sunscreen, wearing a shirt with sleeves, wearing a hat, and wearing sunglasses) [14]; skin examinations; and intentional tanning. In addition, objectively-measured sun exposure was measured at 3-months (but not at baseline) using personal UV dosimeters to collect standard erythemal doses (SEDs); this is the best available objective measure of personal total dose of ultraviolet radiation [18–20].

We measured domain-specific risk-taking at baseline using the revised DOSPERT scale for adult populations [3]. Two domains of risk: 'Health and Safety' (Health) and 'Social' were considered most relevant to a preventive intervention [8] for sun protection behaviours and were included in the baseline questionnaire. For the assessment of 'risk-taking', participants were asked to indicate the likelihood of engaging in a set of described activities or behaviours (such as choosing a career that you truly enjoy over a more secure one) if they found themselves in that situation, by providing a rating from extremely unlikely to extremely likely on a seven point scale.(See appendix) For 'risk perception' participants were asked to indicate how risky they perceived each situation on a seven point scale from 'not at all risky' to 'extremely risky'; (for example, driving a car without wearing a seat belt). The same situations were presented to measure 'risk attitude' and participants were asked to indicate the benefits they would obtain from each situation, from 'no benefits at all' to 'great benefits' (for example, engaging in unprotected sex).

All questions were mandatory in the online questionnaire; for participants who completed the questionnaire on paper, we entered the responses into the database and if any were missing then we followed up with participants by calling and emailing to obtain the missing items.

Dependent variables included the risk taking, risk perception and risk attitude scores for the DOSPERT Health and Social subscales. Each subscale contained 6 questions with a respondent score from 1 to 7. The total subscale score range was therefore 6–42 (e.g. for risk perception, from least risky to most risky). Individuals were classified as risk seeking if their score on a subscale was more than one standard deviation above the mean, as risk averse if their subscale score was more than one standard deviation below the mean, and as risk neutral if their subscale score was in between [7].

2.3. Statistical analysis

Baseline risk taking, risk perception and risk attitude scores have been summarised as means (standard deviation) for the Health and Social domains for all participants and by sex. Participants were categorised as risk-adverse, risk-neutral or risk-seeking for each domain and summarised as frequency (%). The univariate association of baseline risk-taking in the Health and Social domains, and its association to the following baseline characteristics was investigated using ANOVA: age ($>$ 50 years vs. $\leq$50 years); sex; marital status; annual household income; highest educational attainment; employment; country of birth; children; family history of melanoma; family history of other skin cancer; family history of other cancer.

Sun-related behaviours were summarised according to risk-taking categories as mean (SD) if continuous, and a frequency (%) if categorical. Sun exposure, as measured by SEDs, was log-transformed prior to analysis due to their right-skew distribution and results have been back-transformed where appropriate. One-way ANOVA was used to compare continuous outcomes (or a Kruskal-Wallis if non-normal) between risk categories and a chi-square test for categorical variables. To assess whether the effect of the intervention on the sun protection index and SEDs differed between risk propensity groups at 3-months, a multivariable linear regression model was used, including an intervention-by-risk category interaction term alongside the main effects of

Table 1
Descriptive characteristics of 119 participants at study baseline.

Characteristics	n	(%)
Age in years, mean, (range)	53	(21–69)
Sex		
Females	60	(50)
Males	59	(50)
Highest level of education		
Completed High school or equivalent	17	(14)
Trade/diploma	40	(32)
University degree or higher	62	(52)
Country of birth		
Australia and New Zealand	95	(79)
United Kingdom	12	(10)
Other	12	(10)
Household income (AUD)		
< $50,000 per year	29	(24)
$50,000–$100,000 per year	35	(29)
$100,001–$150,000 per year	28	(23)
more than $150,000 per year	21	(18)
Participant preferred not to respond	6	(5)
Employment status		
Student/ Unemployed/ sickness benefits	10	(9)
Retired/ Home duties	40	(34)
Part-time work	24	(20)
Full-time work	45	(38)
Marital status		
Never married	23	(19)
Widowed/divorced	16	(13)
Married/de facto	80	(67)
Children		
Yes	80	(67)
No	39	(33)
Family history of melanoma		
Yes	32	(27)
No	73	(61)
Unsure	14	(12)
Personal and family history of other types of skin cancer		
Yes	51	(43)
No	49	(41)
Unsure	19	(16)
Personal and family history of other types of cancer		
Yes	104	(87)
No	12	(10)
Unsure	3	(3)

intervention and risk. Due to small numbers, analyses were not further stratified by an individual's personalised genomic risk (low, average or high). Model estimates were presented as the ratio of geometric means (interpreted as relative increase) with 95% confidence intervals. Statistical analyses were undertaken using STATA v14 software.

3. Results

A total of 119 participants completed the baseline data collection and were included in this analysis. The mean age of the sample was 53 years (range 21–69) and 50% were male. Table 1 reports participant baseline characteristics. Sixty (50%) participants were allocated to the intervention (provision of genomic information), 58 to the control group and 1 person was not randomised due to insufficient DNA available. The average time to complete all survey questions (including the DOSPERT) in the baseline measures was 20–30 minutes.

The likelihood of pursuing risk taking behaviours in Health situations was much lower than risk taking in Social situations for both men (mean score 12 vs 27) and women (mean score 12 vs 29) (Table 2). Health situations were also *perceived* to be more risky than Social situations (men: mean score 35 vs 17 and women: 37 vs 20). Very few benefits were reported for engaging in risky Health behaviours compared to risky Social behaviours (men: mean score 9 vs 23 and women: 9 vs 26). Interestingly, women showed a slightly higher risk propensity than men in the Social domain, i.e. perceived greater benefits in undertaking risky behaviours such as disagreeing with an authority figure on a major issue; choosing an enjoyable career over a more secure one, or speaking up about an unpopular issue in a meeting at work (e.g. risk attitude mean score 26 vs 23 for women vs men, Table 2).

In terms of overall risk-taking propensity, 19% of participants were classified as risk-seeking, 57% risk-neutral and 24% risk-averse for the Health domain, and 16%, 64% and 20%, respectively, for the Social domain.(Table 3) When classified by risk type, a similar proportion of participants were classified as risk-seeking in regards to their perception of risk compared to risk-seeking in regards to risk-attitude and risk-taking domains.(Table 3)

3.1. Association of socio-demographic factors with risk-taking attitudes

In univariate analysis, there was a significant association of age, country of birth, and a family history of melanoma with Health risk-taking (Table 4). Younger participants had a higher Health risk-taking score compared to older (> 50 years) participants (13.86 (SD 5.26) vs. 11.11 (4.33), p = 0.003) and participants born in the United Kingdom had a higher Health risk-taking score compared to participants born in Australia/New Zealand and other countries. Participants with a family history of melanoma had a lower Health risk-taking score compared to those who did not or were unsure (14.58 (6.40) vs. 11.56 (4.60) vs. 13.92 (4.23), p = 0.03).

Social risk-taking was associated with both country of birth and household income. Participants in Australia/New Zealand had a lower Social risk-taking score compared to those from the UK or other countries (27.05 (6.68) vs. 30.42 (6.75) vs. 31.83 (5.61), p = 0.03), and those with a lower income (< $100,000) also had a lower Social risk-taking score (< $100,000: 26.62 (6.84) and 25.77 (7.51) vs. > $100,000: 28.86 (5.34) and 31.24 (6.55)).

3.2. Association of sun-related behaviours with risk-taking attitudes

Table 5 summarises the univariate association of baseline sun protection behaviours and 3-month SEDs by baseline risk category (averse, neutral, seeking). There was a significant association of risk attitudes in the Health domain with sun exposure (SEDs) and sun protective habits but not skin examinations. Risk averse individuals had lower mean SEDs at 3-months than risk neutral and risk-seeking individuals (2.56 (3.03) vs. 5.81 (2.80) vs. 4.81 (2.86) respectively, p = 0.01). Risk seekers had lower sun protective habits (mean sun protection index (6 item): 2.34 (0.47) vs. 2.90 (0.53) vs. 3.06 (0.36) p < 0.001), and higher intentional tanning behaviours (2 (2–3) vs. 1 (1–2) vs. 1 (1–2), p = 0.01) compared to risk neutral and risk-averse individuals. There was no association between sun protective habits and Social risk-taking, however, a higher proportion of socially risk-averse participants had previously conducted a skin self-examination (p = 0.05).

A multivariable model was fitted including an intervention-by-risk interaction term to investigate whether the effect of the genomic risk intervention on 3-month SEDs differed between risk groups (Table 6). At 3-months, SEDs were 1.6 lower in the intervention group compared to controls, however this result was not statistically significant (p = 0.14). Risk seekers in the Health domain had a 54% reduction (95% CI: 30% increase to 84% reduction) in SEDs for the intervention vs control groups, and risk seekers in the Social domain had a 16% reduction (95% CI: 148% increase to 72% reduction) in SEDs for the intervention vs control groups as a result of the intervention, however the effect of the intervention was not significantly different across risk groups (interaction p = 0.13). This was similar for the sun protection index (Table 7).

4. Discussion

Our study highlights several novel findings about the relationship

Table 2
Summary of risk scores by risk domain and sex.

	Risk-taking[a]		Risk perception[b]		Risk attitude[c]	
	Health Mean (SD)	Social Mean (SD)	Health Mean (SD)	Social Mean (SD)	Health Mean (SD)	Social Mean (SD)
All	12.1 (4.9)	27.9 (6.8)	36.5 (4.2)	18.7 (6.2)	36.5 (4.2)	24.4 (6.9)
Males (n = 59)	12.2 (4.8)	27.2 (6.9)	35.5 (4.4)	17.5 (6.5)	9.4 (4.6)	23.0 (7.7)
Females (n = 60)	12.0 (5.0)	28.5 (6.6)	37.4 (3.8)	19.9 (5.6)	8.7 (3.8)	25.7 (5.7)
p-value (M vs. F)	p = 0.31	p = 0.82	**p = 0.03**	**p = 0.01**	**p = 0.03**	p = 0.34

[a] The likelihood you would engage in the described activity (unlikely to likely), range:6–42.
[b] How risky you perceive the described situations (least risky to most risky), range:6–42.
[c] The benefits you would obtain from each situation (no benefits to great benefits), range:6–42.

Table 3
Summary of participant risk group classifications within the risk domains.

	Risk-taking		Risk perception		Risk attitude	
	Health n (%)	Social n (%)	Health n (%)	Social n (%)	Health n (%)	Social n (%)
Risk averse	28 (24%)	24 (20%)	20 (17%)	14 (12%)	0	18 (15%)
Risk neutral	68 (57%)	76 (64%)	74 (62%)	81 (68%)	105 (88%)	86 (72%)
Risk seeking	23 (19%)	19 (16%)	25 (21%)	24 (20%)	14 (12%)	15 (13%)

between risk attitudes, sun-protection behaviours and the potential impact of a preventive genomic intervention to reduce UV exposure. First, we identified that younger people and those without a family history of melanoma have higher health-related risk-taking scores. Second, we found individuals classified as Health risk-seekers, had significantly higher mean UV sun exposure (SEDs), higher intentional tanning behaviours, and lower mean sun protection habits, than those classified as Health risk-averse. Third, the provision of a genomic risk information intervention was associated with a positive (but not statistically significant) reduction in SEDs among risk seekers than among risk averse participants.

The association of age on risk-taking behaviours has been examined by Rolison and colleagues [5] who conducted a cross-sectional study among 593 members of the general US population aged 18–93 years. They found increasing age was associated with a statistically significant decrease in risk-taking in the Health domain of the DOSPERT for both women and men, (regression model for age $\beta = -0.42$, $p < 0.05$); but not for the social domain of DOSPERT (regression model for age $\beta = -0.09$, $p > 0.05$). This is consistent with the results from our study. A second cross-sectional study among 309 adults in the United States aged 20–77 years, investigated the effect of age on risk-taking using a modified version of the DOSPERT instrument for medical decisions [21]. The authors categorised risk-taking into passive (defined as “inaction”, for example, not attending a doctor’s visit or medical screening test), and active (defined as a tendency to engage in actions that are risky, for example undertaking a course of chemotherapy for cancer treatment). They reported passive risk-taking tended to decrease with increasing age ($\beta = -0.12$, $p = 0.04$); however active risk-taking was not associated with age ($\beta = -0.04$, $p = 0.50$).

Our findings of reduced Health risk-taking on the DOSPERT scale among people with a family history of cancer (in this case melanoma), has not been reported previously. However,

several theories support this association [22–24] as the perceived susceptibility to disease (including heritability) in other cancers has been shown to motivate actions to prevent it [13]. This is particularly relevant to melanoma which may be caused by high UV exposure from sunlight in people who have a low pre-determined (genomic) risk of the disease, or in those with lower UV exposure and a high genomic risk. Humpel and colleagues [25] found significantly lower self-reported sun exposure in adults perceived to be at high risk of cancer following the diagnosis of cancer in a close friend or family member.

We found differences in sun exposure and sun protection behaviours on the basis of risk propensity as classified by the DOSPERT Health and Social domains. Our findings suggest risk seekers may reduce sun exposure when given information about their genomic risk of melanoma. This is important because risk seekers were found to have the highest levels of sun exposure, a factor known to be strongly associated with the development of melanoma and other skin cancers [26]. While these results need to be verified in a larger randomised trial, they do provide some evidence that assessment of risk attitude is useful for evaluation of behaviour change interventions, and that a health-related risk-seeking could be included alongside other socio-demographic or behavioural factors to define ‘high-risk’ individuals who could be the target of focused melanoma prevention interventions.

Our study supports the notion that the degree of risk taking, from risk-averse to risk-seeking, is domain specific. That is, individuals were not consistently risk-seeking or risk-averse across Health, and Social domains [7]. Both younger age and family history of melanoma were associated with Health risk-taking in our study but were not associated with Social risk-taking. Similarly, household income was significantly associated with Social risk-taking but was not associated with Health risk-taking. In terms of differences in sun-related behaviours, classification of risk attitude based on the Health domain was more informative than classification based on Social risk taking, with the exception of the likelihood of undertaking skin checks. Social risk taking is generally known to be higher in younger populations and it is possible that the social pressures for tanning and reluctance to seek shade or apply sunscreen [27] were less prominent in our population with a mean age of 53 years, or that the Social domain of the DOSPERT was not sensitive to these behaviours.

In terms of study limitations, participants were categorised into risk propensity categories based on the mean (SD) of the cohort, meaning that the risk cut-off points can vary according to the cohort under investigation. In a recent sample of 359 English and French Canadians predominantly aged between 22 and 35, the mean risk-taking score in both the Health and Social domains were considerably higher than in the current study population (20.6 vs. 12.1 and 32.6 vs. 27.9, respectively) [3]. Our trial deliberately recruited volunteer participants through a cancer agency, who were on average older and with a high proportion of personal or family history of cancer. It is therefore not surprising that the risk categories indicate a smaller proportion of risk seekers than may be found in the general population. Based on our sample size, we had limited statistical power for assessing the effect of the genomic risk intervention by risk propensity category (i.e.

Table 4
Association between socio-demographic characteristics and risk-taking score.

		Health domain		Social domain	
Characteristic	N	Mean (SD)	P-value	Mean (SD)	P-value
Age (years)			**0.003**		0.53
≤50 years	43	13.9 (5.3)		28.4 (6.6)	
> 50 years	76	11.1 (4.3)		27.6 (6.9)	
Gender			0.82		0.31
Female	60	12.0 (5.0)		28.5 (6.6)	
Male	59	12.2 (4.7)		27.2 (6.9)	
Education			0.69		0.23
High school (or equivalent)	17	11.3 (5.2)		25.3 (6.0)	
Trade/diploma	40	12.5 (5.1)		28.4 (6.5)	
University degree or higher	62	12.1 (4.6)		28.2 (7.1)	
Country of birth			0.05		**0.03**
Australia/New Zealand	95	11.6 (4.6)		27.1 (6.7)	
United Kingdom	12	14.6 (6.4)		30.4 (6.8)	
Other	12	13.9 (4.2)		31.8 (5.6)	
Household Income (AUD)			0.34		**0.03**
< $50,000 per year	29	11.7 (4.9)		26.6 (6.8)	
$50,000–$100,000 per year	35	11.6 (4.1)		25.8 (7.5)	
$100,000–$150,000 per year	28	13.2 (4.9)		28.9 (5.3)	
> $150,000 per year	21	12.9 (6.1)		31.2 (6.6)	
Declined to answer	6	9.3 (3.4)		29.8 (2.6)	
Employment Status			0.15		0.28
Student/unemployed/ sickness	10	12.7 (6.1)		28.7 (7.2)	
Retired/home duties	40	10.9 (3.9)		26.2 (6.6)	
Part time work	24	11.6 (4.9)		28.5 (6.9)	
Full time work	45	13.3 (5.2)		28.9 (6.6)	
Marriage status			0.88		0.55
Married or de facto relationship	80	12.0 (4.6)		28.3 (6.5)	
Never Married	23	12.5 (5.4)		27.5 (6.4)	
Widowed/divorced	16	12.3 (5.3)		26.3 (8.6)	
Children			0.52		0.07
No	39	12.5 (4.7)		29.5 (6.4)	
Yes	80	11.9 (5.0)		27.1 (6.8)	
Family history of melanoma			**0.009**		0.14
No	49	13.3 (5.5)		29.3(6.2)	
Yes	51	10.5 (3.8)		26.6 (6.6)	
Unsure	19	13.1 (4.7)		27.8 (8.0)	
Family history of other skin cancer			0.30		0.27
No	12	14.1 (6.6)		28.4 (7.4)	
Yes	104	11.9 (4.7)		28.0 (6.7)	
Unsure	3	10.7 (2.1)		21.7 (6.8)	

interaction effect), and a larger study assessing this relationship is warranted.

It is possible that risk perception (rather than risk-taking propensity) might be the most relevant component of risk attitude for this intervention (i.e. provision of personal genomic risk). However we were ultimately interested in the change in behaviour (i.e. reduced sun exposure) as a result of the intervention, not just the change in risk perception, and the likelihood that one would engage in intentional tanning for example (due to social pressures) may still be high even when the perception of risk is high. In future research we can test this hypothesis by controlling for risk perception when evaluating risk-taking, however this analysis will require a larger sample size than the current study.

5. Conclusion

In summary, our study suggests an individual's underlying risk attitude is associated with sun-exposure behaviours, and may modify the effect of a genomic risk information behaviour change intervention. Efforts to encourage behaviour change may have more impact if they focus on young people, risk-seekers and those without a family history of melanoma.

Authorship contribution statement

RLM and SW conceived the study. RLM, AS, PNB, MGK, SD, LK and AEC acquired the data. RLM, RA, EP, AT, AS, PNB, MGK, SD, SW, LK and AEC interpreted the data. RLM, RA, EP, AT analysed the data. RLM prepared the first draft of the manuscript and all authors critically revised it for important intellectual content. All authors approved the final version of the manuscript.

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Conflicts of interest

None

Table 5
Association of overall risk-taking score with sun-related behaviours.

Health domain	Risk Averse n = 22	Risk Neutral n = 67	Risk Seeking n = 29	p-value
Sun exposure (weekly SEDs)[a]	2.56 (3.03)	5.81 (2.80)	4.81 (2.86)	**0.01**
Sun protective habits (6 item)	3.06 (0.36)	2.90 (0.53)	2.34 (0.47)	< **0.001**
Intentional Tanning[b]	1 (1–2)	1 (1–2)	2 (2–3)	**0.01**
Doctor skin check	7 (25%)	15 (24%)	3 (18%)	0.84
Skin self- check	13 (46%)	23 (37%)	6 (35%)	0.63
Social domain	**Risk Averse n = 19**	**Risk Neutral n = 76**	**Risk Seeking n = 23**	**p-value**
Sun exposure (SEDs)	7.09 (1.12)	3.81 (0.13)	4.71 (3.10)	0.12
Sun protective habits (6 item)	2.94 (0.55)	2.83 (0.53)	2.85 (0.55)	0.70
Intentional Tanning[b]	2 (1-2)	1 (1-2)	1 (1-2)	0.93
Doctor skin check	8 (36%)	11 (16%)	6 (33%)	0.08
Skin self-check	13 (59%)	21 (31%)	68 (44%)	0.05

[a] UV dosimeter data at 3-months follow-up were missing for 17 participants.
[b] Summarised and Median (IQR) and compared using a Kruskal Wallis test.

Table 6
Association of intervention on SEDs within each risk propensity category.

	Intervention	Control	Model estimate (95% CI)*	p-value
All participants	3.82 (2.92, 5.00)	5.38 (3.75, 7.73)	0.71 (0.45, 1.11)	0.14**
Health				
Risk Averse	3.04 (1.88, 4.92)	1.80 (0.75, 4.29)	1.69 (0.70, 4.09)	0.13***
Risk Neutral	4.82 (3.28, 7.10)	6.81 (4.56, 10.17)	0.71 (0.39, 1.27)	
Risk Seeking	3.27 (1.92, 5.54)	7.07 (3.08, 16.19)	0.46 (0.16, 1.30)	
Social				
Risk Averse	5.85 (3.64, 9.40)	9.52 (4.76, 19.06)	0.61 (0.22, 1.75)	0.91***
Risk Neutral	3.24 (2.33, 4.52)	4.50 (2.83, 7.97)	0.68 (0.38, 1.22)	
Risk Seeking	4.21 (1.66, 10.67)	5.01 (2.60, 9.64)	0.84 (0.28, 2.48)	

* Estimates are the ratio of the geometric mean (e.g. calculated as 3.82/5.38 = 0.71). The results are interpreted in terms of percentages. The estimates were calculated from a linear regression model including a treatment-by-risk group interaction term alongside the main effects and have been back-transformed using exponentials.

** p-value for difference in SEDs between intervention and control – univariate model.

*** p-value for interaction between intervention and risk group – multivariable models.

Table 7
Association of intervention on sun protection index within each risk propensity category.

	Intervention	Control	Model estimate (95% CI)*	p-value
All participants	2.84 (0.54)	2.86 (0.53)	−0.01 (−0.22, 0.19)	0.91**
Health				
Risk Averse	3.04 (0.34)	3.09 (0.43)	−0.05 (−0.44, 0.34)	0.94***
Risk Neutral	2.86 (0.56)	2.93 (0.51)	−0.07 (−0.32, 0.17)	
Risk Seeking	2.35 (0.60)	2.33 (0.34)	0.02 (−0.45, 0.49)	
Social				
Risk Averse	2.94 (0.50)	2.93 (0.62)	0.01 (−0.44, 0.47)	0.37***
Risk Neutral	2.86 (0.58)	2.80 (0.47)	0.06 (−0.20, 0.32)	
Risk Seeking	2.61 (0.27)	2.97 (0.62)	−0.36 (−0.89, 0.17)	

** p-value for difference in sun protection index between intervention and control – univariate model.

*** p-value for interaction between intervention and risk group – multivariable models.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.canep.2019.05.002.

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