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Mediation Analysis of Decisional Balance, Sun Avoidance, and Sunscreen Use in the Precontemplation and Preparation Stages for Sun Protection

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Abstract

Objective—Mediation analyses of sun protection were conducted testing structural equation models using longitudinal data with three waves. An effect was said to be mediated if the standardized path between processes of change, decisional balance, and sun protection outcomes were significant.

Design—Longitudinal models of sun protection using data from individuals in the precontemplation (N=964) and preparation (N =463) stages who participated of an expert system intervention.

Main Outcome Measures—Nine processes of change for sun protection, decisional balance constructs of sun protection (pros and cons), sun avoidance behavior, and sunscreen use.

Results—With the exception of two processes in the preparation stage, processes of change predicted the pros ($r= .126$ to $.614$), and the pros predicted the outcomes ($r= .181$ to $.272$). Three models with the cons as mediator in the preparation stage, and none in the precontemplation stage, showed a mediated relationship between processes and outcomes.

Conclusion—In general, mediation analyses found both the process of change-to-pros and pros-to-behavior paths significant for both precontemplation and preparation stages, and for both sun avoidance and sunscreen use outcomes. Findings provide support for the importance of assessing the role of underlying risk cognitions in improving sun protection adherence.

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Keywords

sun protection; decisional balance; mediation; Transtheoretical Model of Behavior Change

Skin cancer remains an important public health issue. More than 3 million skin cancers are diagnosed each year, melanoma and nonmelanoma (American Cancer Society, 2015). Commonly reported skin cancer risk behaviors are sunburn history, use of indoor tanning devices, sun exposure during the midday, infrequent use of sun protective clothing, and infrequent use of sunscreen (Buller et al., 2011; Coups, Manne, & Heckman, 2008; Hillhouse, Turrisi, Jaccard, & Robinson, 2012; Holman, Berkwitz, Guy, Hartman, & Perna, 2014). Over the past decade, there has been an increase in the interest of the influence of psychosocial factors on the report of skin cancer prevention practices, including perceptions, attitudes, norms, and self-efficacy (Andersen et al., 2012; Glanz, Volpicelli, Jepson, Ming, Schuchtner, & Armstrong, 2015; Goldenberg, Nguyen, & Jiang, 2014; Mahler, Kulik, & Gibbons, 2013; Reid & Aiken, 2013; Wickenheiser, Baker, Gaber, Blatt, & Robinson, 2013).

A mediation structure examines the process through which an independent variable might affect a dependent variable – not directly, but through an intervening component, or mediation variable (Mackinnon, 2008; Mackinnon, Krull, & Lockwood, 2000). Many mediation models for sun protection have been tested to assess the influence of psychosocial factors on sun protection outcomes. Van Osch et al. (2008) reported that action planning mediated the impact of self-efficacy on parental sunscreen use. Andersen et al. (2012) stated that the effect of an intervention to increase sun protection among employees as ski areas was mediated by skin cancer risk perception, sun protection knowledge, and self-efficacy for sun protection at work. Results of an intervention to increase sun protection among adolescents illustrated treatment-to-mediator and mediator-to-behavior effects for the pros of sun protection and the pros of sun exposure as mediators (Adams, Norman, Hovell, Sallis, & Patrick, 2009). Attitudes toward sun protection and behavioral control to avoid unprotected sun exposure mediated the relationship between exposure to health information in television and sun protection behavioral intentions among college students (Lovejoy, Riffe, & Lovejoy, 2015). Jackson and Aiken (2000) reported that intention to sun protection and intention to sunbathe mediated the association between perception (perceived skin cancer risk and perceived benefits of tanning) and sun protection and sunbathing behavior among women. Craciun, Schüz, Lippke, and Schwarzer (2012a) reported that planning on using sunscreen mediated the relation between intentions to use sunscreen and actual use. They also reported a mediation association between intentions to use sunscreen, self-efficacy toward using sunscreen, and sunscreen use (Craciun, Schüz, Lippke, & Schwarzer, 2012c). An assessment of moderated mediation showed that for individuals who believed that having a tan made them feel more attractive, the relation between self-efficacy and sunscreen use was lower

The Transtheoretical Model of behavior change (TTM) is a model of behavior acquisition and cessation that incorporates cognitions, decision-making, intentions, motivation, and behavioral skills. The main constructs of the TTM are: decisional balance (perceived pros

and cons of behavior), temptations/self-efficacy, behavioral measures and outcomes, and processes of change. Its focus is on modifiable, dynamic variables that are associated with health behaviors. TTM incorporates a temporal dimension to its structure, and describes change as a process that unfolds over time involving progression through five stages, including precontemplation and preparation. Precontemplation is the stage in which people are not consistently applying sun protection behaviors, and are not thinking about acquiring these behaviors. Preparation is the stage in which people are intending to acquire sun protection habits in the next month. This change in intentions is facilitated by the use of processes of change (DiClemente et al., 1991). Processes of change are cognitive, emotional, and behavioral strategies that people use to change and maintain behavior (Di Noia & Thompson, 2012; Gokbayrak, Paiva, Blissmer, & Prochaska, 2015; Loprinzi, Cardinal, Qi Si, Bennett, & Winters-Stone, 2012; Romain, Bernard, Hokayem, Gernigon, & Avignon, 2015).

The TTM involves different psychosocial dimensions, including decisional balance (Fernandez, Amoyal, Paiva, & Prochaska, 2015; Hildebrand & Betts, 2009; Jeon, Kim, & Heo, 2014; Lee, Park, Yun, & Chang, 2013; Weller et al., 2014). The decisional balance dimension represents both cognitive and motivational aspects of decision making (Janis & Mann, 1977). Decisional balance measures, the pros and the cons, combine to form a mental decisional balance worksheet of comparative potential gains and losses, as sound decision making requires the consideration of the perceived consequences associated with a behavior. The endorsement of pros and cons is based on the estimated, perceived benefits and costs of acquiring or terminating a targeted behavior and how it may affect the individual and also significant others. For example, for smoking cessation, the pros represent the pleasure, tension reduction, self-image, and habit factors commonly associated with cigarette use. The cons include setting health example for others, how smoking can bother other people, aesthetics, and sense of control as considerations associated with motives for quitting (Velicer, DiClemente, Prochaska, & Brandenburg, 1985). In the precontemplation stage, the cons of behavior change outweigh the pros of behavior change, but this order is altered as intention and behavior modification starts taking place, with the pros outweighing the cons (e.g., preparation). The evaluation of different predictors of health behaviors makes the TTM an ideal framework for the examination of mediation models of health promotion outcomes.

The association between TTM constructs and sun protection has been examined. A cross-sectional study of decisional balance among Turkish adolescents showed that the pros increased across advanced stages of change for sun protection, but the cons didn't decrease (Aygün & Ergun, 2014). A cross-sectional evaluation of a skin self-examination training program organized to increase use of processes of change (e.g., consciousness raising) showed an effect on the decrease of the behavior "I do not perform skin self-examination regularly in every month and I do not think to perform it in the next 6 months" from 52.8% to 35.5% after training (Balyaci, Kostu, & Temel, 2012). When participants in a study to increase sun protection were asked "do you think that the advantages of sunbathing outweigh the disadvantages?", results showed changes at 3 years after the intervention towards lowered risk perception (Falk & Magnusson, 2011). These results show the need for

longitudinal assessment of the effects of perception, skills, attitude, and intentions on skin cancer prevention.

Proposed Study

Previous sun protection mediation research has focused on targeted samples (e.g., outdoor workers, adolescents, and women). This study is the first to examine sun protection mediation models in the population. In addition, previous assessments of the mediation association between psychosocial factors and sun protection haven't used longitudinal data with multiple follow-up assessments. The goal of the present study is to extend prior mediated analyses of psychosocial variables using longitudinal data. We will conduct the mediation analyses in two of the pre-action stages of change from the TTM: precontemplation and preparation¹. In the present study, the mediation effects of the perceived pros and cons of sun protection in the relationship between processes of change and sun protection (sun avoidance and sunscreen use) were tested among those in the precontemplation and preparation stages of change. The precontemplation and preparation stages of sun protection are two of three pre-action stages. Processes of change were used as independent variables (baseline), the pros and cons of sun protection were used as mediators (6-month), and sun avoidance and sunscreen use were used as outcome (12-month). There are three hypotheses for mediation we tested:

1. Processes of change (measured at baseline, T1) will significantly predict the mediators.
2. Mediators (measured at 6 months, T2) will significantly predict the outcomes (measured at 12 months, T3).
3. Predicted associations will be similar across two pre-action stages.

Methods

This study and the secondary analysis of the data were reviewed and approved by the Institutional Review Board of the University of Rhode Island. Informed consent was obtained from all participants.

Procedure and Participants

This study is a secondary data analysis of pooled data collected to evaluate the efficacy of a TTM-tailored multiple behavior expert system intervention. This pooled data analysis combined primary data from four stage-matched population trials. Participants were enrolled in a 2-arm randomized control trial, with the treatment group receiving individualized feedback reports for each of their relevant behaviors (smoking, high-fat diet, and sun exposure) at 0, 6, and 12 months. Participants were recruited at different sites: one sample consisted of parents of adolescents who were subjects in a school-based; for the second sample a health insurance provider provided a list of patient names for an expert system intervention study; for the third sample, total of 22 worksites provided participants who

¹Data from the contemplation stage was available, but it wasn't included in the mediation analysis given that the sample was small for longitudinal assessments.

were part of a larger multiple risk behavior study on smoking, diet, sun exposure and exercise; and for the fourth sample, individuals at risk for sun protection behaviors were recruited proactively at the beach. Details regarding recruitment procedures and characteristics of participants in the study have been described previously (Blissmer et al., 2010; Linnan et al., 2002; Prochaska et al., 2005; Prochaska et al., 2004; Weinstock, Rossi, Redding, & Maddock, 2002; Weinstock, Rossi, Redding, Maddock, & Cottrill, 2000). The intervention was structured to raise the pros and decrease the cons of sun protection and the frequency of use of the processes of change (how often they used strategies to encourage sun protection in the past 30 days). Individuals in the precontemplation (N = 964) and preparation (N = 463) stages of sun protection behavior at baseline were included in the analysis. Assessments were collected at baseline, 6-, and 12-month intervals. Only participants from the intervention group who had data at all three time points were included in the study (the original sample size for the intervention group in precontemplation was N=1079 and for preparation was N=506).

The data from the *Expert System* intervention group was used (Prochaska et al., 2004; Prochaska et al., 2005; Weinstock et al., 2002). In this group, participants were mailed three computer-generated reports at baseline. In addition, they were mailed reports at 6 months and 12 months. The three-to five-page reports provided feedback about each participant's stage of change, the pros and cons of changing, change processes pertinent to their stage, how to increase self-efficacy, and techniques to progress to the next stage. The follow-up reports (6- and 12-month phases) provided feedback about changes since the previous assessment. Participants also received a stage-matched manual at baseline to help them progress at their own pace in between reports. Specific sun protection behaviors were measured, but not used in the generation of the interactive progress reports. The control group only received the outcome measures (stages of change and behavior outcomes) at baseline, 12 months, and 24 months. Only the intervention condition assessed all the variables needed for this analysis.

Of the 964 participants in precontemplation, 61.6% were female, 47.5% were married, 95.2% were white, and 39.5% described their health as "very good". Of the 463 participants in preparation, 61.7% were female, 52.3% were married, 94.3% were white, and 38.9% described their health as "very good" (see Table 1 for additional demographic information).

Measures

Stages of change—The general sun protection algorithm classified participants by stage based on questions that measured their behaviors, and intentions to protect themselves by preventing or regulating their sun exposure whenever they know they would be out in the sun for a prolonged period of time (Prochaska et al., 2005; Maddock, Redding, Rossi, & Weinstock, 2005). The items used in staging algorithm were: (i) do you protect yourself from exposure to the sun consistently, that is, whenever you know you will be out in the sun for more than 15 minutes?; (ii) do you intend to consistently protect yourself from exposure to the sun in the next 12 months?; and (iii) do you intend to consistently protect yourself from exposure to the sun in the next 30 days? Participants who answered "no" to all of these items were classified in the *precontemplation* stage of sun protection. Participants who

answered “no” to the first question and “yes” to the following questions were classified in the *preparation* stage of sun protection. Stage of change at baseline was used to determine eligibility for inclusion in the present study.

Decisional balance: Pros and cons—This measure includes questions about how participants perceived the importance of specific benefits and costs (*pros* and *cons*) for self and others (Prochaska et al., 2005; Prochaska et al, 2004). The decisional balance instrument for sun protection used in this study consists of 4 items assessing the pros of sun protection ($\alpha = 0.75$) and 4 items assessing the cons of sun protection ($\alpha=0.76$). For the pros, the items were: (i) reducing sun exposure is an easy way to protect my health; (ii) using sunscreen allows me to enjoy the outdoors with less worry; (iii) the health risks from sun exposure are serious; and (iv) my skin won’t age so fast if I reduce my sun exposure. For the cons, the items were (i) the sun feels good on my skin; (ii) I feel healthy when I have a nice tan; (iii) having to avoid the sun takes the fun of being outdoors; and (iv) I look better when I have a tan. Participants were asked to rate how important each item is in deciding whether or not to protect themselves from too much sun exposure on a 5-point Likert scale from not important (=1) to extremely important (=5). The range for the pro and con scores was 0-20. Table 1 shows the scores decisional balance when measured at the 6-month follow-up.

Processes of Change—Sun protection processes of change are cognitive, emotional, and social experiences that people engage in when they attempt to protect their skin from sun exposure (behavior (Prochaska et al., 2005; Prochaska et al, 2004). These processes are independent variables that people need to apply, or be engaged in, to move from stage to stage: *counter conditioning, consciousness raising, dramatic relief, environmental reevaluation, helping relationships, reinforcement management, self-reevaluation, social liberation, and self-liberation* ($\alpha = 0.88$). Example of items are “I look for information about the risks of getting too much sun”, “I think about what I’ve seen on TV or in magazines about the health risks of sun” for *consciousness raising*, and “I notice that many people are protecting themselves from the sun these days”, “I see more and more people using sunscreens to protect themselves from the sun” for *social liberation*. Respondents were asked to rate how often they used the processes of change in the past 30 days on a 5- point Likert scale ranging from never (=1) to always (=5). Each process was measured using two items (score range: 0–10). Table 1 shows the scores for each process of change when measured at baseline in each stage. Reinforcement Management received the lowest score, and Social Liberation received the highest score (across stages).

Sun Protection Behavior: Sun Avoidance and Sunscreen Use—The Sun Protection Behavior Scale (SPBS) is a brief inventory that includes measures of sun protection (behavior (Prochaska et al., 2005; Prochaska et al, 2004). One subscale from the SPBS was used to measure sun avoidance ($\alpha = 0.85$), and a subscale was used to measure sunscreen use ($\alpha = 0.87$). Sun avoidance was measured using 4 items, and sunscreen use was measured using 3 items. Each item was being self-report of sun protection behavior on a 5-point Likert scale of frequency ranging from never (=1) to always (=5) *when in the sun for more than about 15 minutes*. The behaviors measured by the sun avoidance items included (i) wear a shirt; (ii) stay in shade; (iii) avoid the sun during the midday hours; and (iv) limit

exposure to the sun during the midday hours. The behaviors measured by the sunscreen use items were (i) use a sunscreen; (ii) use a sunscreen with SPF of 15 or more on your face; (iii) use a sunscreen with SPF of 15 or more on all sun exposed skin areas. The correlation between the behaviors was 0.21. Table 1 shows the scores for each behavior when measured at the 12-month follow-up in each stage.

Statistical Analysis

Mediation analyses were conducted testing structural equation models for individual mediators using longitudinal data with three waves. An effect was said to be mediated if the standardized path between the independent variable (each process of change) and the mediator (pros and cons) and between the mediator and the outcome (sun avoidance and sunscreen use) are significant. Autocorrelated errors between the observed variables across assessments and fixed loadings were included in the models. Fit statistics, including χ^2 test (which can be affected by sample size), root mean square error of approximation (RMSEA), and the comparative fit index (CFI) were evaluated for each model (Kline, 2011). The standardized paths between the variables included in the models were examined. The magnitude of effect sizes for the regression paths was determined as .10, .30, and .50 for small, medium, and large effects (Cohen, 1992). EQS 6.0 software was used to analyze the data (Bentler, 2006).

As diagnostic analysis, an alternative autoregressive model was also tested. Each of the single-mediator models was compared to fully cross-lagged autoregressive models. Fully cross-lagged models include contemporaneous mediation relations, proposed relations (hypotheses 1 and 2), as well as all other options for the mediated effects. This approach included paths in potential directions not included in the proposed model, as a way to confirm the directionality of the mediation associations (MacKinnon, 2008). This model violates the temporal precedence of predictor to mediator to outcome specified by the expected mediation models because paths include reverse directions. Each proposed models were compared to the alternative autoregressive models.

Results

Figure 1 shows an example of the mediation models analyzed. Good fit was found for models, with CFI > .90 (see Table 2 for fit statistics among mediation models). The lower value of the 90% confidence interval for each RMSEA was < .05 and the upper value was < .08 (not shown in table). Comparisons of fit between alternative models and the proposed mediation models were conducted to complete diagnostic assessments. The χ^2 and CFI difference tests showed no decrease in model fit when paths were removed from the alternative models to create the proposed models. These diagnostic analyses were not included in the manuscript.

The mediation effect was tested by evaluating the regression values for each association of interest. For precontemplation, in the models with the pros of sun protection and sun avoidance, all the processes of change predicted the pros ($r = .245$ to $.408$), and the pros predicted the outcome ($r = .183$ to $.243$). The strongest predictors of the pros were Consciousness Raising, Self-Reevaluation, and Self-Liberation (medium effect). In these

three models, the pros had a small-to-medium effect of sun avoidance. In the sunscreen models, the all the processes of change predicted the pros ($r = .284$ to $.470$), and the pros predicted the outcome ($r = .206$ to $.272$). The strongest predictors of the pros were Consciousness Raising, Self-Reevaluation, and Self-Liberation (medium effect). All the models showed a small-to-medium effect of the pros on sunscreen use. In the models with the cons of sun protection and sun avoidance, with the exception of the effect of Consciousness Raising and Counter Conditioning on the cons (small effect), none of the associations were significant. Models for the prediction of sunscreen use mediated by the cons showed similar results.

For those in the preparation stage, seven of nine processes of change predicted the pros ($r = .156$ to $.525$) in sun avoidance models. Consciousness Raising, Environmental Reevaluation, and Helping Relationship had large and medium effects on the pros. The pros predicted the sun avoidance ($r = .230$ to $.308$) in all models. In the sunscreen models, seven of nine processes of change predicted the pros ($r = .129$ to $.614$). Consciousness Raising, Environmental Reevaluation, and Helping Relationship had large and medium effects on the pros. The pros predicted sunscreen use ($r = .145$ to $.236$) in all models. Three of nine processes of change predicted the cons (Environmental Reevaluation, Counter Conditioning, and Self-Liberation; small effect). All sun avoidance models showed a small effect of the cons on this outcome ($r = -.104$ to $-.127$). In sunscreen use models, Environmental Reevaluation and Counter Conditioning had a small effect of the cons. change having small effect on the cons. None of the sun sunscreen models showed a significant association between the cons and this outcome.

Discussion

This study is one of few studies that have applied latent variable modeling to explore sun protection behaviors. Longitudinal intervention data were used to test the mediation effect of psychosocial factors in sun protection in a population-based sample of adults in precontemplation and preparation stages of sun protection. This study examined potential mediators of a 12-month multiple behavior intervention to increase sun protection based on the TTM approach. The pros and cons of sun protection, which represent the perceived benefits and costs of protecting the skin from sun exposure (e.g., opinions some people may have about protecting themselves from summer sun that influence whether or not to reduce sun exposure, including tanning benefits and seriousness of sun exposure as a health risk), were included in the models as individual mediators. We found processes of change to significantly predict the pros of sun protection. In precontemplation, the processes had small and medium effects of the pros in both sun avoidance and sunscreen use models. The regression values for the processes of change were not as constant across processes in the preparation stage as they were in the preparation stage. This suggests that, in general, having feelings, thoughts, and experiences that promote sun protection are better predictors of the importance of sun protection among those in earlier stages of change. Those in preparation need to experience specific processes (e.g., Consciousness Raising, Environmental Reevaluation) to modify their perceptions regarding the potential benefits of protecting their skin from sun exposure. In both stages, the pros of sun protection had a small effect on sun protection and sunscreen use. These effects are consistent with previous research showing

small effects on the association between the pros and targeted behaviors (Aygun & Ergun, 2014; Horwath, Nigg, Motl, Wong, & Dishman, 2010; Maruf, Ibikunle, & Olanrewaju, 2014; Weller et al., 2015). In terms of models with the cons of sun protection as mediator, there was no mediated association between the processes and the outcomes in the precontemplation stage. Three mediated associations for sun avoidance emerged in the preparation stage (with Environmental Reevaluation, Counter Conditioning, and Self-Liberation as predictors), but the rest of the models didn't support the mediation hypothesis for the cons. Although we found no evidence that the cons of sun protection c mediate the longitudinal association between processes of change and sun protection, this path should be explored by further research.

One limitation of this study is that most subjects were female, white, married, and reported a very good health status, restricting the generalizability of the results. Also, most of the participants were between the ages of 34–64. In addition, the results of this study focus on sun avoidance and sunscreen use, and may not hold for other aspects of sun exposure, such as skin cancer diagnosis, screening for skin cancer, and attitudes toward tanning. This analysis was conducted with the treatment group only, and treatment-control comparisons were not available to determine the effect of the intervention on the mechanisms of change.

Previous research has evaluated the effect of psychosocial factors on sun protection using stage-based modeling. Craciun and colleagues (2012b) reported that an intervention involving coping planning (that is, planning specific efforts, both behavioral and psychological to reduce, or minimize anticipated stress related to sun exposure and/or sun protection) was more beneficial in motivated individuals (intenders) compared with unmotivated ones (pre-intenders). Prentice-Dunn, McMath, & Cramer (2009) illustrated that the transition from the precontemplation to contemplation stage of sun protection was promoted by threat appraisal information (exposure graphic photos of cancer lesions, leathery skin and age spots), but transition from contemplation to the preparation stage occurred only when individuals were provided with both high threat and high coping information (threat appraisal photos and information about the benefits of sun avoidance and sunscreen use for skin cancer prevention). Crane et al. (2012) evaluated the use of the Precaution Adoption Model (which includes seven stages of change based on awareness about a health issue, risk perception, personal significance, and perception of significance for others) for the assessment of intervention effectiveness to increase sun protection in children. Movement to advanced stages was associated with being more aware of skin cancer risk factors, perceiving fewer barriers to engaging in sun protection, and regarding sun protection as effective in reducing skin cancer risk (Crane et al., 2012). The present findings point the need for greater attention to motivation, environment, perception, and affective factors as determinants of behavior in health-behavior practice for the promotion of skin cancer prevention. Our study illustrates that is important to evaluate how people perceive (negatively or positively) sun exposure and sun protection behaviors (sunscreen use and sun avoidance). A study of outdoor worker's perception of the effects of sun exposure reported that perceived prioritization of sun protection, concern about sun exposure, knowledge about the effects of sun exposure and perceived supportive workplace culture accounted for 37% of the variation in sunscreen use (McCool, Reeder, Robinson, Petrie, & Gorman, 2009). The results of our study provide support for the importance of assessing the

role of underlying risk cognitions in improving adherence to sun protection in the community. Our study also suggests that TTM constructs are malleable; however particular process and decisional balance variables appear to have different effects on outcomes. While there was a general effect of processes of change and pros of sun protection across sun protection outcomes, the effect of specific emotions and experiences (e.g., a potential influence of other people's behaviors on our own behaviors) differed by stage. This particular finding adds to the body of research illustrating the importance of sociocultural factors on skin cancer prevention (Day, Wilson, Hutchison, & Roberts, 2014; Cafri, Thompson, Jacobsen, & Hillhouse, 2009). Consistent with The Surgeon General's Call to Action to Prevent Skin Cancer (U.S. Department of Health and Human Services, 2014), specific information is needed about effective messaging to influence positive behavior change related to skin cancer prevention for specific groups. More research on interventions would ensure that only the most effective combination of intervention components are disseminated and that they are suitably tailored for those reporting different levels of risk behaviors. However, as noted by Surgeon General's Call to Action, more research is needed on the potential link between targeted new technologies for sharing sun protection messages to specific audiences and the reduction of skin cancer rates.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

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References

- Adams MA, Norman GJ, Hovell MF, Sallis JF, Patrick K. Reconceptualizing decisional balance in an adolescent sun protection intervention: mediating effects and theoretical interpretations. *Health Psychol.* 2009; 28(2):217–225.10.1037/a0012989 [PubMed: 19290714]
- American Cancer Society. *Cancer facts and figures–2015*. Atlanta, GA: American Cancer Society; 2015.
- Andersen PA, Buller DB, Walkosz BJ, Scott MD, Kane IL, Cutter GR, Liu X. Expanding occupational sun safety to an outdoor recreation industry: A translational study of the Go Sun Smart program. *Transl Behav Med.* 2012; 2(1):10–18.10.1007/s13142-011-0101-8 [PubMed: 23105954]
- Aygun O, Ergun A. Decisional balance and self-efficacy for sun protection: Measurement among Turkish adolescents. *Nurs Res.* 2014; 63(5):309–319.10.1097/NNR.0000000000000048 [PubMed: 25171557]
- Balyaci OE, Kostu N, Temel AB. Training program to raise consciousness among adolescents for protection against skin cancer through performance of skin self-examination. *Asian Pac J Cancer Prev.* 2012; 13(10):5011–5017. [PubMed: 23244101]
- Bentler, PM. *EQS 6.0 Structural Equations Programs Manual*. Encino, CA: Multivariate Software INC; 2006.
- Blissmer B, Prochaska JO, Velicer WF, Redding CA, Rossi JS, Greene GW, Robbins M. Common factors predicting long-term changes in multiple health behaviors. *J Health Psychol.* 2010; 15(2): 205–214.10.1177/1359105309345555 [PubMed: 20207664]

- Buller DB, Cokkinides V, Hall HI, Hartman AM, Saraiya M, Miller E, Glanz K. Prevalence of sunburn, sun protection, and indoor tanning behaviors among Americans: Review from national surveys and case studies of 3 states. *J Am Acad Dermatol*. 2011; 65(5 Suppl 1):S114–123.10.1016/j.jaad.2011.05.033 [PubMed: 22018060]
- Cafri G, Thompson JK, Jacobsen PB, Hillhouse J. Investigating the role of appearance-based factors in predicting sunbathing and tanning salon use. *J Behav Med*. 2009; 32(6):532–544.10.1007/s10865-009-9224-5 [PubMed: 19653089]
- Coups EJ, Manne SL, Heckman CJ. Multiple skin cancer risk behaviors in the U.S. population. *Am J Prev Med*. 2008; 34(2):87–93.10.1016/j.amepre.2007.09.032 [PubMed: 18201637]
- Craciun C, Schuz N, Lippke S, Schwarzer R. A mediator model of sunscreen use: A longitudinal analysis of social-cognitive predictors and mediators. *Int J Behav Med*. 2012a; 19(1):65–72.10.1007/s12529-011-9153-x [PubMed: 21394444]
- Craciun C, Schuz N, Lippke S, Schwarzer R. Enhancing planning strategies for sunscreen use at different stages of change. *Health Educ Res*. 2012b; 27(5):857–867.10.1093/her/cys091 [PubMed: 22907532]
- Crane LA, Asdigian NL, Baron AE, Aalborg J, Marcus AC, Mokrohisky ST, Morelli JG. Mailed intervention to promote sun protection of children: a randomized controlled trial. *Am J Prev Med*. 2012; 43(4):399–410.10.1016/j.amepre.2012.06.022 [PubMed: 22992358]
- Craciun C, Schuz N, Lippke S, Schwarzer R. Translating intentions into sunscreen use: An interaction of self-efficacy and appearance norms. *Psychol Health Med*. 2012c; 17(4):447–456.10.1080/13548506.2011.613941 [PubMed: 22292908]
- Day AK, Wilson CJ, Hutchinson AD, Roberts RM. Sun-related behaviours among young Australians with Asian ethnic background: differences according to sociocultural norms and skin tone perceptions. *Eur J Cancer Care (Engl)*. 2014;10.1111/ecc.12275
- DiClemente CC, Prochaska JO, Fairhurst SK, Velicer WF, Velasquez MM, Rossi JS. The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change. *J Consult Clin Psychol*. 1991; 59(2):295–304. [PubMed: 2030191]
- Di Noia J, Prochaska JO. Mediating variables in a transtheoretical model dietary intervention program. *Health Educ Behav*. 2010; 37(5):753–762.10.1177/1090198109334897 [PubMed: 19494057]
- Di Noia, Thompson D. Processes of change for increasing fruit and vegetable consumption among economically disadvantaged African American adolescents. *Eating Behaviors*. 2011; 13:58–61. [PubMed: 22177398]
- Falk M, Magnusson H. Sun protection advice mediated by the general practitioner: an effective way to achieve long-term change of behaviour and attitudes related to sun exposure? *Scand J Prim Health Care*. 2011; 29(3):135–143.10.3109/02813432.2011.580088 [PubMed: 21682578]
- Fernandez AC, Amoyal NR, Paiva AL, Prochaska JO. Motivation for HPV vaccination among young adult men: Validation of TTM decisional balance and self-efficacy constructs. *Am J Health Promot*. 2015;10.4278/ajhp.131108-QUAN-570
- Glanz K, Volpicelli K, Jepson C, Ming ME, Schuchter LM, Armstrong K. Effects of tailored risk communications for skin cancer prevention and detection: The PennSCAPE randomized trial. *Cancer Epidemiol Biomarkers Prev*. 2015; 24(2):415–421.10.1158/1055-9965.EPI-14-0926 [PubMed: 25432953]
- Gokbayrak NS, Paiva AL, Blissmer BJ, Prochaska JO. Predictors of relapse among smokers: transtheoretical effort variables, demographics, and smoking severity. *Addict Behav*. 2015; 42:176–179.10.1016/j.addbeh.2014.11.022 [PubMed: 25481450]
- Goldenberg A, Nguyen BT, Jiang SI. Knowledge, understanding, and use of preventive strategies against nonmelanoma skin cancer in healthy and immunosuppressed individuals undergoing Mohs surgery. *Dermatol Surg*. 2014; 40(2):93–100.10.1111/dsu.12399 [PubMed: 24354730]
- Hildebrand DA, Betts NM. Assessment of stage of change, decisional balance, self-efficacy, and use of processes of change of low-income parents for increasing servings of fruits and vegetables to preschool-aged children. *J Nutr Educ Behav*. 2009; 41(2):110–119.10.1016/j.jneb.2008.09.007 [PubMed: 19304256]

- Hillhouse J, Turrisi R, Jaccard J, Robinson J. Accuracy of self-reported sun exposure and sun protection behavior. *Prev Sci.* 2012; 13(5):519–531.10.1007/s11121-012-0278-1 [PubMed: 22855253]
- Holman DM, Berkowitz Z, Guy GP Jr, Hartman AM, Perna FM. The association between demographic and behavioral characteristics and sunburn among U.S. adults - National Health Interview Survey, 2010. *Prev Med.* 2014; 63:6–12.10.1016/j.ypmed.2014.02.018 [PubMed: 24589442]
- Horwath CC, Nigg CR, Motl RW, Wong KT, Dishman RK. Investigating fruit and vegetable consumption using the transtheoretical model. *Am J Health Promot.* 2010; 24(5):324–333.10.4278/ajhp.071218138 [PubMed: 20465146]
- Janis, IL.; Mann, L. *Decision Making: A Psychological Analysis of Conflict, Choice and Commitment.* New York: Free Press; 1977.
- Kline, RB. *Principles and Practice of Structural Equation Modeling (Third Edition).* New York, NY: The Guilford Press; 2011.
- Lee MK, Park HA, Yun YH, Chang YJ. Development and formative evaluation of a web-based self-management exercise and diet intervention program with tailored motivation and action planning for cancer survivors. *JMIR Res Protoc.* 2013; 2(1):e11.10.2196/resprot.2331 [PubMed: 23612029]
- Linnan LA, Emmons KM, Klar N, Fava JL, LaForge RG, Abrams DB. Challenges to improving the impact of worksite cancer prevention programs: Comparing reach, enrollment, and attrition using active versus passive recruitment strategies. *Annals of Behavioral Medicine.* 2002; 24(2):157–166.10.1207/S15324796ABM2402_1312054321 [PubMed: 12054321]
- Loprinzi PD, Cardinal BJ, Si Q, Bennett JA, Winters-Stone KM. Theory- based predictors of follow-up exercise behavior after a supervised exercise intervention in older breast cancer survivors. *Support Care Cancer.* 2012; 20(10):2511–2521.10.1007/s00520-011-1360-0 [PubMed: 22252545]
- Lovejoy J, Riffe D, Lovejoy TI. An examination of direct and indirect effects of exposure and attention to health media on intentions to avoid unprotected sun exposure. *Health Commun.* 2015; 30(3):261–270.10.1080/10410236.2013.842526 [PubMed: 24597527]
- MacKinnon, DP. *Introduction to Statistical Mediation Analysis.* New York: Lawrence Erlbaum Associates; 2008.
- MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding and suppression effect. *Prevention Science.* 2000; 1(4):173–181.10.1023/A:102659501137111523746 [PubMed: 11523746]
- Maddock JE, Redding CA, Rossi JS, Weinstock MA. Development and validation of an appearance motivation attitudes scale for sun protection. *Psychology & Health.* 2005; 20(6):775–788.10.1080/14768320500165944
- Mahler HI, 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):1009–1031.10.1080/08870446.2013.777966 [PubMed: 23537173]
- Maruf FA, Ibikunle PO, Raji NO. Relationships between transtheoretical model stages of change, decisional balance, self-efficacy, and physical activity level among Nigerian market vendors. *Am J Health Promot.* 2014; 28(5):e118–126.10.4278/ajhp.121024-QUAN-519 [PubMed: 23971521]
- McCool JP, Reeder AI, Robinson EM, Petrie KJ, Gorman DF. Outdoor workers' perceptions of the risks of excess sun-exposure. *J Occup Health.* 2009; 51(5):404–411. [PubMed: 19590155]
- Prentice-Dunn S, McMath BF, Cramer RJ. Protection motivation theory and stages of change in sun protective behavior. *J Health Psychol.* 2009; 14(2):297–305.10.1177/1359105308100214 [PubMed: 19237497]
- Prochaska JO, Velicer WF, Redding C, Rossi JS, Goldstein M, DePue J, Plummer BA. Stage-based expert systems to guide a population of primary care patients to quit smoking, eat healthier, prevent skin cancer, and receive regular mammograms. *Prev Med.* 2005; 41(2):406–416.10.1016/j.ypmed.2004.09.050 [PubMed: 15896835]
- Prochaska JO, Velicer WF, Rossi JS, Redding CA, Greene GW, Rossi SR, Plummer BA. Multiple risk expert systems interventions: impact of simultaneous stage-matched expert system interventions for smoking, high-fat diet, and sun exposure in a population of parents. *Health Psychol.* 2004; 23(5):503–516.10.1037/0278-6133.23.5.503 [PubMed: 15367070]

- Romain AJ, Bernard P, Hokayem M, Gernigon C, Avignon A. Measuring the Processes of Change From the Transtheoretical Model for Physical Activity and Exercise in Overweight and Obese Adults. *Am J Health Promot.* 2015;10.4278/ajhp.140103-QUAN-9
- U.S. Department of Health and Human Services. The Surgeon General's Call to Action to Prevent Skin Cancer. Washington, DC: U.S. Dept of Health and Human Services, Office of the Surgeon General; 2014.
- Van Osch L, Reubsaet A, Lechner L, Candel M, Mercken L, De Vries H. Predicting parental sunscreen use: Disentangling the role of action planning in the intention-behavior relationship. *Psychol Health.* 2008; 23(7):829–847.10.1080/08870440701596577 [PubMed: 25160883]
- Velicer WF, DiClemente CC, Prochaska JO, Brandenburg N. Decisional balance measure for assessing and predicting smoking status. *J Pers Soc Psychol.* 1985; 48(5):1279–1289. [PubMed: 3998990]
- 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. [PubMed: 12460526]
- Weinstock MA, Rossi JS, Redding CA, Maddock JE, Cottrill SD. Sun protection behaviors and stages of change for the primary prevention of skin cancers among beachgoers in southeastern New England. *Ann Behav Med.* 2000; 22(4):286–293. [PubMed: 11253439]
- Weller KE, Greene GW, Redding CA, Paiva AL, Lofgren I, Nash JT, Kobayashi H. Development and validation of green eating behaviors, stage of change, decisional balance, and self-efficacy scales in college students. *J Nutr Educ Behav.* 2014; 46(5):324–333.10.1016/j.jneb.2014.01.002 [PubMed: 24613445]
- Wickenheiser M, Baker MK, Gaber R, Blatt H, Robinson JK. Sun protection preferences and behaviors among young adult males during maximum ultraviolet radiation exposure activities. *Int J Environ Res Public Health.* 2013; 10(8):3203–3216.10.3390/ijerph10083203 [PubMed: 23912201]

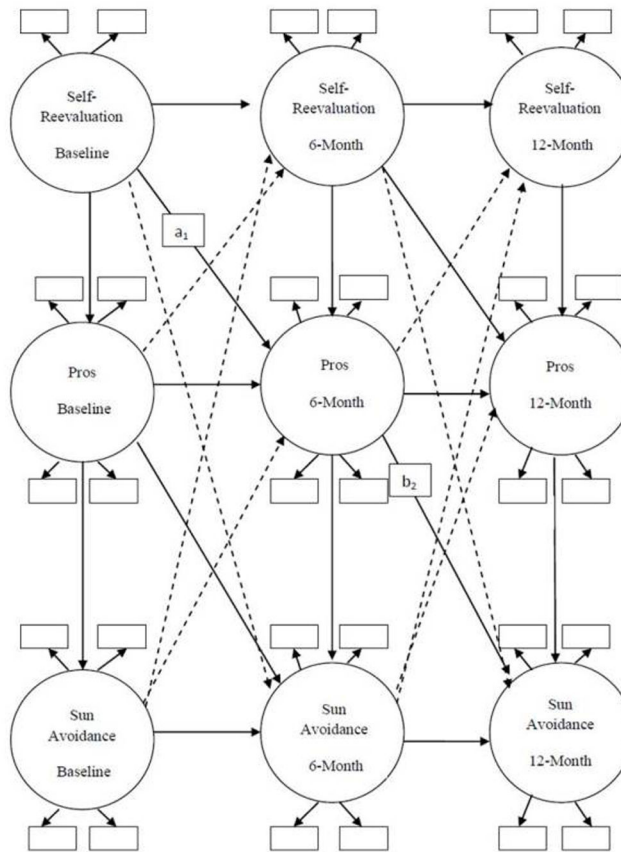


Figure 1.

Example of a mediation model tested: proposed model (paths represented by straight lines) and alternative model (paths represented by straight and dashed lines); self-reevaluation (1 of 9 process of change) =X; pros (1 of 2 mediators)=M; sun avoidance (1 of 2 outcomes)=Y; the predictor-to-mediator path (a_1) and the moderator-to-outcome path (b_2) are emphasized as the main paths of interest. Circles represent the latent variables, and the boxes represent the observed (manifest; items) variables.

Table 1

Demographic Frequencies and Composite Variables Mean Scores of Processes of Change at Baseline, Decisional Balance at 6-month, and Sun Protection Outcomes at 12-month for Precontemplation and Preparation

Variables at baseline	Precontemplation (N=964)	Preparation (N=463)
Gender %		
Female	61.6	66.7
Marital Status %		
Married	47.5	52.3
Race %		
White	95.2	94.3
Ethnicity %		
Non-Hispanic	99.2	98.0
Health Status %		
Excellent	21.6	21.7
Very good	39.5	38.9
Good	30.0	31.1
Fair	7.6	7.2
Poor	0.9	1.1
Sun sensitivity %		
Rarely burn	29.6	20.3
Mild burn	42.6	39.8
Usually burn	22.3	27.4
Sunburns last year %		
No	86.0	83.8
Age	$M = 40.39 (SD = 13.45)$	$M = 41.9 (SD = 12.19)$
Processes of Change (range: 0–10); $M (SD)$		
Counter Conditioning	6.5(2.2)	7.3(1.9)
Consciousness Raising	4.7(1.7)	6.2(1.8)
Dramatic Relief	5.8(2.2)	7.2(2.0)
Environmental Reevaluation	5.3(2.0)	6.9(1.9)
Helping Relationship	5.6(2.4)	6.7(2.3)

Variables at baseline	Precontemplation (N=964)	Preparation (N=463)
Reinforcement Management	2.7(1.1)	3.4(1.6)
Self-Liberation	3.9(1.8)	5.9(2.0)
Self-Reevaluation	4.8(2.2)	6.5(2.1)
Social Liberation	7.2(1.7)	7.8(1.6)
Decisional Balance (range: 0–20); <i>M (SD)</i>		
Pros	12.4(3.7)	15.5(3.0)
Cons	12.3(3.9)	10.9(3.6)
Sun Avoidance (range: 0–20); <i>M (SD)</i>	10.1(3.5)	12.7(3.5)
Sunscreen Use (range: 0–15); <i>M (SD)</i>	8.0 (3.6)	10.8 (3.4)

Table 2
Fit Statistics for Predicted Mediation Models in Precontemplation and Preparation (Sun Avoidance as Outcome and Sunscreen as Outcome)

List of Predictors	Precontemplation					Preparation						
	Sun Avoidance		Sunscreen Use		df	Sun Avoidance		Sunscreen Use		df		
χ^2	CFI	RMSEA	χ^2	CFI		RMSEA	χ^2	CFI	RMSEA		χ^2	CFI
Mediator=Pros	df = 359			df = 281			df = 359			df = 281		
Consciousness Raising	902.0	.965	.040	1185.1	.954	.058	592.5	.961	.039	607.5	.948	.053
Dramatic Relief	914.4	.967	.041	1231.8	.946	.060	623.4	.958	.042	613.4	.949	.053
Environmental Reevaluation	960.3	.961	.042	1195.6	.943	.059	723.8	.937	.050	659.0	.936	.057
Self-Reevaluation	1017.9	.963	.044	1332.7	.944	.063	684.6	.950	.046	653.5	.945	.056
Social Liberation	904.5	.965	.040	1194.1	.944	.059	643.7	.952	.043	665.1	.938	.057
Counter Conditioning	1186.6	.947	.049	1202.8	.943	.059	818.7	.930	.055	627.1	.946	.054
Helping Relationship	954.1	.963	.042	1235.9	.943	.060	694.0	.948	.047	636.7	.946	.054
Reinforcement Management	906.2	.961	.040	1202.1	.938	.059	601.9	.957	.040	576.4	.949	.050
Self-Liberation	1048.5	.956	.045	1233.6	.942	.060	680.1	.946	.064	636.1	.943	.055
Mediator=Cons	df = 359			df = 281			df = 359			df = 281		
Consciousness Raising	1115.8	.951	.047	787.6	.966	.044	671.7	.951	.045	492.4	.966	.042
Dramatic Relief	1050.9	.958	.045	765.3	.970	.043	659.7	.956	.045	462.6	.972	.039
Environmental Reevaluation	1159.9	.958	.045	1000.8	.952	.052	703.6	.943	.048	511.4	.961	.045
Self-Reevaluation	1127.4	.955	.048	961.9	.960	.051	695.2	.951	.047	507.1	.966	.044
Social Liberation	980.9	.960	.043	737.2	.971	.041	687.0	.950	.047	523.6	.962	.045
Counter Conditioning	1208.9	.947	.050	644.3	.977	.037	813.1	.935	.055	429.5	.978	.036
Helping Relationship	957.8	.963	.042	721.0	.973	.041	717.5	.949	.049	461.2	.973	.034
Reinforcement Management	989.6	.956	.043	673.3	.972	.039	653.7	.953	.044	415.2	.978	.034
Self-Liberation	1289.7	.940	.052	932.8	.957	.050	790.4	.933	.053	535.1	.959	.046

Table 3

Longitudinal Regression Paths between Processes of Change (X; baseline) and Mediator (M; Pros, Cons Self-Efficacy; 6-month), and between Mediator and Outcome (Y; sun avoidance and sunscreen use; 12-month) for Precontemplation and Preparation

List of Predictors	Precontemplation				Preparation			
	Sun Avoidance		Sunscreen Use		Sun Avoidance		Sunscreen Use	
	X->M	M->Y	X->M	M->Y	X->M	M->Y	X->M	M->Y
Mediator=Pros								
Consciousness Raising	.383*	.227*	.401*	.230*	.525*	.235*	.546*	.236*
Dramatic Relief	.371*	.199*	.375*	.206*	.156*	.271*	.205*	.206*
Environmental Reevaluation	.245*	.183*	.348*	.252*	.462*	.253*	.614*	.145*
Self-Reevaluation	.385*	.243*	.398*	.237*	.271*	.257*	.285*	.208*
Social Liberation	.266*	.200*	.284*	.230*	.126*	.230*	.129*	.202*
Counter Conditioning	.305*	.190*	.285*	.214*	.311*	.263*	.307*	.181*
Helping Relationship	.305*	.191*	.301*	.217*	.401*	.239*	.399*	.200*
Reinforcement Management	.299*	.198*	.288*	.225*	.019	.234*	.028	.186*
Self-Liberation	.408*	.221*	.470*	.272*	.013	.308*	.013	.229*
Mediator=Cons								
Consciousness Raising	-.145*	-.013	-.129*	-.028	-.044	-.114*	-.043	-.017
Dramatic Relief	-.019	-.012	-.016	-.019	-.030	-.109*	-.007	-.016
Environmental Reevaluation	-.022	-.021	-.032	-.023	-.195*	-.104*	-.194*	-.009
Self-Reevaluation	-.062	-.035	-.061	-.014	-.017	-.122*	-.023	-.090
Social Liberation	-.071	-.023	-.057	-.021	-.081	-.113*	-.083	-.003
Counter Conditioning	-.194*	-.046	-.176*	-.011	-.150*	-.106*	-.154*	-.036
Helping Relationship	-.079	-.023	-.079	-.020	-.087	-.117*	-.043	-.026
Reinforcement Management	-.063	-.025	-.046	-.017	-.083	-.104*	-.061	-.013
Self-Liberation	-.062	-.035	-.084	-.012	-.100*	-.127*	-.079	-.001

* p < .05