Student Column

EVALUATING A THEORETICAL MODEL OF INDOOR TANNING USING STRUCTURAL EQUATION MODELING

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Skin cancer incidence has increased during the last 20 years,[1] and research now demonstrates a link between purposeful ultraviolet exposure through indoor tanning and skin cancer.[2,3] The International Agency for Research on Cancer has assigned indoor tanning to its highest cancer risk category, "carcinogenic to humans," joining asbestos, tobacco, arsenic, and mustard gas.[4]

Although research on indoor tanning has increased during the past 20 years, from one article in 1990 to more than 24 articles in 2009, few published studies have reported on the utility of health behavior theories in predicting indoor tanning intentions and behavior. Most published research highlights a single construct, or small selection of constructs, rather than fitting a complete health behavior theory to indoor tanning. For example, Greene and Brinn report perceived susceptibility and perceived threat from the Health Belief Model as significant predictors of indoor tanning intentions and behavior.[5] The belief that tanning is safer indoors than outdoors has also been shown to predict indoor tanning.[6] Peer modeling from the Social Cognitive Theory has been reported as a significant predictor.[7,8] Gibbons and colleagues applied selected constructs from the Prototype Willingness Model including willingness, vulnerability, and perception of prototype tanners in a study of indoor tanning in college students.[9]

Several studies have examined the theory of reasoned action (TRA), the theory of planned behavior (TPB), and the behavioral alternative model (BAM) in predicting indoor tanning intentions and behavior.[10–12] The TRA examines behavior predicted by intentions, which are influenced by self attitudes and the attitudes of significant others (i.e., subjective norms). The TPB adds behavioral control as a predictor of both intentions and behavior, while the BAM includes attitudes and intentions toward viable alternative behaviors to predict the behavior of interest. The TRA and TPB appear to predict indoor tanning intentions and behavior well,[11–14] and the BAM has been successful in modeling indoor tanning behavior.[13,15]

While TRA and TPB have generally but not universally been shown to predict health behaviors across a variety of domains, effect sizes vary widely.[16] Furthermore, the process of translating theoretical models of health behavior into efficacious interventions directed toward the behavior requires a detailed understanding of the path loadings associated with the specific health behavior.[17] The process involves empirically modeling the health-related behavior (e.g., indoor tanning), testing the model in the targeted population, then adjusting and expanding the model to identify constructs that represent impact points of intervention.[18] Despite the fact that health behavior theories are generally found to be reasonable predictors of health behaviors, it is important to publish the specific models with path loadings that are associated with efficacious interventions so that the interventions can be modified and improved for future interventions.

We report on an empirical evaluation of a theoretical model of indoor tanning based on the theory of reasoned action, which formed the basis of several efficacious randomized controlled trial (RCT) interventions.[18,19] The intervention was translated from the model using the previously described process. Despite the success of these RCT interventions, a formal test of the model guiding them has never been published. Formally testing and reporting on this model in the context of structural equation modeling (SEM) will provide important information for skin cancer prevention so that these interventions can be further tailored and improved.

METHODS

Sample

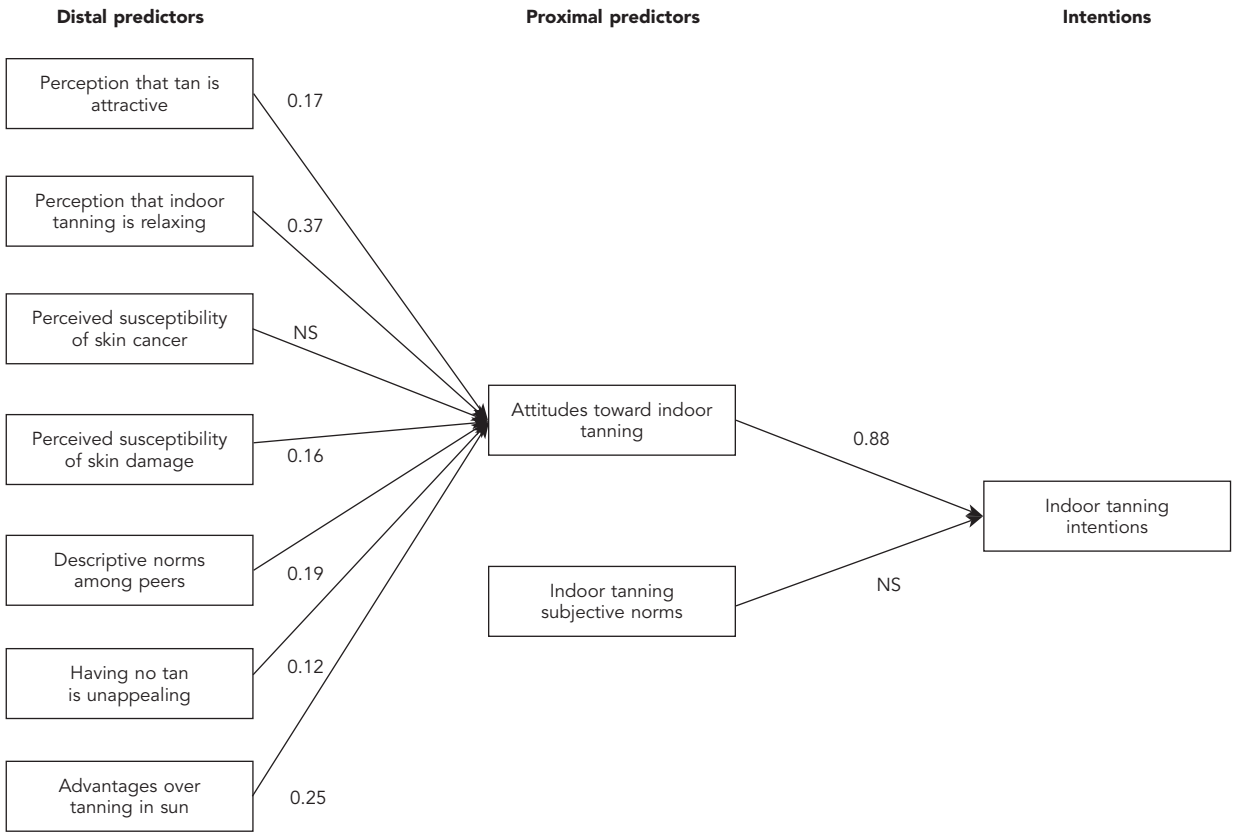
Respondents included 384 students from a southeastern U.S. city (median age = 21.8 years, standard deviation = 4.92) participating in research for extra credit. The sample was predominantly female (78.4%), single (93%), and Caucasian (91%), matching national samples of indoor tanners well (i.e., 77% females and 85% Caucasian).[20,21]

Procedures

After completing informed consents, respondents completed a 45-minute battery of questionnaires from October 2009 to May 2010. The questionnaire assessed model constructs that appear in the Figure. All scales have been successfully used in previously published research with indoor tanners.

These scales were developed in earlier work in which

Figure. Model specification and parameter estimates relating to the theoretical model of indoor tanning



NS = not significant

confirmatory factor analysis (CFA) was conducted to establish convergent and discriminant validity (listwise n=269). CFA analyses indicated good model fit, with strong evidence of convergent and discriminant validity among the constructs (i.e., items loaded significantly on their own construct [all $p<0.001$], with no significant cross-loadings). Test-retest reliability estimates from an independent sample (n=300) were uniformly high (r=0.83–0.95). Correlations between scales and a measure of social desirability[22] were low and non-significant ($p>0.10$), suggesting minimal social desirability influence.

RESULTS

The factor structure in the measurement model (Figure) was confirmed via structural equation analyses. The residuals (measurement errors) were assumed to be uncorrelated. The model fit and parameter estimates were evaluated using a sample covariance matrix as input and maximum likelihood function in AMOS 18.0.[23] The models were statistically overidentified. The Chi-square statistic acts as a general estimation of dissimilarity of the sample covariances from the model prediction.[24] A non-significant Chi-square indicates that the predicted model is congruent with the observed data. However, it is difficult to obtain non-significant Chi-square statistics when sample sizes are >200, so it is important to consider other fit indices.[25]

The comparative fit index (CFI) is a normed index frequently used as an adjunct to the Chi-square statistic. CFI estimates the degree to which the model being tested fits the data better than models with uncorrelated variables. A model with a CFI >0.95 is considered to have acceptable fit.[26] The root mean square error of approximation (RMSEA) estimates average error in the model, which is then squared to produce an index similar to the standardized root mean square measure from analysis of variance.[27] A model with an RMSEA ≤0.05 is considered a good fit.[28]

Results can be found in the Figure. Correlations between predictors are not represented in the model.

The data fit the model well. While Chi-square was significant (χ^2 (276)=363.5, p=0.001), the RMSEA was small indicating low error (RMSEA=0.027, 95% confidence interval 0.018, 0.035) and the CFI showed an excellent fit (0.991). Examination of path coefficients revealed a statistically significant effect for indoor tanning attitudes with indoor tanning intentions (r=0.88). Significant zero-order correlations with indoor tanning attitudes were observed for the belief that tans are attractive (r=0.17), the perception that indoor tanning is relaxing (r=0.37), the perceived susceptibility to skin appearance damage (r=−0.16), indoor tanning descriptive norms (r=0.19), the belief that not being tan is unappealing (r=0.12), and the belief that indoor tanning has advantages over sun tanning (r=0.25). Overall, these beliefs accounted for 62% of indoor tanning attitude variance (data not shown).

DISCUSSION

Summary

We tested an extension of the TRA that formed the basis of several successful skin cancer prevention RCT interventions. The data fit the model well, accounting for more than 70% of the indoor tanning intention variance. Interestingly, perceived vulnerability to appearance-related skin damage, but not perceived cancer vulnerability, significantly predicted indoor tanning attitudes. This finding supports literature that finds appearance concerns are more important than health concerns with youth tanning behavior.[9,18,29] Perceptions of peer tanning were also significantly related to indoor tanning attitudes, indicating that those with whom we interact daily influence our tanning decisions.[30]

The belief that indoor tanning is relaxing and relieves stress proved to be more strongly associated with positive indoor tanning attitudes than the belief that a tan improves appearance. There is growing evidence that stress relief, relaxation, and dependence issues are important in driving tanners' decisions.[31–33]

Examining zero-order relationships, it is clear that individual underlying beliefs or perceptions do not account for large amounts of indoor tanning attitude variance. However, taken together, they account for substantial amounts of indoor tanning attitude variance. This finding further emphasizes the importance of a multivariate, theoretical approach to health-related behaviors such as tanning. Interventions that only impact one or two beliefs are likely to have a small behavioral effect. However, the model predicts that changing the beliefs and perceptions even a small amount can lead to relatively large changes in intentions and, ultimately, behavior.

The theoretical model reported in this study was successfully translated into an efficacious skin cancer prevention intervention by empirically testing the model in the target populations, examining the path loadings of the model, and then expanding the model to include beliefs and cognitions that could be targeted in an educational intervention. Mediation analyses from the RCTs confirmed the importance of changes in the model constructs targeted for the final outcomes. Despite this confirmation, an evaluation of the original model with details on path loadings has never been published. This study provides information that will be useful to adapt and tailor this intervention to improve efficacy.

Limitations

This study was limited by a cross-sectional sample of college students. However, epidemiologic data indicate that college-age individuals represent an important target audience with high rates of indoor tanning.[34] There is also evidence that regular indoor tanning during this period significantly increases the risk of melanoma development.[3,35]

CONCLUSIONS

Through SEM, we confirmed the fit including path loadings of the model used to develop an intervention that has successfully reduced tanning intentions and behavior in young women in two RCT interventions.[18,19] Future work could expand the testing of this model in a more nationally representative sample using a longitudinal design and compare it with other health behavior models. Such work will provide information that can be used to further tailor and improve the existing intervention. Despite the fact that youthful tanning can appear to be a difficult behavior to understand and change, the use of carefully constructed and empirically tested models to identify key variables should allow public health success in reducing future skin cancer risk behaviors.

The study received Institutional Review Board (IRB) approval from East Tennessee State University's IRB.

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