

Systematic Review of Interventions to Increase Awareness of Ultraviolet Radiation-Induced Harm and Protective Behaviors in Post-Secondary School Adults



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Abstract

College and university students are a group known for excessive sun exposure and indoor tanning. Health education campaigns for avoidance of ultraviolet (UV) radiation have been relatively unsuccessful in this population. This systematic review examines interventions aimed at post-secondary school young adults on college and university campuses for skin cancer awareness, photoprotection, and change in UV-exposure-related behavior. Fifty-nine studies were identified for inclusion according to predetermined criteria. Study heterogeneity was high; methods of intervention were individual or group-based, and were mostly visually delivered and/or passive learning. Most interventions occurred at a single time point. Intervention success was assessed by evaluating subject behavior, intention, attitudes, knowledge, and emotion. Multicomponent interventions, generally consisting of UV photography and a passively delivered educational component, may be more effective than a single component alone. Overall, study quality was poor. Sample size of the majority of studies was <150 subjects. Most studies used self-report of behavior and had a short follow-up time. Generalizability of findings may be impacted as women, particularly white/Caucasian women, were overrepresented in the studies identified by this systematic review. For this specific target population, themes arising from the review include the importance of self-relevance and message framing. Self-affirmation was identified as a potential challenge in designing interventions for this target group, which can lead to defensiveness and a negative reaction to the health message. The findings of this systematic review may inform future research in this field, as well as guide planning of effective interventions in this target population.

Keywords

systematic review, sunburn, public health, health behavior, education, students, photoprotection, sun safety, college, university, skin cancer, sun avoidance

Introduction

Skin cancer is rising globally. In Canada, cutaneous basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), collectively known as nonmelanoma skin cancers or keratinocyte carcinomas, represent 30% of all new cancer cases.¹ Melanoma is currently the eighth most common cancer in Canada, and is the only one ranked where both incidence and mortality rates are increasing.² While risk for BCC, SCC, or melanoma may differ based on the patterns of ultraviolet (UV) radiation exposure,³ UV light is a known carcinogen⁴ that is a risk factor for all 3 skin cancers. Lifetime sunburn exposure is a risk factor for development of melanoma.⁵ College and university students are known for unhealthy behaviors, including smoking, risky drinking, poor nutrition

and physical activity, and a lack of sun-protective behavior.⁶ Despite health education campaigns, this population has been unaffected by interventions aimed at decreasing UV exposure such as covering up with clothing or use of

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sunscreen⁷; some studies have even shown increased intention to indoor tan post-intervention.^{8,9} There is a known disconnect between health literacy and sun-protective behaviors in this specific age group—one American study showed that while higher health literacy was associated with lower levels of intentional tanning, it was also linked to higher incidental UV exposure and lower skin protection.¹⁰ This systematic review examines interventions to change UV-related behavior of young adults (18, 30 years old) or post-secondary school young adults on college and university campuses. This work was conducted to describe knowledge gaps and inform the planning of interventions to increase awareness of UV-induced harm, and decrease tanning behavior in this population.

Methods

This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) and documented in a protocol registered with PROSPERO (CRD42020152358).¹¹

Search Strategy

The initial search was developed in conjunction with a health sciences librarian. MEDLINE, EMBASE, PsycINFO, CINAHL, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science were searched for articles published from January 1, 1990 to July 6, 2019, using a combination of search terms including sun safety, or photo protection, or sun avoidance, or skin protection, or skin cancer, or carcinoma, melanoma, or skin care, or skin tumour, or dermatology, AND young adult, or post-secondary, or university, or college, AND health education, or school intervention, or lifestyle modification, or health behaviour, or health behaviour, or risk reduction. The search strategy for MEDLINE is presented in Supplemental Material.

Eligibility Criteria

Retrieved English-language publications were initially screened for relevance by title and abstract. Inclusion and exclusion criteria were specified prior to the literature search. Studies evaluating interventions aimed at educating and modifying health behaviors related to sun safety and skin cancer prevention in young adults (18, 30 years) or post-secondary students were considered for inclusion. More specifically, studies were considered eligible if they involved an intervention, either in isolation or in comparison to another intervention or control group, that implements a pre- and posttest design. To maintain an adequate number of studies in the systematic review, studies were not required to be randomized controlled trials (RCTs). In addition, studies were considered for inclusion if they reported outcomes related to

best practices, evidence, and promising practices that have been or could be effective in raising awareness and changing health behaviors among post-secondary school young adult populations on college and university campuses, knowledge levels, perceptions, or behaviors related to sun safety and skin cancer prevention (eg, sun protection intentions, UV exposure intentions, sun-protective behaviors). Cross-sectional studies, case reports, editorials, news and letter, opinion pieces, systematic reviews, narrative reviews, or studies published in languages other than English were excluded.

Study Selection and Data Extraction

Details of the data collection process are presented in Table 1. Two reviewers (DA and MM) independently screened all relevant titles and abstracts for eligibility. Full-text articles were obtained for abstracts identified by both reviewers as potentially relevant. Eligibility assessment of full-text articles was performed independently by 2 reviewers (DA and MM or CX and YA). Data extraction was performed by CX using a form developed a priori. Accuracy of the data was checked by YA. The data extraction form was piloted prior to use and refined accordingly. Disagreement related to the extracted data was resolved through discussion and consensus between the reviewers. The data characteristics extracted from each included study is presented in Table 1.

Quality Assessment

Two authors (CX and YA) independently assessed the risk of bias using 3 tools. The Cochrane Collaboration Risk of Bias tool (RoB) was used to assess randomized trials. The Risk Of Bias In Nonrandomized Studies—of Interventions (ROBINS-I) assessment tool was used for quality assessment for nonrandomized studies that contain at least 1 comparison or a control group. The Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group from the National Institutes of Health (NIH)-National Heart, Lung and Blood Institute was used for pretest and posttest studies.

Results

The PRISMA flow chart is shown in Figure 1. Fifty-nine articles met the full-text inclusion criteria; 44 studies were RCTs, and the remaining were quasi-experimental (manipulation of an independent variable without randomization): 4 were nonrandomized studies with at least 1 comparison or a control group, 8 were pre- and posttest design, and 3 were posttest design. Two citations^{12,13} were the same study with separate publications, with the same sample size and demographic characteristics. The majority of studies were quantitative. There was a large amount of study heterogeneity, in

Table 1. Methods—Data Collection Process.

Steps	Tools	Guided by	Completed by
Title and Abstract Screening	Covidence	The title and abstract must (1) appear to be describing an intervention related to sun safety or skin cancer prevention and (2) be studying young adults or post-secondary students.	DA MM YA (tie breaker)
Full-text Screening	Covidence	The full article must (1) describe a pretest and posttest study design, controlled trial, or randomized controlled trial, (2) implement an intervention related to sun safety or skin cancer prevention, (3) include young adults (18, 30 years) or post-secondary students, (4) be published in English, and (5) be published after 1990.	Early on: DA MM YA (tie breaker) Later on: CX YA CR (tie breaker)
Data Extraction	Excel	Extracted data: Corresponding author name, email, institution, year of publication, country of origin, funding source, study setting and population, recruitment methods, study design, sample size, female sex (%), mean age (SD), dominant race (%), intervention description and duration, length of follow-up(s), type of measures, significance between group characteristics at baseline, aims, and corresponding outcomes.	CX YA
Quality Assessment	Excel	Three assessment tools: 1. The Cochrane Collaboration Risk of Bias tool (RoB). ¹¹⁶ 2. The Risk Of Bias in Nonrandomized Studies—of Interventions (ROBINS-I). ¹¹⁷ 3. The Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group from the National Institutes of Health (NIH)-National Heart, Lung and Blood Institute. ¹¹⁸	CX YA CR (tie breaker)

study type, recruitment, intervention, duration of intervention, assessment of intervention, as well as follow-up assessment and duration. The data extraction table including population characteristics can be found in Supplementary Material 2. Study populations skewed toward female and the majority occurred on campus or were recruited from campus. The mean age reported in the studies ranged from 17 to 25.

Populations

While some studies targeted anyone within the age group or anyone in the location of interest (campus/college), other studies targeted specific groups for recruitment as a study parameter. Women, specifically white/Caucasian young women, were the most targeted group—27 of 59 studies only targeted women, and 9 specifically targeted white/Caucasian women. Twenty-two additional studies had a population that had a majority of women as subjects (>50%). Only 1 study specifically targeted college men.¹⁴ Studies did not appear to differentiate biological sex versus gender.

Regional and ethnic differences are likely important due to behavioral and biological differences, but there is a paucity of data in this area. Fifteen of 59 studies did not report the race or ethnicity of the population. Two studies were

conducted in the Middle East^{15,16} and 1 in China.¹⁷ Even within a country there may be regional variation; comparison of American university students subjected to a 10-minute videotaped slide show and a UV photo found that compared to the California site, the Iowa site had higher tanning booth use, intentional sunbathing, and risky sun behavior at baseline and follow-up.¹⁷

Interventions

Most interventions occurred at a single time point (40/59 studies) and fell into 2 main groups: visual and passive learning, and could be given individually or group-based.

Most visual-based interventions used an interactive visual interface to educate individuals about risks of UV radiation. These included photoaging software¹⁸ or apps¹⁹ that result in photoaging of a self-portrait of the subject (ie, a selfie), UV photos,^{17,20–26} or a side-by-side comparison of photoaged and non-photoaged photographs of themselves or others.^{27,28} This type of intervention was used in 24 studies identified.

Studies where the subjects were given pamphlets, oral, video, website, or poster information with no interactive component were considered passive learning interventions. Studies mainly used text messages,²⁹ short (15 minutes) to

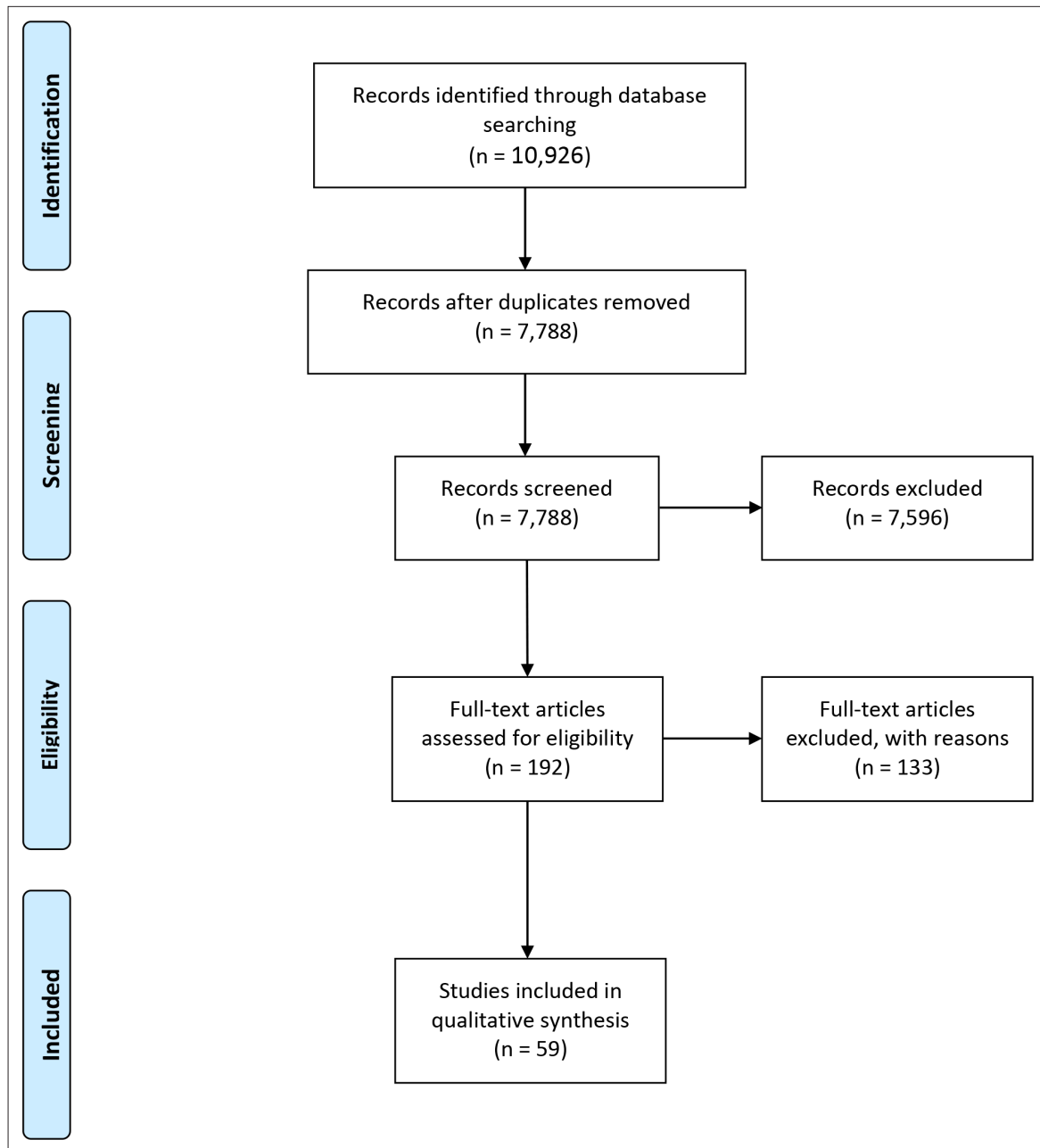


Figure 1. PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Review and Meta-Analyses.

long (45 minutes) presentations, either in group or individual format. Many studies used passive interventions as the control intervention—generally pamphlets or websites from national dermatology or skin cancer organizations. Some studies used photographs and information posters posted in communal areas used by the population.¹⁶ This type of intervention was used in 27 studies identified.

A smaller number of studies had additional types of interventions available. Three studies made sunscreen samples or sunless tanners available to participants as part of the intervention or incentive or reward for participation.^{21,30,31} Introspective interventions included a workbook on sun

protection^{32–35} or behavior tracking (similar to a diary),²⁹ a self-assessment of risk³⁶ or web-based, interactive indoor-tanning intervention.^{12,13,37}

Cognitive-behavioral interaction in a small groups of 4-6 people, with rewards (eg, gift certificates for the participant who could name the most famous and attractive people who were not tanned), was conducted in 1 study,³⁸ and motivational interviews were also used in some studies.^{39,40} Dissonance induction was used in 1 study: under deception, participants were advised they were providing input for an intervention for appearance beliefs and attitudes of

adolescent females. They were required to role-play to convince someone to avoid pursuing tanning.⁴¹

Many studies had multiple interventions, or interventions that were a combinations of methods, for example passive learning plus a visual-based intervention,²⁶ or sunless tanner and a visual-based intervention,²¹ and cognitive behavioral interaction with personal UV imaging.³⁸ While multiple-component interventions—generally of UV photography combined with educational information—were commonly found to work better than 1 component alone,^{17,20,22,25,42} these results were not consistent.³⁹

Message Delivery: Framing, Self-Relevance, Self-Affirmation, Self-Efficacy

Method of delivery of information within the intervention was a feature in several studies. Messaging was evaluated in 23 studies; narrative messaging generally employed a story, often about a peer who had a skin cancer related to UV radiation, while statistical messaging used facts and figures to convey information. Framing the message as a gain or a loss was also a key feature of interventions. Loss-framed warnings (eg, UV radiation causes skin cancer) were evaluated compared to gain-framed warnings (eg, protecting yourself from UV radiation leads to healthy skin) in some studies.^{8,43} Messaging can be conveyed in written or spoken text, or a visual format such as images of tumors or postoperative pictures. Some interventions deliberately incite thoughts of mortality, such as the “terror management health model,” where individuals were shown an image of a woman sunbathing on the beach surrounded by individuals that looked as if they were attending her funeral.⁴⁴

Self-relevance, where a subject feels an idea is about or affects them personally, was also investigated in several studies. Self-relevant interventions are evident in UV photo selfies and facial morphing software,^{18,19,26,27,45,46} but images of aspirational peers, such as fashion models or celebrities,^{47,48} social comparison with peers with very little sun damage and high rates of sun protection,^{23,25} and narrative examples of individuals similar to the subject⁴⁹ are methods through which interventions can have self-relevance. Experiential information processing, where the individual was encouraged to reflect on their feelings and previous experiences related to the narrative message about skin cancer,⁵⁰ as well as listening to other college students discuss sun protection trends²² are also ways to increase self-relevance of interventions. Self-relevance is tied to threat appraisal—the perceived severity of the threat and perceived vulnerability of the individual.⁵¹

Studies also identified self-affirmation as a potential challenge in designing interventions. Self-affirmation is a theory in psychology on how individuals adapt to information or experiences that are threatening to their self-concept or self-integrity and is linked to defensiveness, denial, and avoidance.⁵²

Assessments

According to the Theory of Planned Behavior,⁵³ health behavior changes are predicted by intentions, which are in turn predicted by 3 factors: (1) attitude toward the behavior, (2) subjective norm, and (3) perceived behavioral control. Factors such as emotions and levels of knowledge and awareness significantly contribute to a person’s attitude/belief formation and decision-making process, ultimately influencing behavior changes.^{54–56} Using this framework, assessments of intervention efficacy typically fell in 5 domains: (1) Behavior, (2) Intention, (3) Attitudes/Beliefs/Perception, (4) Knowledge/Awareness, and (5) Emotion/Reaction.

Assessments of Behavior could be reported or observed, and included sunscreen use, indoor tanning, outdoor incidental and intentional sun exposure (including sunbathing), sun protection (clothing, hat, staying in shade), and other measures of sun protection tendencies, such as number of sample sunscreen packets taken by the subject.^{28,44} Most assessments in the Behavior domain were self-reported, because the majority of studies collected self-reported data, using surveys, questionnaires, interviews and phone calls.

Assessments falling into the Intention domain included intention to tan, intention to decrease or stop tanning, intention to use sunscreen, intention to avoid sun. These measured a subject’s determination to act in a certain way, but were not a measure of the act itself.

The Attitude/Beliefs/Perception domain investigated subject responses to questions regarding susceptibility, threat, severity, benefits, risk, barriers, self-efficacy, information avoidance or denial, and information acceptance. These types of assessments gauge a subject’s broad beliefs about sun or sun exposure behavior.

Assessments in the Knowledge/Awareness domain investigated the subject knowledge level and awareness of facts about sun exposure, usually concerning risks for skin cancer, or identification of skin cancer, or self-skin examination. The Emotion/Reaction domain assessments evaluated subject emotions or reactions, such as worry, fear, shock, concern, and boredom.

Most studies focused on Behavior ($N = 35$), Intention ($N = 46$) and Attitudes/Beliefs/Perception ($N = 43$), although some also focused on Emotion/Reaction ($N = 18$). Fewest studies investigated Knowledge/Awareness ($N = 9$). Older studies were more likely to focus on Knowledge alone,⁵⁷ likely because newer literature shows the disconnect between skin cancer knowledge and behaviors and intention^{58,59} in this population.

Choice of assessment tool was linked with the type of message used in the intervention. Emotion/Reactions were often linked with negative message framing. Self-efficacy, falling within the Attitude/Beliefs/Perception grouping, was a component of several studies, and also interacted with message framing. Self-efficacy refers to a person’s belief in his or her abilities to perform a given action and/or obtain a goal.⁶⁰ A Dutch study on skin self-examination found a loss-framed

message may be more effective than a gain-framed message, but only in individuals with high self-efficacy.⁶¹

Follow-Up Time

There is limited information on the long-term efficacy of any interventions in this target population. Follow-up time was categorized into immediate (evaluation occurred immediately after intervention), short-term (≤ 3 months), medium-term (≤ 6 months), and long-term (1 year). Twenty-three studies had an immediate evaluation, 27 had a short-term follow-up, 6 had medium-term follow-up, and only 2 articles had long-term follow-up (2 publications of the same study). One study did not report the length of follow-up time.⁶² Some interventions, such as facial morphing, showed a decrease in magnitude of effects at 1-month assessments compared to immediately after the intervention⁴⁵; data was lacking on the long-term efficacy of any intervention.

Risk of Bias and Quality Assessment

For RCTs, studies were evaluated on the following characteristics: method of randomization, allocation concealment, blinding to participants, research personnel and outcome assessors, selective outcome reporting, incomplete/missing outcome data, as well as other types of biases specific to each article. Many of these features were not reported, making ability to assess bias limited. Although study quality for many studies was poor, no RCTs were excluded from the review on the basis of the risk of bias. For quasi-experimental studies, some had no paired data for pre- and posttest data (only group data), and most did not report response rate to surveys or could not report this information due to opportunity or convenience sampling. Of the 4 studies assessed using the (ROBINS-I) tool, 3 were found to be at moderate risk of bias and 1 could not be assessed due to lack of information. Evaluation of the pre-post studies found none were of good quality, but 9 were of fair quality and 2 were of poor quality.

The majority of sample sizes of 59 studies are relatively small, with 50% falling under a size of 200; the largest sample size was of 1 study of 956 participants.

Discussion

The multiple issues involved in the development and evaluation of complex interventions⁶³ explain the considerable study heterogeneity identified in this and other smaller systematic reviews of this population.⁶⁴ Despite these challenges it is encouraging that multiple research groups are investigating how to target this population that has been recalcitrant to sun safety interventions.⁵⁹ This systematic review identified multiple methods and important

considerations to shape future research and choice of specific interventions for this population.

Previous work has found that education and policy approaches to increase sun-protective behaviors were effective for primary schools and in tourist or recreational settings; evidence regarding effectiveness in secondary schools and colleges was insufficient,⁶⁵ lending support for the necessity of our current work. Specific to college students, a previous systematic review focused on tanning behaviors, attitudes, beliefs, and intentions in college students supported that appearance is a factor in tanning behavior, as well as emotion, health perceptions, and the influence of parents, peers, and the media.⁶⁶ A systematic review and meta-analysis specifically investigating appearance-based interventions to reduce UV exposure found appearance-based intervention to be a significantly effective type of intervention,⁶⁷ and the update 5 years later found a moderate effect size for UV photography and photoaging information on meta-analysis;⁶⁸ the decrease in effect is likely due to studies that used an active control group that received baseline sun protection information rather than no education. McWhirter *et al* found in a systematic review of population-based studies that visual images specifically may be particularly effective in influencing attitudes and behaviors to UV radiation.⁶⁹ The themes of these previous related systematic reviews are paralleled in our results and a support for UV photography in combination with educational information was noted in our systematic review,^{26,70} although our work focused on the university/college population, and included a larger number of identified articles than the previous systematic review. Extensive study heterogeneity means it would be inappropriate to meta-analyze results for this systematic review.

The disconnect between behavior and attitudes toward UV radiation exposure and knowledge of skin cancer has been described,^{71,72} but is not fully understood. It has been suggested that the belief that a tan is attractive may be a part of the contradiction between knowledge and attitudes and behavior.⁷³ In those studies with control arms that had no intervention or a sham intervention unrelated to skin cancer, it is interesting to note that any intervention improved outcomes, whether it was passive reading, a lecture, or gain-framed messages.^{15,16,42,74}

Themes arising out of the studies in the review include the importance of self-relevance and message framing. In an era where individuals may be inundated with multiple and often conflicting preventative health messaging in the media, having a strong negative reaction to a photo relevant to one's own face may motivate a change in behavior. Loss-framed messages appear to decrease intention to indoor tan.^{8,42,43} However, framing may depend greatly on what specific message is being delivered and to whom—avoidance-oriented individuals may benefit more from loss-framed messages and approach-oriented individuals may benefit more from gain-framed messages.³¹ Narrative messages may be more powerful for promoting

preventive health behavior,⁷⁵ perhaps due to provocation of a feeling of realism,³⁶ and with a narrative message, subject identification with the exemplar was more likely to result in interaction with a loss-framed message.⁴⁹ Narrative messaging may be more effective due to self-relevance; the health message must be relevant to the target individual in order to resonate.

Self-relevance is key to reach this population through UV photos, facial morphing, images or experiences of peers or aspirational peers,^{22,25,47,48} experiential information processing,⁵⁰ or a peer-delivered motivational interview.⁴⁰ Self-relevance has also been important in other behavioral health interventions, such as a study of visual aging and smoking in women.⁷⁶ As one of the key reasons for tanning behavior identified is the idea of attractiveness being linked to a tanned appearance,⁷³ targeting the main motivation behind tanning behavior through appearance-based interventions can be helpful. Pictorial messages appear to be more effective than text-only messaging⁷⁷ and facial aging interventions appear more effective than literature alone.⁴⁶ Several qualitative studies identified that the self-relevant images showing UV damage or photoaging provoked a sensation of shock, fear, or unattractiveness, which then influenced intentions or attitudes toward suntanning behaviors.^{18,19,27} Interestingly, one study found one-third of subjects opted not to see their UV photograph; this was linked to greater perceived risk of sun damage particularly among those who reported infrequent sun protection behavior.²⁸ Negative emotions can be a powerful stimulus for behavior; expectation of negative emotions with failure to use sun protection was associated with self-reported sun protection intention and predicted sun protection use in follow-up.²⁶ Appearance-based interventions may be useful when combined with mortality information,⁴⁴ as self-relevance is tied to the perceived severity of the threat and perceived vulnerability of the individual,⁵¹ and perceived threat of skin cancer has been found to be greater for appearance-focused negatively framed messages.⁷⁸ This aspect of self-relevance is seen in other data: in a study of 68 patients with melanoma, 71% reported being informed about sun protection prior to their diagnosis, but did not feel they needed to adopt these measures prior to their diagnosis; a diagnosis of melanoma was the main motivating factor for their behavioral change.⁷⁹

However, concentration on negative framing can backfire; self-affirmation was found to increase intention to indoor tan in college students by producing a defensive reaction to the framed message.⁸ Reactance—a psychological concept where an unpleasant motivational state comes from an intervention that threatens behavioral freedom—has been identified as an issue in previous literature on tanning intention in young adults.⁹ Researchers in one study of university students specifically avoided instructing participants not to sunbathe, but instead concentrated on positively framed messages in a deliberate effort to avoid reactance.⁴⁸ Phrasing of messages in directive language (“should”) versus nondirective language (“could”) decreases reactance to sun safety messages.⁸⁰

Manipulation of self-affirmation may be used, for example, having subjects rank values (eg, appearance, creativity, sense of humor, relations with family and friends, and so on) prior to exposure to the sun protection message, and write about either the value they deemed most important, or the value they deemed least important.⁸¹ Photoaging messages may be subject to more defensiveness than skin cancer messages; the authors postulate that this is because the relationship between skin cancer and UV radiation is well known in the public domain, while the relationship between photoaging and UV radiation is less known and thus more easily denied.⁸¹

Subjects in the target population in the United States who were randomized to receive behavior tracking of their tanning activities for 14 days reported UV radiation exposure and more sun-protective behaviors when compared to those who received text messages about sun protection and skin cancer.²⁹ Another Australian study investigating text-delivered sexual health and sun protection messages found that the sun protection arm of the study had limited effectiveness.⁸² It is difficult to assess if the findings of the text-message studies are due to decreased self-relevance, or directive language, or self-affirmation, or a combination of these factors.

The variation in results of these studies is consistent with the research that shows that different types of indoor tanners may exist.^{32,35} The variation in study results on gain or loss framing may be influenced by self-efficacy: a loss-framed message regarding skin self-examination may be more effective than a gain-framed message, but only in individuals with high self-efficacy.⁶¹ Self-efficacy could also play a role in the healthy user bias—a type of selection bias where those individuals who agree to participate in medical research, or appropriately follow the experimental intervention are not representative of the general population as they tend to be healthier because they are more adherent to medical advice in general. Individuals who were randomized to a one-time exposure to their own UV photo did not appear to have any difference in subsequent sun protection behaviors compared to those who were randomized to multiple times, but those who had the option of viewing it more often than they were assigned engaged in more sun protection behaviors at follow-up 1 month later.²⁴ In addition to self-efficacy, response efficacy, or how well a recommended behavior works to prevent the threat may also be responsible for the varying results on health message framing. Individuals at the precontemplation or preintention phase for behavioral change react to different messaging compared to those at the contemplation or intention stage.^{51,83} Similarly, high threat messages are most effective if combined with high response efficacy messages.⁸⁴ In other words, interventions with high threats must also be paired with an action that can be taken by the subject to prevent the threat.

Provision of sunscreen can act as both an intervention, through facilitation of its use via increased availability for application and reapplication,³⁰ or be used as a subject compensation,³¹ token of appreciation,²¹ or a surrogate of intention to

avoid UV radiation.^{28,44} Only 1 study provided sunless tanner (topical dihydroxyacetone) as part of an intervention, and interestingly only 37% of those individuals provided with sunless tanner sample reported using it, but those who did use it had the lowest mean reported hours spent sunbathing, although this was not statistically significant.²¹ While sunscreen availability in the locker room increased sunscreen use by 1.13 days per week in an RCT of female college golf teams, it did not affect reapplication rates.³⁰ This may be because this study did not appear to include a knowledge-based component such as a presentation or pamphlet.

Knowledge Gaps and Generalizability

A major knowledge gap is the long-term efficacy of any of the interventions. It remains to be seen if the effects of any interventions are carried into adult life, and the impact, if any, on primary prevention of skin cancer. While the best study design would be to tie preventative interventions to the development of skin cancer rates, this type of study would be prohibitively long, given the lag time between carcinogen exposure and cancer development. Perception of susceptibility to and severity of skin cancer, as well as reduction of perceived barriers to sun exposure may not necessarily result in increased sun protection behavior in this target group.⁸⁵

The vast majority (53 studies) looked at intention or attitudes toward UV radiation, skin cancer and sun protection. Behavior, examined in only 34 studies, was generally measured by self-report, and thus may be subject to a social acceptability bias and recall bias.

There is an absence of assessments of occupational sun exposure in this age group—recreational and daily life appears to be the most studied area for this specific population. This is important as any interventions aimed at specific occupations rather than this age group or a campus population would have been excluded using the specified search strategy. College and university students may perform summer jobs or part-time jobs, which would result in high occupational exposure for UV radiation (painting, landscaping, construction, lifeguarding, ski instructor, as examples). The closest stand-in for occupational sun exposure would be studies targeting student athletes.^{30,62,86,87} A key component noted in a few studies is the inclusion of individuals in positions of authority or guidance in the intervention, such as trainers or coaches.^{62,86} Parental attitudes are known to shape child and adolescent attitudes toward sun protection.^{88,89}

The gender imbalance in many of the studies, either intentional or nonintentional, could be a potential issue with implementation of a campus sun safety program, as women, particularly white/Caucasian group, are overrepresented in the studies found in this systematic review. Although overall risk of melanoma is highest in men, melanoma is increasing among young adults, and the rates in this age group are greater in women than in men.^{90,91} Women seek more health information in general than men,⁹² and different genders have distinct

preferences for acquisition of health knowledge⁹³; these differences may not be adequately captured by the studies in this review given the predominance of women in the studies. Three of the 4 studies found in this review focusing on student athletes were specifically targeted toward female student athletes. Masculinity predicts low levels of sun protection behaviors^{94,95} and male young adults are less likely to perform skin self-examinations or receive professional skin examinations.^{96,97} Only 1 study specifically investigated college men, which found that UV photography may be effective in this group.¹⁴ No study specified inclusion of intersex or transgender individuals. Additionally, sexual minority males have a far greater rate of indoor tanning^{45,98,99} and may require specific targeted intervention. However, this gender-based knowledge gap may not be related to the specific research question in this report: current guidelines for preventive measures and screening for Canadian primary care providers for all age groups and genders is exactly the same.¹⁰⁰

UV radiation exposure and sun protection behaviors are associated with other high-risk behaviors: smoking and sunbed use have been associated in a Danish study.¹⁰¹ In a US study of indoor tanning among high school students, indoor tanning was associated with smoking, substance abuse, taking steroids without a physician's prescription, having sexual intercourse with 4 or more persons, suicide attempts, and unhealthy weight control practices.^{102,103} Some studies identified through this systematic review employed modalities previously used for smoking cessation⁷⁶ and eating disorders.⁴¹ As these maladaptive and unhealthy behaviors may be linked, and specific types of individuals may be participating in multiple risk behaviors, it may be of interest for further research to investigate tools used in these linked conditions for effective means of reaching the university and campus population.

The nature of the search strategy excluded some sun safety programs that are public health interventions aimed at all ages and populations. These were often targeted interventions for all individuals found in a specific area—usually places with heavy sun exposure—such as the beach,¹⁰⁴⁻¹⁰⁶ ski hill,^{107,108} swimming pools,¹⁰⁹⁻¹¹¹ or public spaces for day camps.^{112,113} It would not be uncommon to identify college or university students at these locations, but the studies targeted a range of individuals at various ages. While the search strategy in this review identified these studies during abstract review, the outcomes were not stratified by age, resulting in their exclusion for final inclusion. Additionally, an argument could be made that some interventions aimed at high school students may also be relevant to this specific group.¹¹⁴

Conclusion

There is little to no long-term data for effective interventions for sun safety in post-secondary school young adult populations on college and university campuses. Caution must be made with interpretation, given the predominance of studies on female

Caucasian subjects, the low study quality of most publications, the lack of hard outcomes, reliance on self-reported behavior and absence of longer follow-up, as well as study heterogeneity. Studies with control arms show that any intervention is better than no intervention, but the most commonly studied intervention is UV photo-based interventions. Appearance-based interventions, in combination with a negatively framed, high-threat, self-relevant message, may be helpful in this group, but careful attention must be paid to framing of the message for best impact. Delivery within a narrative message, with strong elements of self-efficacy and response efficacy, is key: a story about prevention of skin cancer shown in one's self or a similar peer, with information that is actionable may resonate with this group. It would be necessary to ensure the message is conveyed in a manner that would avoid defensiveness in the target audience. Many of these findings are echoed in a set of best practice guidelines from Australia for social marketing programs aimed at adolescent and young adults.¹¹⁵

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Supplemental Material

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References

1. Xie L, Semenciw R, Mery L. Cancer incidence in Canada: trends and projections (1983-2032). *Health Promot Chronic Dis Prev Can.* 2015;35(Supplement 1):2-186. doi:10.24095/hpcdp.35.S1.02
2. Canadian Cancer Society. *Snapshot of incidence, mortality and survival estimates by cancer type.* February 28, 2020 ed; 2020.

3. Savoye I, Olsen CM, Whiteman DC, et al. Patterns of ultraviolet radiation exposure and skin cancer risk: the E3N-SunExp study. *J Epidemiol.* 2018;28(1):27-33. doi:10.2188/jea.JE20160166
4. Arnold M, de Vries E, Whiteman DC, et al. Global burden of cutaneous melanoma attributable to ultraviolet radiation in 2012. *Int J Cancer.* 2018;143(6):1305-1314. doi:10.1002/ijc.31527
5. Dennis LK, Vanbeek MJ, Beane Freeman LE, Smith BJ, Dawson DV, Coughlin JA. Sunburns and risk of cutaneous melanoma: does age matter? A comprehensive meta-analysis. *Ann Epidemiol.* 2008;18(8):614-627. doi:10.1016/j.annepidem.2008.04.006
6. Bonevski B, Guillaumier A, Paul C, Walsh R. The vocational education setting for health promotion: a survey of students' health risk behaviours and preferences for help. *Health Promot J Austr.* 2013;24(3):185-191. doi:10.1071/HE13047
7. Koch S, Pettigrew S, Hollier LP, et al. Trends in Australian adolescents' sun-protection behaviours: implications for health campaigns. *Aust N Z J Public Health.* 2016;40(5):468-473. doi:10.1111/1753-6405.12561
8. Mays D, Zhao X. The influence of framed messages and self-affirmation on indoor tanning behavioral intentions in 18- to 30-year-old women. *Health Psychology.* 2016;35(2):123-130. doi:10.1037/hea0000253
9. Jones JL, Leary MR. Effects of appearance-based admonitions against sun exposure on tanning intentions in young adults. *Health Psychol.* 1994;13(1):86-90. doi:10.1037/0278-6133.13.1.86
10. Heckman CJ, Auerbach MV, Darlow S, Handorf EA, Raivitch S, Manne SL. Association of skin cancer risk and protective behaviors with health literacy among young adults in the USA. *Int J Behav Med.* 2019;26(4):372-379. doi:10.1007/s12529-019-09788-1
11. Research NifH. PROSPERO: International prospective register of systematic reviews. October 01, 2019. <https://www.crd.york.ac.uk/prospero/>
12. Heckman CJ, Handorf EA, Darlow SD, Ritterband LM, Manne SL. An online skin cancer risk-reduction intervention for young adults: mechanisms of effects. *Health Psychol.* 2017;36(3):215-225. doi:10.1037/hea0000420
13. Heckman CJ, Darlow SD, Ritterband LM, Handorf EA, Manne SL. Efficacy of an intervention to alter skin cancer risk behaviors in young adults. *Am J Prev Med.* 2016;51(1):1-11. doi:10.1016/j.amepre.2015.11.008
14. Walsh LA, Stock ML. UV photography, masculinity, and college men's sun protection cognitions. *J Behav Med.* 2012;35(4):431-442. doi:10.1007/s10865-011-9372-2
15. Zareipour MA, Mahmoodi H, Valizadeh R, Ghelichi Ghoghj M, Rezaie Moradali M, Zare F. Impact of an educational intervention based on the BASNEF model on skin cancer preventive behavior of college students. *Asian Pac J Cancer Prev.* 2018;19(10):2717-2722. doi:10.22034/APJCP.2018.19.10.2717

16. Erkin Özüm, Ardahan M, Temel AB. Effects of creating awareness through photographs and posters on skin self-examination in nursing students. *J Cancer Educ.* 2018;33(1):52-58. doi:10.1007/s13187-016-1037-y
17. Mahler HIM, Kulik JA, Gerrard M, Gibbons FX. Effects of photoaging information and UV photo on sun protection intentions and behaviours: a cross-regional comparison. *Psychol Health.* 2013;28(9):1009-1031. doi:10.1080/08870446.2013.777966
18. Williams AL, Grogan S, Buckley E, Clark-Carter D. A qualitative study examining women's experiences of an appearance-focussed facial-ageing sun protection intervention. *Body Image.* 2012;9(3):417-420. doi:10.1016/j.bodyim.2012.04.008
19. Brinker TJ, Schadendorf D, Klode J, et al. Photoaging mobile apps as a novel opportunity for melanoma prevention: pilot study. *JMIR Mhealth Uhealth.* 2017;5(7):e101. doi:10.2196/mhealth.8231
20. Mahler HIM, Kulik JA, Gibbons FX, Gerrard M, Harrell J. Effects of appearance-based interventions on sun protection intentions and self-reported behaviors. *Health Psychol.* 2003;22(2):199-209. doi:10.1037/0278-6133.22.2.199
21. Mahler HIM, Kulik JA, Harrell J, Correa A, Gibbons FX, Gerrard M. Effects of UV photographs, photoaging information, and use of sunless tanning lotion on sun protection behaviors. *Arch Dermatol.* 2005;141(3):373-380. doi:10.1001/archderm.141.3.373
22. Mahler HIM, Kulik JA, Butler HA, Gerrard M, Gibbons FX. Social norms information enhances the efficacy of an appearance-based sun protection intervention. *Soc Sci Med.* 2008;67(2):321-329. doi:10.1016/j.socscimed.2008.03.037
23. Mahler HIM, Kulik JA, Gerrard M, Gibbons FX. Effects of upward and downward social comparison information on the efficacy of an appearance-based sun protection intervention: a randomized, controlled experiment. *J Behav Med.* 2010;33(6):496-507. doi:10.1007/s10865-010-9279-3
24. Mahler HIM. Effects of multiple viewings of an ultraviolet photo on sun protection behaviors. *Public Health.* 2018;160:33-40. doi:10.1016/j.puhe.2018.03.023
25. Mahler HIM. The relative role of cognitive and emotional reactions in mediating the effects of a social comparison sun protection intervention. *Psychol Health.* 2018;33(2):235-257. doi:10.1080/08870446.2017.1310860
26. Mahler HIM. The role of emotions in UV protection intentions and behaviors. *Psychol Health Med.* 2014;19(3):344-354. doi:10.1080/13548506.2013.802359
27. Lo Presti L, Chang P, Taylor MF. Young Australian adults' reactions to viewing personalised UV photoaged photographs. *Australas Med J.* 2014;7(11):454-461. doi:10.4066/AMJ.2014.2253
28. Dwyer LA, Shepperd JA, Stock ML. Predicting avoidance of skin damage feedback among college students. *Ann Behav Med.* 2015;49(5):685-695. doi:10.1007/s12160-015-9703-6
29. Darlow S, Heckman C. Results from a tailored SMS and Behavior-tracking pilot study on Sun-Safe behaviors in young women. *Health Educ Behav.* 2017;44(6):937-944. doi:10.1177/1090198117699507
30. Dubas LE, Adams BB. Sunscreen use and availability among female collegiate athletes. *J Am Acad Dermatol.* 2012;67(5):876.e1-87876. doi:10.1016/j.jaad.2011.11.962
31. Hevey D, Dolan M. Approach/avoidance motivation, message framing and skin cancer prevention: a test of the congruency hypothesis. *J Health Psychol.* 2014;19(8):1003-1012. doi:10.1177/1359105313483154
32. Stapleton J, Turrisi R, Hillhouse J, Robinson JK, Abar B, et al. A comparison of the efficacy of an appearance-focused skin cancer intervention within indoor tanner subgroups identified by latent profile analysis. *J Behav Med.* 2010;33(3):181-190. doi:10.1007/s10865-009-9246-z
33. Hillhouse JJ, Turrisi R. Examination of the efficacy of an appearance-focused intervention to reduce UV exposure. *J Behav Med.* 2002;25(4):395-409. doi:10.1023/A:1015870516460
34. Hillhouse J, Turrisi R, Stapleton J, Robinson J. Effect of seasonal affective disorder and pathological tanning motives on efficacy of an appearance-focused intervention to prevent skin cancer. *Arch Dermatol.* 2010;146(5):485-491. doi:10.1001/archdermatol.2010.85
35. Abar BW, Turrisi R, Hillhouse J, Loken E, Stapleton J, Gunn H. Preventing skin cancer in college females: heterogeneous effects over time. *Health Psychol.* 2010;29(6):574-582. doi:10.1037/a0021236
36. Greene K, Brinn LS. Messages influencing college women's tanning bed use: statistical versus narrative evidence format and a self-assessment to increase perceived susceptibility. *J Health Commun.* 2003;8(5):443-461. doi:10.1080/713852118
37. Stapleton JL, Manne SL, Darabos K, et al. Randomized controlled trial of a web-based indoor tanning intervention: acceptability and preliminary outcomes. *Health Psychol.* 2015;34(Suppl):1278-1285. doi:10.1037/hea0000254
38. Roberts DC, Black D. Comparison of interventions to reduce sun exposure. *Behav Med.* 2009;35(2):67-78. doi:10.3200/BMED.35.2.67-78
39. Heckman CJ, Zhu F, Manne SL, et al. Process and outcomes of a skin protection intervention for young adults. *J Health Psychol.* 2013;18(4):561-573. doi:10.1177/1359105312449193
40. Turrisi R, Mastroleo NR, Stapleton J, Mallett K. A comparison of 2 brief intervention approaches to reduce indoor tanning behavior in young women who indoor tan very frequently. *Arch Dermatol.* 2008;144(11):1521-1524. doi:10.1001/archderm.144.11.1521
41. Chait SR, Thompson JK, Jacobsen PB. Preliminary development and evaluation of an appearance-based dissonance induction intervention for reducing UV exposure. *Body Image.* 2015;12:68-72. doi:10.1016/j.bodyim.2014.09.004

42. Mays D, Tercyak KP. Framing indoor tanning warning messages to reduce skin cancer risks among young women: implications for research and policy. *Am J Public Health.* 2015;105(8):e70-e76. doi:10.2105/AJPH.2015.302665
43. Mays D, Evans WD. The effects of gain-, loss-, and Balanced-Framed messages for preventing indoor tanning among young adult women. *J Health Commun.* 2017;22(7):604-611. doi:10.1080/10810730.2017.1332119
44. Morris KL, Cooper DP, Goldenberg JL, Arndt J, Gibbons FX. Improving the efficacy of appearance-based sun exposure interventions with the terror management health model. *Psychol Health.* 2014;29(11):1245-1264. doi:10.1080/08870446.2014.922184
45. Blashill AJ, Rooney BM, Luberto CM, Gonzales M, Grogan S. A brief facial morphing intervention to reduce skin cancer risk behaviors: results from a randomized controlled trial. *Body Image.* 2018;25:177-185. doi:10.1016/j.bodyim.2018.04.002
46. Williams AL, Grogan S, Clark-Carter D, Buckley E. Impact of a facial-ageing intervention versus a health literature intervention on women's sun protection attitudes and behavioural intentions. *Psychol Health.* 2013;28(9):993-1008. doi:10.1080/08870446.2013.777965
47. Cox CR, Cooper DP, Vess M, Arndt J, Goldenberg JL, Routledge C. Bronze is beautiful but pale can be pretty: the effects of appearance standards and mortality salience on sun-tanning outcomes. *Health Psychol.* 2009;28(6):746-752. doi:10.1037/a0016388
48. Jackson KM, Aiken LS. Evaluation of a multicomponent appearance-based sun-protective intervention for young women: uncovering the mechanisms of program efficacy. *Health Psychol.* 2006;25(1):34-46. doi:10.1037/0278-6133.25.1.34
49. Hoffner C, Ye J. Young adults' responses to news about sunscreen and skin cancer: the role of framing and social comparison. *Health Commun.* 2009;24(3):189-198. doi:10.1080/10410230902804067
50. Dillard AJ, Hisler G. Enhancing the effects of a narrative message through experiential information processing: an experimental study. *Psychol Health.* 2015;30(7):803-820. doi:10.1080/08870446.2014.996565
51. Prentice-Dunn S, McMath BF, Cramer RJ. Protection motivation theory and stages of change in sun protective behavior. *J Health Psychol.* 2009;14(2):297-305. doi:10.1177/1359105308100214
52. Steele CM. The psychology of self-Affirmation: sustaining the integrity of the self. *Advances in Experimental Social Psychology.* 1988;21:261-302.
53. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process.* 1991;50(2):179-211. doi:10.1016/0749-5978(91)90020-T
54. Fabrigar LR, Petty RE, Smith SM, Crites SL. Understanding knowledge effects on attitude-behavior consistency: the role of relevance, complexity, and amount of knowledge. *J Pers Soc Psychol.* 2006;90(4):556-577. doi:10.1037/0022-3514.90.4.556
55. Ferrer RA, Mendes WB. Emotion, health decision making, and health behaviour. *Psychol Health.* 2018;33(1):1-16. doi:10.1080/08870446.2017.1385787
56. Kite J, Gale J, Grunseit A, Li V, Bellew W, Bauman A. From awareness to behaviour: testing a hierarchy of effects model on the Australian make healthy normal campaign using mediation analysis. *Prev Med Rep.* 2018;12:140-147. doi:10.1016/j.pmedr.2018.09.003
57. Katz RC, Jernigan S. Brief report: an empirically derived educational program for detecting and preventing skin cancer. *J Behav Med.* 1991;14(4):421-428. doi:10.1007/BF00845117
58. Schneider S, Zimmermann S, Diehl K, Breitbart EW, Greinert R. Sunbed use in German adults: risk awareness does not correlate with behaviour. *Acta Derm Venereol.* 2009;89(5):470-475. doi:10.2340/00015555-0689
59. Coogan PF, Geller A, Adams M, Benjes LS, Koh HK. Sun protection practices in preadolescents and adolescents: a school-based survey of almost 25,000 Connecticut school children. *J Am Acad Dermatol.* 2001;44(3):512-519. doi:10.1067/mjd.2001.111621
60. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84(2):191-215. doi:10.1037/0033-295X.84.2.191
61. van 't Riet J, Ruiters RAC, Werrij MQ, De Vries H. Self-efficacy moderates message-framing effects: the case of skin-cancer detection. *Psychol Health.* 2010;25(3):339-349. doi:10.1080/08870440802530798
62. Ally MS, Swetter SM, Hirotsu KE, et al. Promoting sunscreen use and sun-protective practices in NCAA athletes: impact of SUNSPORT educational intervention for student-athletes, athletic trainers, and coaches. *J Am Acad Dermatol.* 2018;78(2):289-292. doi:10.1016/j.jaad.2017.08.050
63. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new medical Research Council guidance. *BMJ.* 2008;337:a1655. doi:10.1136/bmj.a1655
64. Gopee N, Hibberd C, Abhyankar P. Improving sun protection in adolescents and young adults: a systematic review of intervention effectiveness. *British Journal of Dermatology.* 2018;54
65. Saraiya M, Glanz K, Briss PA, et al. Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *Am J Prev Med.* 2004;27(5):422-466. doi:10.1016/j.amepre.2004.08.009
66. Gambia WC, Fernandez AM, Gassman NR, Tan MCB, Daniel CL. College tanning behaviors, attitudes, beliefs, and intentions: a systematic review of the literature. *Prev Med.* 2017;105:77-87. doi:10.1016/j.ypmed.2017.08.029
67. Williams AL, Grogan S, Clark-Carter D, Buckley E. Appearance-based interventions to reduce ultraviolet exposure and/or increase sun protection intentions and behaviours: a systematic review and meta-analyses. *Br J Health Psychol.* 2013;18(1):182-217. doi:10.1111/j.2044-8287.2012.02089.x

68. Persson S, Benn Y, Dhingra K, Clark-Carter D, Owen AL, Grogan S. Appearance-based interventions to reduce UV exposure: a systematic review. *Br J Health Psychol.* 2018;23(2):334-351. doi:10.1111/bjhp.12291
69. McWhirter JE, Hoffman-Goetz L. Systematic review of population-based studies on the impact of images on UV attitudes and behaviours. *Health Promot Int.* 2015;30(2):397-410. doi:10.1093/heapro/dat031
70. Gibbons FX, Gerrard M, Lane DJ, Mahler HIM, Kulik JA. Using UV photography to reduce use of tanning booths: a test of cognitive mediation. *Health Psychol.* 2005;24(4):358-363. doi:10.1037/0278-6133.24.4.358
71. McLoone JK, Meiser B, Karatas J, Sousa MS, Zilliacus E, Kasparian NA. Perceptions of melanoma risk among Australian adolescents: barriers to sun protection and recommendations for improvement. *Aust NZ J Public Health.* 2014;38(4):321-325. doi:10.1111/1753-6405.12209
72. Robinson JK, Rademaker AW, Sylvester JA, Cook B. Summer sun exposure: knowledge, attitudes, and behaviors of Midwest adolescents. *Prev Med.* 1997;26(3):364-372. doi:10.1006/pmed.1997.0156
73. Asvat Y, Cafri G, Thompson JK, Jacobsen PB. Appearance-based tanning motives, sunbathing intentions, and sun protection intentions in adolescents. *Arch Dermatol.* 2010;146(4):445-446. doi:10.1001/archdermatol.2010.35
74. Zhou G, Zhang L, Knoll N, Schwarzer R. Facilitating sunscreen use among Chinese young adults: Less-motivated persons benefit from a planning intervention. *Int J Behav Med.* 2015;22(4):443-451. doi:10.1007/s12529-014-9458-7
75. Lemal M, Van den Bulck J. Testing the effectiveness of a skin cancer narrative in promoting positive health behavior: a pilot study. *Prev Med.* 2010;51(2):178-181. doi:10.1016/j.ypmed.2010.04.019
76. Grogan S, Fry G, Gough B, Conner M. Smoking to stay thin or giving up to save face? Young men and women talk about appearance concerns and smoking. *Br J Health Psychol.* 2009;14(Pt 1):175-186. doi:10.1348/135910708X327617
77. Sontag JM, Noar SM. Assessing the potential effectiveness of pictorial messages to deter young women from indoor tanning: an experimental study. *J Health Commun.* 2017;22(4):294-303. doi:10.1080/10810730.2017.1281361
78. Thomas K, Hevey D, Pertl M, Ní Chuinneagáin S, Craig A, Maher L. Appearance matters: the frame and focus of health messages influences beliefs about skin cancer. *Br J Health Psychol.* 2011;16(Pt 2):418-429. doi:10.1348/135910710X520088
79. Soto E, Lee H, Saladi RN, et al. Behavioral factors of patients before and after diagnosis with melanoma: a cohort study - are sun-protection measures being implemented? *Melanoma Res.* 2010;20(2):147-152. doi:10.1097/CMR.0b013e328328f802
80. Aspden T, Ingledew DK, Parkinson JA. Effects of motives on reactions to safe sun messages. *Psychol Health Med.* 2015;20(3):274-286. doi:10.1080/13548506.2014.936882
81. Good A, Abraham C. Can the effectiveness of health promotion campaigns be improved using self-efficacy and self-affirmation interventions? An analysis of sun protection messages. *Psychol Health.* 2011;26(7):799-818. doi:10.1080/08870446.2010.495157
82. Gold J, Aitken CK, Dixon HG, et al. A randomised controlled trial using mobile advertising to promote safer sex and sun safety to young people. *Health Educ Res.* 2011;26(5):782-794. doi:10.1093/her/cyr020
83. Craciun C, Schüz N, Lippke S, Schwarzer R. Enhancing planning strategies for sunscreen use at different stages of change. *Health Educ Res.* 2012;27(5):857-867. doi:10.1093/her/cys091
84. Stephenson MT, Witte K. Fear, threat, and perceptions of efficacy from frightening skin cancer messages. *Public Health Rev.* 1998;26(2):147-174.
85. Christensen K, Champion J, Wagner C. The effects of appearance-based and health-based interventions on sun protection attitudes, intentions, and behaviors of college students. In: *16th World Congress of Psycho-Oncology and Psychosocial Academy Lisbon.* Psycho-Oncology; 2014:317.
86. Shue McGuffin K, Jordan K, Langford D, Honeycutt J, et al. Assessing knowledge, attitudes, and behaviors regarding sun safety in female collegiate athletes. *J Dermatol Nurses Assoc.* 2019;11(1):20-33. doi:10.1097/JDN.0000000000000441
87. Bagatti M, Englert N, Cline T. Assessing behavior, knowledge, and attitudes about melanoma: an educational intervention for female college athletes. *The Journal for Nurse Practitioners.* 2016;12(1):12-18. doi:10.1016/j.nurpra.2015.09.012
88. Behrens CL, Thorgaard C, Philip A, Bentzen J. Sunburn in children and adolescents: associations with parents' behaviour and attitudes. *Scand J Public Health.* 2013;41(3):302-310. doi:10.1177/1403494813476158
89. Banks BA, Silverman RA, Schwartz RH, et al. Attitudes of teenagers toward sun exposure and sunscreen use. *Pediatrics.* 1992;89:40-42.
90. The American Cancer Society medical and editorial content team. Key Statistics for Melanoma Skin Cancer. Accessed January 06, 2020. <https://www.cancer.org/cancer/melanoma-skin-cancer/about/key-statistics.html>
91. Reed KB, Brewer JD, Lohse CM, Bringe KE, Pruitt CN, Gibson LE. Increasing incidence of melanoma among young adults: an epidemiological study in Olmsted County, Minnesota. *Mayo Clin Proc.* 2012;87(4):328-334. doi:10.1016/j.mayocp.2012.01.010
92. Ek S. Gender differences in health information behaviour: a finnish population-based survey. *Health Promot Int.* 2015;30(3):736-745. doi:10.1093/heapro/dat063
93. Al-Khashan HI, Almulla NA, Galil SAA, Rabbulnabi AA, Mishriky AM. Gender differences in health education needs and preferences of Saudis attending Riyadh military hospital in the Kingdom of Saudi Arabia. *J Fam Community Med.* 2012;19(3):172-177. doi:10.4103/2230-8229.102317

94. Mahalik JR, Lagan HD, Morrison JA. Health behaviors and masculinity in Kenyan and U.S. male college students. *Psychol Men Masc.* 2006;7(4):191-202. doi:10.1037/1524-9220.7.4.191
95. Mahalik JR, Levi-Minzi M, Walker G. Masculinity and health behaviors in Australian men. *Psychol Men Masc.* 2007;8(4):240-249. doi:10.1037/1524-9220.8.4.240
96. Rodriguez GL, Ma F, Federman DG, et al. Predictors of skin cancer screening practice and attitudes in primary care. *J Am Acad Dermatol.* 2007;57(5):775-781. doi:10.1016/j.jaad.2007.04.023
97. Weinstock MA, Martin RA, Risica PM, et al. Thorough skin examination for the early detection of melanoma. *Am J Prev Med.* 1999;17(3):169-175. doi:10.1016/S0749-3797(99)00077-X
98. Blashill AJ, Safren SA. Skin cancer risk behaviors among US men: the role of sexual orientation. *Am J Public Health.* 2014;104(9):1640-1641. doi:10.2105/AJPH.2014.301993
99. Blashill AJ, Rooney BM, Wells KJ. An integrated model of skin cancer risk in sexual minority males. *J Behav Med.* 2018;41(1):99-108. doi:10.1007/s10865-017-9879-2
100. Shimizu T, Bouchard M, Mavriplis C. Update on age-appropriate preventive measures and screening for Canadian primary care providers. *Can Fam Physician.* 2016;62(2):131-138.
101. Bentzen J, Krarup AF, Castberg I-M, Jensen PD, Philip A. Determinants of sunbed use in a population of Danish adolescents. *Eur J Cancer Prev.* 2013;22(2):126-130. doi:10.1097/CEJ.0b013e3283581934
102. Guy GP, Berkowitz Z, Tai E, Holman DM, Everett Jones S, Richardson LC. Indoor tanning among high school students in the United States, 2009 and 2011. *JAMA Dermatol.* 2014;150(5):501-511. doi:10.1001/jamadermatol.2013.7124
103. Sendelweck MA, Bell E, Anderson AM, et al. Associations between indoor tanning and substance use among Colorado high school students. *JAMA Dermatol.* 2016;152(5):575-577. doi:10.1001/jamadermatol.2015.5663
104. Detweiler JB, Bedell BT, Salovey P, Pronin E, Rothman AJ. Message framing and sunscreen use: gain-framed messages motivate beach-goers. *Health Psychol.* 1999;18(2):189-196. doi:10.1037/0278-6133.18.2.189
105. Greaney ML, Puleo E, Geller AC, et al. Patient follow-up after participating in a beach-based skin cancer screening program. *Int J Environ Res Public Health.* 2012;9(5):1836-1845. doi:10.3390/ijerph9051836
106. Weinstock MA, Rossi JS, Redding CA, Maddock JE. Randomized controlled community trial of the efficacy of a multicomponent stage-matched intervention to increase sun protection among beachgoers. *Prev Med.* 2002;35(6):584-592. doi:10.1006/pmed.2002.1114
107. Andersen PA, Buller DB, Walkosz BJ, et al. Testing a theory-based health communication program: a replication of go sun smart in outdoor winter recreation. *J Health Commun.* 2009;14(4):346-365. doi:10.1080/10810730902873117
108. Andersen PA, Buller DB, Walkosz BJ, et al. Expanding occupational sun safety to an outdoor recreation industry: a translational study of the go sun smart program. *Transl Behav Med.* 2012;2(1):10-18. doi:10.1007/s13142-011-0101-8
109. Glanz K, Geller AC, Shigaki D, Maddock JE, Isnec MR. A randomized trial of skin cancer prevention in aquatics settings: the pool cool program. *Health Psychol.* 2002;21(6):579-587. doi:10.1037/0278-6133.21.6.579
110. Andersen PA, Buller DB, Walkosz BJ, et al. A randomized trial of an advanced sun safety intervention for Vacationers at 41 North American Resorts. *J Health Commun.* 2017;22(12):951-963. doi:10.1080/10810730.2017.1382615
111. Geller AC, Glanz K, Shigaki D, Isnec MR, Sun T, Maddock J. Impact of skin cancer prevention on outdoor aquatics staff: the pool cool program in Hawaii and Massachusetts. *Prev Med.* 2001;33(3):155-161. doi:10.1006/pmed.2001.0870
112. Glanz K, Maddock JE, Lew RA, Murakami-Akatsuka L. A randomized trial of the Hawaii SunSmart program's impact on outdoor recreation staff. *J Am Acad Dermatol.* 2001;44(6):973-978. doi:10.1067/mjd.2001.113466
113. Glanz K, Lew RA, Song V, Murakami-Akatsuka L. Skin cancer prevention in outdoor recreation settings: effects of the Hawaii SunSmart program. *Eff Clin Pract.* 2000;3(2):53-60.
114. Brinker TJ, Faria BL, Gatzka M, et al. A skin cancer prevention photoaging intervention for secondary schools in Brazil delivered by medical students: protocol for a randomised controlled trial. *BMJ Open.* 2018;8(3):e018299 doi:10.1136/bmjopen-2017-018299
115. Johnson KM, Jones SC, Iverson D. Guidelines for the development of social marketing programmes for sun protection among adolescents and young adults. *Public Health.* 2009;123(Suppl 1):e6-e10. doi:10.1016/j.puhe.2009.06.018
116. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ.* 2011;343(2):d5928 doi:10.1136/bmj.d5928
117. Sterne JAC, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ.* 2016;355:i4919. doi:10.1136/bmj.i4919
118. NIH National Heart Lung and Blood Institute. Study Quality Assessment Tool - Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group: NIH National Heart, Lung, and Blood Institute. <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>