RESEARCH ARTICLE

Risk perception normalization of sunlight exposure

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Abstract: Health organizations recommend avoiding direct sunlight exposure usually between 11 am and 5 pm. Nevertheless, it is common to see people on the beach during all day. This study focuses on understanding if sunlight exposure risk might be normalized. Risk normalization is a process by which people minimize a perceive threat to psychologically cope with it, frequently by using positive illusions. A pilot study (N = 44) suggests that the positive illusions most referred to explain exposition at unrecommended hours are the use of protective measures. To explore if knowledge of sunlight exposure risk and risk perception were negatively associated, illustrating risk normalization, a questionnaire was applied to a convenience sample (N = 276). This effect was found among those individuals that exposed themselves to sunlight between 12 am and 3 pm and reported a use of protective measures that was above the average. Furthermore, health literacy moderated the negative relation between knowledge and risk perception. This study suggests that it is important communicating that the use of protective measures during unrecommended hours does not guarantee protection, promoting health literacy, as it can minimize risk normalization, and understanding how information on risks and benefits interacts to influence risk perception.

Keywords: Sunlight exposure; normalization of risk perception; positive illusions; health literacy

1. Introduction

Every year people are told about the misdeeds of the sun and about the care they must take during exposure to sunlight. Furthermore, with global warming ultraviolet rays (UV) have changed, posing more serious problems to the human skin[1]. The longer one is under the sun, the greater is the damage on human skin and the risk to develop skin cancer[2]. Thus, efforts have increasingly been made to ensure that information on sunlight exposure risk reach the entire population. Although campaigns appear to have been effective in informing people about the risks of sunlight exposure, behaviors do not seem to have changed[4,5]. There is evidence that individuals have risky behaviors despite their awareness of sunlight exposure risk[6]. As such, this study explores the possible occurrence of a process of risk perception normalization of sunlight exposure.

On the opposite, there is also data suggesting that people might not be exposing themselves enough to sun. For instance, although Portugal is a country with lots of sunshine and great sunlight exposure, many people do not expose the daily time sufficient to maintain optimal levels of Vitamin D. A recent study illustrated that 23% of a sample that was studied had vitamin D deficiency insufficiency in summer, and 74% in winter[7]. Therefore, as moderated exposure to sunlight has also benefits for human health, in this study we also explored the role of knowledge of benefits of sunlight exposure.

1.1 Exposure to sunlight

The sun both dangerous and essential to human life. The sunlight is composed of rays with varying wavelengths

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and energy. A part of the sun's rays is retained by the ozone layer, but UV (UVA and UVB) are not and act on the skin. Ultraviolet radiation is the major environmental factor affecting the function and structure of the human skin[8]. In accordance with the World Health Organization, human exposure to solar UV has important public health implications[8]. Evidence of harm associated with overexposure has been demonstrated in many studies, particularly of skin cancer and malignant melanoma. The rise in the incidence of skin cancers over the past decades is strongly related to outdoor activities and recreational exposure. Overexposure to sunlight is widely accepted as the underlying cause for harmful effects on the skin, eye and immune system. Experts believe that four out of five cases of skin cancer could be prevented, as UV damage is mostly avoidable[9].

Excessive sunlight exposure is a major cause of skin lesions, leading to premature aging and skin cancer[7]. According to De Gruijl[4], the habits of light skinned individuals in developed countries in the search for the sun have contributed to the increase in skin cancer observed over the last century, being the most common type of cancer in the USA and in Australia[8]. In Sweden, skin cancer is also the type of cancer that is increasing most rapidly[6]. In Portugal, there are about twelve thousand new cases of skin cancer per year[10]. Thus, it is recommended that individuals should avoid direct sunlight, especially between 11 am and 5 pm. Nevertheless, it is common to see many people on the beach during these hours. Therefore, it is necessary to understand how individuals might be dealing with the risk of sunlight exposure during these hours. Furthermore, during exposure to sunlight, that should happen at the recommended hours, individuals should be hydrated by drinking lots of water and avoiding sugar drinks; protect against heat and always search for shadowing and fresh places when outdooring; use light clothing, if possibly made of cotton, use hats and sunglasses; use sunscreen with protection factor 30 or higher, reapplying every two hours[11].

On the other hand, the World Health Organization also recommends a moderate degree of UV exposure, necessary to produce Vitamin D which is essential for the health of the bones[9]. In the medical community, vitamin D is gaining a lot of interest since it can help to reduce the risk of developing cardiovascular disease and increase levels of wound healing[12]. It is also essential because it releases serotonin - a neurotransmitter acting inside the brain which regulates sleep, mood, sensitivity to pain, body temperature and other things – which is very important to keep a good mental health[2].

Thus, public health policy on ultraviolet radiation needs to aim at preventing the disease burden associated both with excessive and with insufficient UV exposure. Achieving the balance between overexposure and insufficient exposure might be a challenge. Indeed, studies illustrate that Americans have been recommended to reduce their sunlight exposure, based on the worries that this exposure will promote the appearance of skin cancer but, simultaneously, there has been an increasing number of individuals suffering from vitamin D deficiencies, which brings enormous health problems[13]. As such, in addition to understanding how individuals deal with knowing the risks of sunlight exposure, this research aims to contribute to the discussion on how individuals might integrate the benefits of sunlight exposure in their risk perception.

1.2 Risk perception normalization

Risk perception is associated with qualitative aspects such as the voluntariness of exposure, the immediacy of the effects, the nature of the devastation that can cause, and the degree of knowledge about the risks[14]. However, the relation between knowledge and risk perception is not straightforward. Although many studies have found that knowledge about risks directly influence the assessments people make about risks, with higher knowledge relating to higher risk, this is not always the case[15-17]. When people continuously experience and have more knowledge of a risk, they can, paradoxically, normalize or minimize their perception of risk, as a way to psychologically cope with the threat posed by risk. Risk normalization is particularly likely when individuals voluntarily expose themselves to threats[18] and when the effects of risks are not immediate[19].

This study explores if this might be the case for the risk of sunlight exposure. Considering the amount of information that is available about the dangers of excessive sunlight exposure, knowledge about their harm and protective behaviors might have become commonplace. Therefore, people might know the risks of direct sunlight

exposure at unrecommended hours but find a way to deal with it, such as using complementary protective measures (e.g., sunscreen). This effect might be stronger for people who perceive voluntary exposure to the sun and who perceive that the health consequences of exposure might only appear later in time.

1.2.1. Positive illusions

Taylor[20] developed the Theory of Cognitive Adaptation, after studying several patients with cancer, heart diseases among others, that is people whose lives were threatened and evidencing how the human mind had the ability to successfully overcome several tragedies of life. Very often people tend to use their individual resources and social networks instead of seeking professional help. This theory suggests that individuals develop cognitive illusions - or positive illusions - to deal with some sort of threat[17]. It also suggests that individuals respond with cognitively adaptive efforts when they experience personal tragedies or setbacks, and it may provide them to return to or exceed their previous level of psychological functioning.

Positive illusions are psychological coping strategies that people use to deal with risks and gain control over environmental, health, or social hazards. These illusions may have an adaptive role in mental health and well-being of individuals, but they are not necessarily functional, as the hazards are not changed. One example is how people that live in areas with high coastal risk have lower risk perceptions because they rely on the current coastal protective measures, that are without any doubt insufficient[15].

If individuals know about the risk and want to keep exposing themselves to hazardous sunlight hours, a way to psychologically cope with this threat might be by using positive illusions. In particular, they can rely on the use of protective measures as a positive illusion. These measures (such as sunscreen and light clothing) function as protective measures at the recommended hours of sunlight exposure. It is important to emphasize once again that people should not directly expose themselves between 11 am and 5 pm, as it is recommended.

1.3 Heath Literacy

The term health literacy was first used in the health education context over forty years ago. Nowadays, health literacy represents the set of cognitive and social skills which determine the motivation and ability of individuals to access, comprehend and use information in ways which promote and maintain good health[21]. Health literacy builds on the idea that both health and literacy are critical resources for everyday living. The level of literacy directly affects our ability to not only act on health information but also to take more control of one's health within his social context.

In this study we analyzed if health literacy could moderate the effect of risk normalization. In concrete, we expected that for individuals with higher health literacy, higher information on sunlight risk exposure did not lead to lower risk perception.

1.4 Objective and hypothesis

The main goal of this study was to understand how people deal with the risk of exposing themselves to direct sunlight exposure during hazardous hours. In particular, we tested if a process of risk normalization could be taking place. Between 11 am and 5 pm people direct sunlight exposure should be avoided[11]. In this study, we considered a stricter time period that includes the most hazardous hours: between 12 am and 3 pm.

This work is comprised by two studies: a pilot study to explore positive illusions that people might use to deal with the risk of sunlight exposure, and a main survey study to test the risk normalization effect and possible moderators. The hypotheses were based on risk perception normalization studies. We expected to find:

H_1: A negative relationship between the knowledge of risk associated with direct sunlight exposure and the perception of risk (risk normalization effect) when individuals rely on positive illusions;

H_2: A moderation effect of voluntariness of exposure to risk of sunlight exposure on the risk normalization effect;

H_3: A moderation effect of the late consequences of sunlight exposure on the risk normalization effect;

H_4: A moderation effect of health literacy on the risk normalization effect.

In addition, a secondary goal of this study was to tap the role of knowledge on benefits. For that purpose, we

explored if risk perception of exposure to sunlight could be explained by both knowledge on the risks and benefits of sunlight exposure.

2. Pilot Study

Hours	Risk perception (Mean; 1-7)	Reasons for risk perception	Percentage
Between 12 am and 3 pm	3.0	Protection measures (e.g., sunscreen, drinking water)	22.73%
Not between 12 am and 3 pm	2.2	The sun is not strong	20.45%
Not between 12 am and 3 pm	2.8	It is not too hot	18.18%
Not between 12 am and 3 pm	2.75	Sunlight exposure before 12 am and after 3 pm is not bad for the skin	15.91%

Table 1. Results of the pilot study on sunlight exposure habits and reasons.

The goal of the pilot study was to explore if people could be using protective measures as positive illusions to deal with the threat of sunlight exposure during hazardous hours. The study was conducted online (N = 44). Participants were asked to indicate the hours they directly exposed themselves to sunlight at the beach / pool / river and asked to rate how dangerous it was, on a scale of 1 (not dangerous) to 7 (very dangerous) in terms of possible negative impacts on their health. To know which positive illusions individuals might be using, participants were asked to indicate up to three reasons to justify the previous response.

As can be seen in Table 1, 22.73% of respondents exposed themselves to sunlight between 12 am and 3 pm. The reasons that they mentioned related to the use of protective measures. As for the other individuals, that constituted the majority of the respondents, their responses were related to the harmless characteristics of the sun during the hours that they exposed and to not exposing themselves during the hazardous hours. It should also be noted that the individuals that exposed themselves to sun between 12 am and 3 pm had low risk perceptions. The average of responses related to the risk of their sunlight exposure is below the midpoint of the scale and it is only slightly higher that the individuals that did not exposed themselves to sunlight between 12 am and 3 pm.

3. Main study

3.1 Method

3.1.1 Participants

This study has a sample of 276 participants, collected through a convenience and snowball sampling. Most of the participants are female (66.2%) and participants are aged from 18 to 70 years (M = 31.03, SD = 11.28). Most are from coastal zones (66.4%) and had a graduation (42.7%).

3.2.2 Procedure and measures

Knowledge, risk perception, protection behaviors, sunlight exposure hours and other information were collected in a questionnaire administered via the internet.

Knowledge. Objective knowledge consists of 2 questions with response scales ranging from 1 (certainly false) to 5 (certainly true). One question regards knowledge on risk, particularly on the frequency of skin cancer in Portugal. The other regards knowledge on sunlight exposure benefits through vitamin D. These measures are considered adequate as previous studies indicate that these categories of knowledge are highly relevant. In particular, individuals tend to identify skin cancer as the most common negative effect of sunlight exposure, and to identify vitamin D as the most benefic thing we take from this exposure[3].

Risk perception. We focused on personal health risk perception, which was measured by two items on a scale

ranging between 1 (very low) and 7 (very high), assessing the risks of sunlight exposure to health and the likelihood of occurrence of health problems (Spearman-Brown = .67). Regarding the moderator variables, voluntariness of exposure and mediation in time of the consequences, we followed on the psychometric approach[14]. The questions ranged from 1(involuntarily / immediate) to 7 (voluntarily / late).

Protective behaviors. In a scale from 1 (never) to 7 (always), individuals were asked to identify what types of protection they use when they were exposed to sunlight: use of sunscreen with protection factor 30 or higher; applying protector every 2 hours; drinking plenty of water throughout the day; wearing light and light clothes on hot days; wearing hats and sunglasses on hot days; protecting yourself in the shade of the parasol (Cronbach's $\alpha = .68$). These protection measures were retrieved from the general recommendations from General Directorate of Health[11].

Sunlight exposure hours. Participants were asked to indicate the hours they usually go to the beach (e.g., 8 am - 9 am; 10 am - 11 am, etc.).

Health literacy. The reduced scale of the HLS-EU-Q16 instrument was used[22]. It consists of sixteen questions that are divided into three major groups: health care (e.g., "... find information on treatments of illnesses that concern you?"), disease prevention (e.g., "... why do you need health screenings?") and health promotion (e.g., "... understand information in the media on how to get healthier?")[21]. The questions were retrieved from a validated health literacy scale for the Portuguese population[23]. A composite variable was created through this scale (Cronbach's $\alpha = 0.91$).

3.1 Results

3.1.1 Descriptive analyses

The mean values of the variables of the study are presented in Table 2. Individuals mean knowledge of risk and benefit was at the midpoint of the scale, suggesting uncertainty in their responses. Individuals considered that the health impact of sunlight exposure was moderately elevated, had high health literacy, and reported frequent protective behaviors. In addition, individuals believed that at the beach people voluntarily expose themselves to the sunlight and that the effects of sunlight exposure occur later in time.

Variables	Mean	Standard Deviation
Knowledge of risks	2.85	1.09
Knowledge of benefits	3.23	1.13
Risk perception	5.82	1.02
Health literacy	3.04	0.43
Protective behaviors	5.08	1.02
Voluntary exposure	5.41	1.36
Late consequences	5.20	1.46

Table 2. Descriptive statistics of the variables. Note: The knowledge variables range between 1 and 5, the health literacy between 1 and 4, all others between 1 and 7.

3.1.2 Hypothesis testing

We expected to find a negative relation between the knowledge about the risk of sunlight exposure and the perception of risk (risk normalization process) when individuals use positive illusions to cope with the threat of sunlight exposure (H_1). As such, and in accordance with the pilot test results, we expected to find this process in the individuals that a) go to the beach between 12 am and 3 pm and b) report an above the average use of protective measures. Therefore, we run the analyses in the sample of this individuals ($n = 41$). H_1 was corroborated. The association between knowledge of risk and risk perception is negative, $r =. -.44$, $p = .004$.

Furthermore, in the group of individuals that a) did not expose themselves to sunlight between 12 am and 3 pm but b) also reported using above the average protective measures ($n = 74$), the process of normalization did not emerge. In this case, the relationship between the knowledge of risks and risk perception was non-significant, $r =-.16$, $p > .050$.

We expected the risk normalization effect to be moderated by three variables. The perception of voluntary

exposure to risk was expected to enhance the negative relation between knowledge of risks and risk perception (H_2). However, this hypothesis was not corroborated. No moderation effect emerged.

Late mediation in time was also hypothesized to enhance the negative relation between knowledge of risks and risk perception (H_3). However, this hypothesis was also not corroborated.

Lastly, health literacy was expected to decrease the negative relation between knowledge of risks and risk perception (H_4). This hypothesis was corroborated. A model including knowledge of risk, health literacy, and an interaction member explains 28% of the variation of health risk perception ($F(3,37) = 4.91$, $p = .006$). The interaction effect is marginally significant ($t(40) = 1.95$, $p = .059$). Simple slope analyses showed that the effect emerged when health literacy was one standard deviation above average ($b = -.65$, $t = -3.68$, $p < .001$) and it did not emerge when it was one standard deviation above average ($b = -.06$, $t = -0.26$, $p > .050$), as illustrated in **Figure 1.** In other words, as health literacy increases, diminishes the strength of the negative relation between risk knowledge and risk perception. As such, health literacy appears to minimize the process of risk normalization.

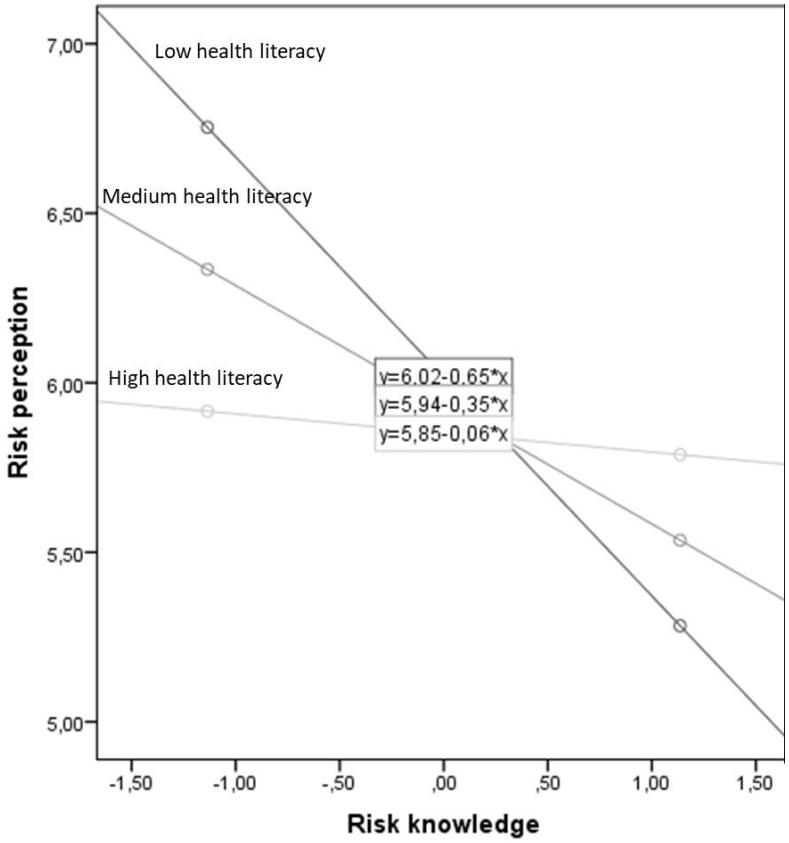

Figure 1. Moderation effect of health literacy on the relation between risk knowledge and risk perception.

Variables	B	SE B	β
Risk knowledge	-0.37	0.13	-.41**
Benefit knowledge	0.24	0.13	.26+
$R^2 = .26$; $F(2;38) = 6.63$, $p = .003$			

Table 3. Multiple regression analysis predicting personal risk perception. Note: Knowledge measures ranges from 1 to 5. ** $p < .010$, $^{+}$ $p = .76$.

A multiple regression analysis was also conducted to understand if knowledge on risk and on benefit are simultaneously related to risk perception of exposure to sunlight. Results are illustrated in Table 3. Risk perception is both related to knowledge on risk, negatively, and on benefit, positively. It is more significantly and more strongly related to knowledge on risk than on benefits.

4. Discussion

This study intends to understand if there is a process of risk normalization in individuals who expose themselves to the sun on the beach, during 12 am and 3 pm, a timing that is within the hazardous period that is unrecommended by health experts. The hypotheses on this study were based on risk perception normalization and on how positive illusions (in concrete the adoption of protective behaviors) account for it. As expected, results illustrate that a negative association between knowledge of risk and risk perception emerged when individuals exposed themselves to sunlight and used protective measures above the average, suggesting the protective behaviors allowed individuals to lower their risk perception. Of importance, protective measures, such as applying sunscreen and drinking water, allow to reduce risk but do not make individuals immune to it, especially during exposition between 12 am and 3 pm.

We expected that perceived voluntary exposure to sunlight would enhance the relationship between knowledge of risks and the perception of risk, since normalization is more likely when individuals voluntarily exposes themselves to threats. The effect was not found in this study. It might be the case that this variable would amplify this effect when we are considering exposure to sunlight in different scenarios, such as recreational and work. In this study participants were only asked to focus on their experience of direct exposure to sunlight on the beach, and this is something people usually always do voluntarily. We further expected that the late consequences in time of sunlight exposure would enhance the relationship between knowledge of risks and the perception of risk, however it did not moderate risk normalization. Although we were focusing in long term problems related to sun exposure, there are other problems that are immediate, such as sunburns, and might remember people of the risk they are facing.

Health literacy decreased risk normalization. Risk normalization was more likely when people had lower health literacy. In line with the health literacy literature, people with higher health literacy that expose themselves to sunlight at hazardous hours appear to be more realistic about the risk they are taking, even when using protective measures, than people with lower health literacy. As such, the promotion of health literacy can be away of decreasing the risk normalization of sunlight exposure.

A secondary goal of this work was to understand how knowledge of risks and benefits could simultaneously relate to risk perception. Data analysis suggests that, in the sample of people that expose themselves to the sun in hazardous hours and use above the average protective measures, risk perception is related to both, although in opposite and counterintuitive directions. One would expect the association between benefit knowledge and risk to be negative: higher benefit knowledge should relate to lower, not higher, risk perception. We believe this result might be related with the complexity associated to the risks and benefits of sunlight exposure and to the way these have been communicated to the public. We have browsed the subject of sunlight exposure in the websites of some of the relevant health organizations: World Health Organization, European Commission, and Portuguese General Directorate of Health. We found only one reference to the benefits of sunlight exposure (on the World Health Organization website, in the frequently asked questions), and numerous reference to the risks. So, it is likely that people knew about benefits "collaterally" and might have associated them to the much more discussed risks. It is also important to note that the psychological origins of the intention to be exposed to the sun (and its benefits) and of the intention to protect oneself from the sun might be different[24].

There is evidence suggesting that the current public health messages regarding sunlight exposure and vitamin D is causing confusion in the population[25]. Public health messages on sunlight exposure need to be designed for a better understanding. Nowadays individuals have to deal with the availability of high amounts of information and it might be complicated to weight it. It is essential that efforts are made to reduce the distance between risk and benefit communication in order to reverse the likely trend of increased cases of both skin cancer and vitamin D insufficiency.

4.1 Study limitations

The present study reveals some methodological limitations that must be provided in future studies. This study is correlational. Therefore, it is more difficult establishing causal relationships between variables. Nonetheless,

relationships between variables that emerged in the study are supported by a substantial set of research on risk perception[6,15-17]. Furthermore, the knowledge measures were single items, and this might difficult capturing different aspects of knowledge towards risks and benefits of sunlight exposure. Future studies could benefit from a) covering a large sample size in order to find effects of smaller size, b) understanding better the differences and associations between knowledge of risks and benefits, c) experimenting on both reducing exposure and vulnerability to risk and promoting the benefits of sunlight exposure.

Author Contributions

Gabriela Gaspar was responsible for designing the study, collecting and analysing the data and writing. Sílvia Luís was responsible for supervising the study and collaborated in writing.

Conflict of Interest

No conflict of interest was reported by the authors.

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