Effect of Seasonal Affective Disorder and Pathological Tanning Motives on Efficacy of an Appearance-Focused Intervention to Prevent Skin Cancer

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**Objective:** To evaluate the robustness of an appearance-focused intervention to prevent skin cancer in individuals reporting seasonal affective disorder (SAD) symptoms and pathological tanning motives.

**Design:** Randomized, controlled clinical trial.

**Setting:** College campus.

**Participants:** Four hundred thirty adult female indoor tanners (200 in the intervention group and 230 control participants).

**Intervention:** A booklet discussing the history of tanning, current tanning norms, UV radiation's effects on skin, recommendations for indoor tanning use focusing on abstinence and harm reduction recommendations, and information on healthier, appearance-enhancing alternatives to tanning.

**Main Outcome Measures:** Self-reported attitudes, intentions, and tanning behaviors; pathological tanning motives assessed by a questionnaire developed for this study; and SAD symptoms assessed by the Seasonal Pattern Assessment Questionnaire.

**Results:** Two of the 4 pathological tanning scales, opiatelike reactions to tanning and dissatisfaction with natural skin tone, were significant moderators demonstrating stronger treatment effects for individuals scoring higher on these scales. Treatment effects were equivalently positive (ie, no significant moderator effects) for all levels of SAD symptoms and all levels of the other 2 pathological tanning motive scales (ie, perceiving tanning as a problem and tolerance to the effects of tanning).

**Conclusions:** The appearance-focused skin cancer prevention intervention is robust enough to reduce indoor tanning among tanners who exhibit SAD symptoms or pathological tanning motives. Tailored interventions may address individuals' motivations for tanning and their relation to maladaptive behavior, such as dissatisfaction with appearance or the need for relaxation because of anxiety.

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Indoor tanning is a growing concern for health professionals, with prospective, case-controlled, and laboratory studies pointing toward an association of youthful indoor tanning with melanoma and nonmelanoma carcinoma.\(^{1,5}\) Despite this, the tanning industry promotes itself as safe and even healthful to its 30 million customers in the United States.\(^{9}\) Indoor tanning remains particularly attractive to youth, with recent national surveys reporting approximately 10% of those younger than 15 years and 25% to 40% of older adolescent females using sunbeds.\(^{7,9}\)

Recently, skin cancer prevention efforts using appearance-focused messages have demonstrated consistent efficacy in convincing young people to reduce tanning and increase sun protection behaviors.\(^{10-17}\) A new randomized controlled trial using a theoretically grounded, appearance-focused intervention achieved large reductions (35%) in indoor tanning use at long-term follow-up in young female tanners.\(^{13}\) Secondary analyses showed that the changes in tanning behavior at follow-up were mediated by short-term changes in beliefs and attitudes about tanning, appearance, and other factors predicted by a theoretical model of tanning behavior.

The exploration of mediator and moderator variables in intervention trials can help specify the critical next steps for future intervention research and implementation.\(^{18}\) In interventions, mediators represent changes occurring during the intervention that explain how it works, whereas moderators define subgroups with...
greater or lesser intervention effects. For example, the effect of an intervention designed to increase skin self-examinations (SSEs) may affect SSE behavior by increasing patients’ feelings of competence in their ability to perform the examinations. These SSE competency beliefs represent a mediator variable for the relationship between the intervention and SSE behavior change. If individuals experiencing depression symptoms are less likely to experience increases in SSE competency beliefs resulting from the intervention, then the degree of depression is acting as a moderator of the effects of the intervention on SSE. It is important to note that depression does not need to have a direct effect on SSE behavior for it to be an important moderator. Individuals experiencing more depression may be less likely to pay attention to the intervention information, leading to less effect on SSE competency beliefs and, ultimately, behavior. In this case, while it is the competency beliefs that are mediating the intervention-outcome relationship, the psychological process is still operating indirectly to affect the outcomes. The moderating effect of depression level provides the clinician an important piece of information concerning for whom the intervention will be most likely to have a positive impact.

Therefore, moderator analyses of efficacious behavioral interventions provide information on how robust an intervention is across various subpopulations. Interventions that achieve clinical thresholds broadly across subpopulations are robust. Those that do not achieve these thresholds may require tailoring and specific targeting within subgroups. Such information can be used by clinicians to help them tailor their messages to optimize healthy behavior change in their patients.

Skin cancer prevention interventions seek to achieve levels of behavior that reduce the risk associated with the behavior (eg, using sun protection most or all of the time when outside between 10 AM and 4 PM and decreasing tanning behaviors to low levels). Because skin cancer risk behaviors are strongly predicted by motivational factors, tanning motives are of particular interest for moderator analyses of skin cancer prevention interventions. For example, it might be expected that a health-based intervention would work best for individuals who exhibit strong health-related motivations, while an appearance-focused intervention would be recommended for individuals primarily motivated by appearance concerns. The current study used secondary analyses of data from the previous efficacy study to examine the effect of non-appearance-related tanning motivations on the relative effectiveness of an appearance-focused intervention directed at young women.

Although the desire to improve appearance remains the most common reason young people cite for intentional tanning, recent investigations have begun to point to motivations related to depression and dependence/addiction factors as also being potentially important. In a double-blind controlled study, Feldman and associates have shown that UV light can function as a reinforcing stimulus, possibly through UV light-induced cutaneous endorphin production, for frequent indoor tanners. Follow-up studies have shown withdrawal symptoms in frequent tanners administered naltrexone, an opioid antagonist, supporting this physiologic hypothesis. Recently, this evidence of a physiologic basis of pathological tanning has also been supported by studies demonstrating that UV irradiation induction of pigment secretes α-melanocyte-stimulating hormone, a cleavage product of the prohormone peptide pro-opiomelanocortin. Cleavage of this peptide yields β-endorphin, an endogenous opioid that can induce analgesia and euphoria.

Although it is possible that pathological tanning motives may have direct relationships with tanning outcomes (ie, increased pathological motives leading to increased tanning), this study was interested in how the relative level of these motives affected the ability of the appearance-focused intervention to change tanning behavior. There are a number of ways that pathological tanning motives may have such a moderating effect. For example, someone who scores high in these motives may find the material presented in the appearance-focused intervention more or less novel, salient, or relevant because of the pathological processes operating. Thus, an individual who is experiencing opiate-like reactions to tanning may be more likely to ignore or discount information on harmful tanning effects. In this case, the pathological tanning motives, as a moderator, will influence the strength of the effect of the intervention on appearance-related motivations (the mediator of the effect of the intervention on tanning behavior) (Figure 1). In practical terms, this would mean that, to be effective, the intervention may have to be modified to be more salient or relevant to individuals with high levels of pathological tanning motives.

The current study used dimensional scales reflecting feelings that personal tanning behavior is out of control, evidence of physiologic dependence (eg, reported feelings of euphoria, relaxation, and increased concentration after tanning, as well as evidence of tolerance or withdrawal when tanning ceases), and strong dissatisfaction with one’s natural skin tone. These scales have been shown to predict tanning intentions and behaviors beyond the variance accounted for by appearance and social normative motivations alone. In addition, the study used a well-validated scale of seasonal affective disorder (SAD) symptoms to examine how robust an appearance-focused intervention to prevent skin cancer is in individuals scoring high on these scales.

Figure 1. Potential mediator and moderator relationships of the influence of appearance intervention on tanning outcomes.
RECRUITMENT AND SAMPLE

The study was conducted at a mid sized southeastern university and a large northeastern university between September 2005 and April 2007. The study received approval of the institutional review board Human Subjects Committee before initiation.

A random selection of 1690 from more than 23,000 female students at 2 universities were sent an e-mail with a screening survey inviting them to participate in the study. Inclusion criteria were past-year indoor tanning or a score on the intentions to tan scale indicating positive future tanning intentions (ie, a score of 5 or greater on the 7-point scale). Receipt of the e-mail was confirmed for 853 individuals, 454 of whom met inclusion criteria. A total of 430 agreed to participate (94.7%). They were offered monetary compensation for their participation ($20 per assessment).

The 430 participants (mean [SD] age, 18.6 [0.78] years; range, 17-21 years) completed informed consent documents, were randomized into intervention (n = 200) or no-intervention control (n = 230) conditions, and completed the baseline assessments. All participants were treated identically with the exception that intervention participants received the intervention before the follow-up test.

A relatively small number of participants who initiated the study did not complete the follow-up assessment (18 participants; 5 in the intervention group and 13 control participants). The final sample for the current analysis consisted of 195 intervention participants and 217 control participants. There were no significant differences in background characteristics between intervention and control group participants.

All participants received the baseline assessment in the fall, and intervention participants then received the intervention material. Follow-up assessments were conducted in April, 6 months after distribution of the intervention.

CONTENTS OF INTERVENTION

The booklet13 sequentially presents the history of tanning to provide a context for current tanning norms, analyzes current tanning norms, and examines media and peer image norms. Next, it discusses UV radiation’s effects on skin to increase perceived susceptibility to skin damage and skin damage specifically related to indoor tanning use. The booklet then gives recommendations for indoor tanning use focusing on tanning abstinence and including harm reduction recommendations. Finally, it provides links to and discusses healthier, appearance-enhancing alternatives to tanning, including exercise, choosing fashion that does not require a complementary tan, and sunless tanning products. Both the Web site links and the booklet content related to sunless tanning highlight the fact that sunless tanning provides little protection against UV exposure.

MEASURES

Indoor tanning frequency and intention were assessed. At baseline, indoor tanning frequency was measured for the preceding 3, 6, and 12 months. At 6-month follow-up in April, past 3-month frequency was reassessed to capture the peak months of indoor tanning (February through April).43 These measures are reliable and have good evidence of validity (ie, correlate highly with diary measures of indoor tanning frequency during the same time frame; r = 0.77-0.86).44,45

Participants were asked to indicate how strongly they intended to tan indoors in the next year by using 2 items measured on 7-point Likert-type scales. An indoor tanning intentions scale with good reliability (r = 0.89) is calculated by summing these 2 items.

MODERATOR VARIABLES

Seasonal Affective Disorder

SAD was assessed with the Seasonal Pattern Assessment Questionnaire, the most widely used screening tool for assessing seasonal variations in behavior.46 Respondents rate 6 critical questionnaire items (sleep length, mood, social activity, weight, energy, and appetite) on the degree of change with the seasons according to a scale of 0 (no change) to 4 (extremely marked change). Although the Seasonal Pattern Assessment Questionnaire does not provide a SAD diagnosis, which requires a face-to-face interview, the 6 items can be summed to obtain a Global Seasonality Score.47 This score is a screening scale of depressive seasonality symptoms, ranging from 0 to 24, that can be used to place individuals into SAD, subsyndromal SAD, or no-SAD symptom categories. The Global Seasonality Score has good internal consistency48 and good test-retest reliability and factor structure.49

Pathological Tanning Motives

The measure of pathological tanning motives followed a dimensional approach, treating the maladaptive motives as continuous variables. The original scales were developed by modifying a questionnaire developed by Rozin and Stoess50 that covered theoretical aspects of addictive behaviors.51 Items were added to assess self-reports of opiatelike responses to tanning sessions as predicted by Nolan and Feldman’s studies.32 According to J. K. Thompson, PhD (oral communication, April 6, 2006), there is a potential for a pathological dissatisfaction with one’s natural skin tone in some tanners that may parallel body dysmorphic tendencies. Items were also added to assess this hypothesized construct. Factor analysis of these items yielded a scale of 16 items divided into the following 4 subscales42: (1) the belief that one’s tanning is out of control or a problem (perceiving tanning as a problem, 6 items); (2) evidence of tolerance to the effects of tanning (tolerance, 3 items); (3) opiatelike reactions to tanning (opiatelike reactions, 4 items); and (4) the perception that one’s natural skin tone is unattractive and unappealing (dissatisfaction with skin tone, 3 items). Psychometric evaluation of these scales in more than 300 young adults (S. Jain, MD, and J.H., unpublished data, 2009) demonstrated adequate to excellent internal reliability (Cronbach α = 0.62-0.90). Correlations with a measure of tanning preference (ie, positive attitudes toward tanning) were generally low (0.08-0.13) to moderate (0.42-0.56). Furthermore, the pathological tanning motives scales predicted tanning intentions significantly beyond the variance accounted for by tanning preferences, providing good evidence that they do not simply measure tanning preference.41,42

STATISTICAL ANALYSES

Moderator effects reflect the dependence of one variable on another in predicting intervention efficacy. For example, the impact of the intervention in reducing tanning sessions in treatment vs control participants may depend on the severity of opiatelike tanning reactions. Moderator effects can be determined by creating a product term of the predictor variables in question (eg, treatment group × opiatelike tanning reactions) and including this variable in a multiple regression equation predicting frequency of tanning at intervention follow-up.43 The strength of the moderator effect is reflected in the slope of the
product term variable (ie, treatment group × opiatelike reactions), which can be tested for significance. The nature of a significant moderator effect can be examined by measuring the relationship of one of the variables (eg, treatment group) to intervention outcomes at various levels of the other variable (eg, low, medium, and high levels of opiatelike reactions) and presented visually on graphs.

These types of interaction regression analyses were used to test for the presence of moderator effects based on the work of Jaccard and colleagues.\textsuperscript{51} In the first step, continuous moderator variables (eg, the pathological tanning motives scales) were centered to reduce multicollinearity as suggested by Cronbach.\textsuperscript{52} In the second step, product terms were computed by computing the 95% bootstrapped confidence intervals around the interaction effect provide a significance test for the presence of an interaction effect. In the final step, the 3-month tanning outcome was regressed onto the 3 terms (the intervention condition, the mean-centered moderator variable, and the product term) to test for the presence of an interaction effect. Three-month outcome was used as the dependent variable, and not change from baseline or 3-month outcome while controlling for baseline, because the follow-up 3-month outcome measure assessed the period of heaviest indoor tanning behavior (February through April), whereas the 3-month baseline measure reflects the period of lowest indoor tanning (July through September). All analyses were also run while controlling for baseline indoor tanning rates (12 months, then 6 months). Observed changes in regression factors were minor, which suggests that the observed moderator effects held when preintervention indoor tanning was considered. Significance was assessed by computing the 95% bootstrapped confidence intervals around the product term regression coefficient. The traditional linear regression model assumes that variables are normally distributed. Behavioral outcome variables are often highly skewed because of many more individuals exhibiting low-than-high-risk behavioral frequency. Bootstrapped confidence intervals created around the interaction effect provide a significance test that is not reliant on this normality assumption.\textsuperscript{51} Confidence intervals were obtained by using 2000 bootstrapped samples in AMOS 7.0 software (SPSS Inc, Chicago, Illinois). If the confidence intervals around the product term do not contain the value of 0, there is evidence of a significant interaction effect.

For significant interaction effects, the influence of intervention condition on indoor tanning frequency was examined for participants who reported average, above average, and below average levels of the moderator variable (ie, accomplished by subtracting scores associated with +1 SD or -1 SD and rerunning the analyses). Because of its categorical nature, the SAD variable was dummy coded to test for moderator effects.

There were no significant baseline differences between treatment and control participants in indoor tanning behavior, pathological tanning motives, and SAD symptoms (Table 1). Two of the 4 pathological indoor tanning scales were found to be significant moderators of the appearance-focused intervention effects: opiatelike reactions to tanning and dissatisfaction with natural skin tone (Table 2). Both of these scales showed progressively greater between-group differences from below average through average and above average levels of each moderator variable. The nature of the interaction effect can be seen in Figure 2. In other words, the intervention showed small effects for participants scoring below average on these 2 pathological tanning behavior scales, while demonstrating modest effects for individuals having average scores and strong effects for participants scoring above average on these constructs. Tanners who reported evidence of physiologic reinforcement for their tanning behavior also demonstrated the biggest reductions in indoor tanning behavior at follow-up. In addition, it appears that the intervention was particularly effective for tanners who were more strongly dissatisfied with their natural skin tone. Scores on the other 2 pathological tanning scales, perceiving tanning as a problem and tanning tolerance, did not moderate the effects of the appearance-related intervention, instead demonstrating intervention effects across all levels of these variables (Table 2).

There were also no significant interaction effects observed for SAD symptom scores (Table 3). These findings suggest that baseline levels of SAD symptoms are not influential in the relationship between the intervention condition and the 6-month follow-up indoor tanning outcome. In other words, the intervention demonstrated robust positive effects in the context of SAD symptom scores, with similar, strong reductions in indoor tanning behavior at follow-up being found in participants reporting no SAD symptoms, subsyndromal SAD symptoms, and significant SAD symptoms.

Table 1. Comparison of Intervention and Control Participants on Baseline Indoor Tanning Behaviors, Pathological Tanning Motives Scales, and Seasonal Affective Disorder (SAD) Symptoms

<table>
<thead>
<tr>
<th>Measure</th>
<th>Intervention (n=168)</th>
<th>Control (n=190)</th>
<th>Test for Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor tanning behaviors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous 12-mo indoor tanning 28.99 (31.35)</td>
<td>29.28 (32.51)</td>
<td>t=0.09, P=.93</td>
<td></td>
</tr>
<tr>
<td>Previous 6-mo indoor tanning 13.40 (16.65)</td>
<td>12.31 (17.46)</td>
<td>t=-0.60, P=.55</td>
<td></td>
</tr>
<tr>
<td>Pathological tanning motives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanning a problem</td>
<td>11.56 (5.22)</td>
<td>11.95 (5.14)</td>
<td>t=0.72, P=.48</td>
</tr>
<tr>
<td>Dissatisfaction with</td>
<td>9.15 (3.14)</td>
<td>8.55 (2.96)</td>
<td>t=-1.86, P=.06</td>
</tr>
<tr>
<td>natural skin tone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opiatlike reactions</td>
<td>9.72 (4.25)</td>
<td>10.47 (4.45)</td>
<td>t=1.21, P=.23</td>
</tr>
<tr>
<td>Tanning tolerance</td>
<td>4.70 (2.05)</td>
<td>4.92 (2.18)</td>
<td>t=0.73, P=.47</td>
</tr>
<tr>
<td>SAD symptoms, No. (%)</td>
<td>64 (38.1)</td>
<td>75 (39.5)</td>
<td></td>
</tr>
<tr>
<td>Subsyndromal SAD</td>
<td>85 (50.6)</td>
<td>95 (50.0)</td>
<td></td>
</tr>
<tr>
<td>SAD</td>
<td>19 (11.3)</td>
<td>20 (10.5)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Interactions of Variables for Pathological Tanning Motives and Intervention Condition With Bootstrapped 95% Confidence Intervals (CIs)

<table>
<thead>
<tr>
<th>Moderator Intervention Interaction</th>
<th>β (SE)</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opiatlike reactions</td>
<td>-0.77 (0.28)</td>
<td>-1.39 to -0.16</td>
<td>.01</td>
</tr>
<tr>
<td>Skin tone dissatisfaction</td>
<td>-1.05 (0.40)</td>
<td>-1.76 to -0.35</td>
<td>.003</td>
</tr>
<tr>
<td>Tolerance</td>
<td>-0.23 (0.61)</td>
<td>-1.45 to 1.03</td>
<td>.69</td>
</tr>
<tr>
<td>Tanning a problem</td>
<td>-0.30 (0.23)</td>
<td>-0.75 to 0.14</td>
<td>.17</td>
</tr>
</tbody>
</table>
Moderator analyses demonstrated that the appearance-focused skin cancer intervention was effective even for participants who reported non–appearance-related, pathological motives to tan. The intervention reduced indoor tanning behavior equivalently for participants reporting low, average, or high levels of perceiving tanning as a problem or experiencing symptoms of tolerance to the effects of tanning. It was also equally effective for individuals reporting no, subsyndromal, or significant symptoms of SAD. Participants scoring high on the opiatelike reactions to tanning scale and the number of indoor tanning sessions in a 3-month period.

The question remains why this appearance-focused intervention would be equally or more effective in individuals exhibiting non–appearance-related tanning motives. Results from this and other studies show that, although the correlations between appearance and pathological motives are typically low, individuals reporting pathological motives for tanning often report tanning to improve their appearance as well.\(^\text{20,21,23}\) Hence, individuals scoring high on the pathological tanning motives or SAD scales typically exhibit appearance-related tanning motives as well.\(^\text{23}\) It is possible that the appearance-damaging effects of tanning were less relevant or salient to individuals high in pathological tanning motives before the intervention because of the pathological processes operating. For example, an individual experiencing opiatelike stress relief in response to tanning may ignore or misinterpret information regarding tanning’s harmful effects. Examining correlations within the baseline scores in this study showed that 3 of the pathological tanning motives scales were significantly negatively correlated with a measure of perceived susceptibility to skin damage from tanning, indicating that those who scored high on the pathological scales may have been less aware of potential appearance damage from tanning before the intervention. The appearance-focused information presented in this study may have been able to produce effects in the group of pathological tanners because of the information being presented in a novel or appealing way that allowed them to overcome their tendency to ignore negative tanning information. In this way, the pathological tanning motives may be acting as a classic moderator variable in that they affected tanning behavior indirectly through influencing the ability of the intervention to change appearance-related motives.

It is also possible that the appearance-focused intervention had unintended effects on nonappearance tanning motivations. Relaxation and stress relief during tanning sessions, which are reported particularly strongly by tanners scoring high on the opiatelike reactions to tanning scale, is typically found to be almost as important a tanning motivator as appearance factors.\(^\text{20,23}\) Follow-up interviews with intervention participants showed many reporting negative, anxious thoughts and emotions during tanning sessions after the intervention (eg, reporting a feeling of skin burning and tightening). These increases in anxiety during tanning sessions may have interfered with the ability of these tanners to relax or experience the stress relief that

### Table 3. Interactions of SAD Symptom Category and Intervention Condition With Bootstrapped 95% CIs

<table>
<thead>
<tr>
<th>SAD Classification–Intervention Interaction</th>
<th>β (SE)</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>No SAD vs SAD</td>
<td>−9.83 (4.37)</td>
<td>−10.48 to 7.50</td>
<td>.83</td>
</tr>
<tr>
<td>No SAD vs S-SAD</td>
<td>1.99 (2.73)</td>
<td>−3.16 to 7.42</td>
<td>.46</td>
</tr>
<tr>
<td>S-SAD vs SAD</td>
<td>−2.99 (4.45)</td>
<td>−11.61 to 4.55</td>
<td>.41</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; SAD, seasonal affective disorder; S-SAD, subsyndromal SAD.
they report as important in maintaining their tanning behavior. These conjectures are supported by a significant reduction in the perception that tanning sessions are relaxing and stress relieving in intervention participants relative to controls. Of course, the reasons for the success of the appearance-focused intervention with individuals exhibiting relatively strong non-appearance-related tanning motives cannot be made empirically clear without further study and analysis.

This study’s limitations include the fact that it was conducted onl only on female, college-based participants. However, recent census data show that a large number of young adults attend higher educational institutions. In addition, college students constitute one of the highest risk groups, exhibiting high levels of intentional tanning, particularly indoors, and low levels of UV protection behaviors.35 Population studies on UV risk behaviors finds little evidence of differential behavioral frequencies between college-attending and non–college-attending young adults.7,9,57 In addition, females represent the heaviest indoor tanning users, reporting 4 to 6 times the use rate of males.7,9,57 Future studies should expand this work to males, to non–college-attending young adults, and to high school students, at whose age indoor tanning behaviors often begin. The pathological tanning motives scales require further validation before their usefulness for guiding skin cancer prevention work can be fully ascertained. The growing evidence of the potential physiologic basis for pathological tanning motives supports the potential role of the pathological tanning construct measured by these scales.

Analyses of moderator variables in this study are further evidence that appearance-focused interventions, when grounded in strong theoretical models that have been empirically verified, can have robust, clinically significant effects on UV risk behaviors even in subpopulations with strong nonappearance tanning motives. Emphasizing the appearance-damaging effects of UV light, both indoor and outdoor, to young patients who are tanning is important no matter what their pathological tanning behavior status. Still, tailored interventions may be able to better address some individual motivations for tanning and their relation to psychopathology. The best methods for delivering these powerful messages and for matching message communication to individual preferences remain to be explored so that this promising intervention approach to skin cancer prevention can have a wider impact across varied settings.

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