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Concurrent Psychosocial Predictors of Sun Safety Among Middle School Youth*

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Abstract

BACKGROUND—Sun-induced skin damage, which increases skin cancer risk, is initiated in early life and promoted through later sun exposure patterns. If sun safety determinants are well understood and addressed during the school years, skin cancer incidence might be reduced. This study tested psychosocial influences on youth's sun safety and assessed their strength within and across gender and ethnicity in a sample of 1782 middle school students.

METHODS—Predictors included sunburn and skin cancer knowledge, tanning attitudes, peer norms, and barriers regarding sun exposure and were assessed with a self-administered, validated questionnaire. The hypothesized relationships were tested with structural equation models and confirmed with multilevel regression.

RESULTS—Across gender and ethnicity, knowledge emerged as an important sun safety predictor with both direct and indirect effects mediated through tanning attitudes. The relationship with barriers did not reach statistical significance within any of the subgroups, possibly due to measurement limitations. An indirect effect of peer norms on sun safety, mediated through tanning attitudes, was confirmed only among girls. Also, an indication that peer norms operate differently

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within the ethnic groups was found, since this predictor had a statistically significantly stronger relationship with sun safety among non-Hispanics.

CONCLUSIONS—Youth's sun safety is a multifactorial practice, partially determined by ethnicity- and gender-based standards. In order to ensure health-promoting school environments, needed are multicomponent programs where peer norms and knowledge are salient and where sun safety is addressed individually and together with other health risk behaviors.

Keywords

adolescents; sun safety; psychosocial factors; structural equation models

Evidence suggests that sun-induced skin damage, which increases skin cancer risk, is initiated in early life and promoted through later sun exposure patterns.^{1,2} However, adolescents have the lowest sun safety rates of all age groups.³ Only about a third of US youth report routine sun safety.^{4–6} Generally, boys practice less sun protection,^{4,5} whereas girls display more sun safety knowledge.^{7–9} Yet, girls are more likely to tan.^{10–12} No gender differences in sunburn rates have been observed.^{7,13,14} Also, own and peer appearance attitudes are important sun safety predictors across gender.^{4,5,8,15}

Due to the complex relationships among the sun safety predictors (eg, a positive association between skin cancer knowledge and tanning among girls), the lack of clear gender-specific patterns, and the interdependence among the sun protection methods (eg, use of sunscreen might obviate the need for shade), more careful work on the predictors and across subgroups is warranted. The purpose of this study was to test psychosocial associations with youth's sun safety in order to broaden knowledge about concurrent influences, as well as to assess their strength within and across gender and ethnicity. Structural equation modeling (SEM) was chosen because of its flexibility in specifying theory-driven models.¹⁶ Particularly, the direct and indirect effects of knowledge, tanning proclivity, perceived barriers, and peer norms about sun safety were assessed. The selected constructs were grounded in social cognitive theory.¹⁷ It highlights the reciprocal interaction of personal factors (knowledge, attitudes), behavior (sun safety), and the social and physical environment (peer norms about outdoor sun exposure), as well as the importance of observing and modeling behavior of similar others. Perceived barriers tapped into beliefs about factors that might hinder sun protection and were thus derived from the theory of planned behavior.¹⁸

Our main hypotheses pertained to directional links between sun safety and each of the psychosocial constructs. Specifically, negative influences on sun safety for all factors except knowledge were predicted. Led by the literature and findings on mediation,¹⁹ indirect effects of knowledge and peer norms on sun safety via the tanning and barriers constructs were also hypothesized. Finally, tanning proclivity was expected to be a stronger predictor of sun safety among girls than boys. The proposed recursive model is presented in Figure 1.

METHODS

Subjects

Baseline data from sixth- through eighth-grade students (aged 11–15 years) from 30 schools in Colorado, New Mexico, and Arizona were used. Subjects were recruited for a group-randomized controlled trial designed to evaluate the *Sunny Days, Healthy Ways* curriculum. Details on recruitment, construct selection, psychometrics, and intervention results are published elsewhere.^{19–21} Briefly, schools were enrolled upon obtaining consent from principals and district personnel. All forms and procedures were approved by each site's

institutional review board. Students who had signed informed assent forms and had parental consent were included in the study.

Instruments and Procedures

Data from Colorado and some of the New Mexico schools were obtained during the early spring of the 2001–2002 school year; data from Arizona and the remainder of the New Mexico schools were collected during the spring of the 2002–2003 school year. Trained research staff conducted the assessments in the classrooms in teachers' presence. Students completed self-administered, validated 70-item questionnaires. Sun safety during the previous month was the main outcome and was assessed with 6 primary prevention items (eg, use of sunscreen with sun protection factor (SPF) of at least 15; wearing protective clothing, hats, and sunglasses; staying in the shade; and limiting midday sun exposure). Response options ranged from 1 = "always" to 5 = "never," and a lower score indicated more sun safety. Perceived barriers (10 items) and peer norms (4 items) were measured with attitude scales with possible responses ranging from 1 = "strongly disagree" to 5 = "strongly agree." A lower score on either measure indicated less importance of that construct. The 2-week test-retest kappa statistic for barriers and peer norms was .67.²⁰

Knowledge was measured with 10 true/false items, and lower scores indicated less knowledge. The 2-week test-retest kappa statistic for knowledge was .39. Although the kappa was low, concordance rates were over 80%.²⁰ For SEM purposes, 2 summary knowledge variables were created—one capturing knowledge about sunburn (6 items) and the other capturing knowledge about skin cancer (4 items). Finally, 5 items assessed tanning proclivity over the past month, 2 of which assessed behavior and 3 items assessed attitudes. A lower score indicated less preference for tanning.

Data Analysis

Initial univariate and bivariate linear regression analyses, followed by exploratory factor analyses (EFAs), were performed using SAS version 9.0.²² Principal component EFAs with oblique and orthogonal rotations were used in selecting the most reliable measures. Since the factors were not highly correlated (all correlations < .27), results from the orthogonal rotation were retained. The selected indicators were chosen because of their high factor loadings, satisfactory distribution, and the amount of variance explained. All selected factors had eigenvalues greater than 1.0. Next, the hypothesized measurement model was ascertained by confirmatory factor analyses. Finally, SEM with standardized covariance matrices as input, maximum likelihood function with robust estimation, and Lagrange multiplier tests were employed in evaluating the overall model fit and the parameter estimates.

The structural model included unidirectional paths from the psychosocial predictors, as well as correlations between knowledge and peer norms and between tanning and barriers. The model was evaluated with the goodness-of-fit chi-square statistic. Although the large sample was an advantage of the study, it inflated chi-square values, thus compromising the potential for establishing statistical fit. Therefore, 2 approximate fit indices robust to sample size²³ were used: the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Conventionally, CFI values of 0.95 or greater and/or RMSEA values of 0.06 or lower signify appropriate fit.^{16,24} Model fitting and estimation procedures were performed with EQS, version 6.1 for Windows,²⁵ and the provided p values are 2 sided.

Our data are considered multilevel structured with students clustered within schools. However, statistical software and methods for multilevel SEM for the examination of cluster effects and control for the dependence among observations (and the potential inflation of

type I error) are not readily available. One way to investigate the influence of clustering is to conduct multilevel regressions using SAS. For this purpose, the variables were recoded into continuous summary scores, which were then modeled (without predictors) as fixed effects while modeling school as a random effect. Finally, intraclass correlation coefficients (ICCs) were calculated in order to estimate the correlation among observations within each cluster (ie, school). Only ICCs greater than 0.03 are considered to have nonnegligible effects, possibly reducing the standard errors of the statistical estimates.²⁶ In order to adjust the SEM results for the effect of clustering, design effect values²⁶ that take into account both the ICC and the average cluster size were calculated and applied.

RESULTS

The total number of subjects was 2038 with a median age of 13 years. There were more girls (57%) than boys. About a quarter of the participants were Hispanic, and close to 80% (Hispanic and non-Hispanic) were white. For SEM purposes, observations with missing values were deleted, reducing the sample to 1782 (87%). Characteristics of the final study sample are presented in Table 1. There were no demographic differences between the samples with missing and nonmissing data, except for the latter having somewhat more non-Hispanics (ie, 67% vs 75%). On average, there were 59 subjects per school.

Exploratory Factor Analyses

Factor loadings from the EFA are summarized in Table 2. The following sun safety indicators were retained for SEM: wearing protective clothing, limiting midday sun exposure, and use of shade. These were the most reliable items with the highest factor loadings. Thus, all subsequent references to sun safety do not imply sunscreen use. For the barriers construct, the empirically strongest items were availability of shady places, difficulty in choosing sunscreen, and location of sunscreen. Because of the potential for substitution among the sun protection methods (ie, staying in the shade might obviate the need for applying sunscreen), the sunscreen-related barrier items were retained even though sunscreen use was not retained as an outcome.

Importance of having a tan, attractiveness of a good tan, and desire for a tan were retained for the tanning construct. Hence, it was assessed by tanning attitudes, which had higher reliabilities in our sample, rather than by tanning behavior. Finally, the 2 summary knowledge variables loaded highly on a single “knowledge” factor. Overall, 15 indicators were retained for SEM, all of which had significant zero-order correlations with sun safety, suggesting the importance of each of these predictors.

Preliminary Analyses

The *t* tests and linear regression models revealed no significant differences in sun safety by gender, age (11–13 vs 14–15 years), or ethnicity (Hispanic vs non-Hispanic). Perceived peer norms also appeared the same across demographic groups. There were no differences in perceived barriers or knowledge about sunburn between boys and girls. Compared to boys, however, girls had slightly higher tan-related scores ($p < .0001$) and slightly more knowledge about skin cancer ($p < .05$). Linear regressions and *t* tests by Hispanic ethnicity revealed significant differences in knowledge, barriers, and the tan-related variables (all $p < .0001$) with Hispanics having lower scores on the knowledge and tan-related measures and slightly higher scores on barriers. Finally, *t* tests by age group revealed expected differences in knowledge and tanning attitudes ($p < .0001$) with older students having higher scores on these variables than their younger counterparts.

SEM With Full Sample

The proposed model was tested within and across gender and ethnic groups. Due to significant differences in knowledge and tanning attitudes by age and Hispanic ethnicity, these variables were included as covariates in the SEM. Results showed a good empirical fit between the conceptual model and the data. Both the CFI (0.96) and the RMSEA (0.03) demonstrated that the model had accounted for a substantial portion of the variation among the observed variables despite the large chi-square value of 259.7 ($p < .0001$). As seen by the effect sizes (eg, the standardized SEM solution) in Figure 2, the hypothesized relationships of knowledge, peer norms, and tanning attitudes with sun safety were statistically significant. Knowledge had the strongest influence on sun safety, displaying significant direct and indirect effects mediated through tanning attitudes. Finally, there were no significant correlations between knowledge and peer norms or between tanning attitudes and barriers to sun safety.

SEM With Multiple Groups

To assess the moderating effects of gender and Hispanic ethnicity, multiple group comparisons were conducted according to the procedures outlined by Pentz and Chou²⁷ and Byrne et al.^{28,29} First, a separate measurement model was established for each group. Then, relying on theory and the Lagrange multiplier test, adequate fit for each model was pursued by adding meaningful paths. The next steps entailed combining the groups and testing for equality by sequentially imposing and releasing constraints.

Globally, the subgroup results were consistent with those from the full sample. The effect sizes from the model comparing boys and girls are presented in Figure 3. The same direct and indirect effects were observed within the 2 groups with 1 exception. Namely, a unique finding among girls included a significant indirect effect of perceived peer norms on sun safety mediated through tanning attitudes. There was some indication of differential reliability of the measures, evidenced by the significance of some of the constrained regression paths, and a somewhat stronger empirical fit among boys. For example, the perception of suntan as attractive differed significantly between the genders ($p < .03$), with the estimate being slightly more stable among boys. Also, the link between peer norms and barriers to sun safety, which was significant for both genders, was stronger among boys ($p < .04$). With these exceptions, the overall results supported the equivalency of the 2 groups ($\chi^2 = 264.6$, $df = 166$, $p < .0001$, CFI = 0.97, RMSEA < 0.02).

Results from the ethnic group analyses are presented in Figure 4. The major findings were again replicated. An exception pertained to a significant negative correlation between knowledge and peer norms only among Hispanics. Additionally, the relationship between peer norms and sun safety—significant in both groups—had a stronger estimate among non-Hispanics ($p = .05$). Also, the estimates for peer norms regarding sunscreen and hat use and desire for a tan displayed higher stability among Hispanics (all $p < .005$). A perfect empirical model fit was observed among Hispanics (CFI = 1.0, RMSEA = 0.00). Nonetheless, the empirical fit was strong among non-Hispanics as well. With these exceptions, the results again supported the equivalency of the 2 groups ($\chi^2 = 254.2$, $df = 167$, $p < .0001$, CFI = 0.98, RMSEA < 0.02).

Post Hoc Multilevel Regression

In order to assess cluster effects (since our data are multilevel structured), multilevel models without predictors were conducted, where school was a random effect and the SEM variables were fixed effects. The results did not change appreciably from those obtained with SEM. For the purpose of increasing the confidence in our findings, ICCs were also calculated. Of the 19 variables, 7 had ICC greater than 0.03, primarily the variables related

to tanning, knowledge, and use of protective clothing and shade. Next, design effect values (which can only be positive) were calculated in order to examine the extent to which the standard errors of the estimates were deflated as a result of the clustering. The mean design effect was 1.75. In general, the closer the value is to 1.00, the smaller the clustering impact. Finally, each unadjusted standard error was multiplied by the corresponding design effect, and the significance of the corrected test statistics was examined using *z* distributions. Test statistics (ie, each regression path) remained highly significant after these adjustments, hence clustering effects in this study are likely trivial.

DISCUSSION

As hypothesized and consistent with prior findings, significant concurrent psychosocial predictors of sun safety among youth included knowledge about sunburn and skin cancer, perceived peer norms about sun safety, and tanning attitudes. Using the full sample, knowledge emerged as an important predictor with both direct and indirect effects on sun safety mediated through tanning attitudes. Whereas some studies report a weak or nonsignificant relationship between knowledge and sun protection,^{7,9,14,30} it is possible that as a result of different school-based educational efforts, awareness about the importance of sun safety is increasing. In line with some previous findings (particularly among girls) and contrary to our hypothesis, a positive relationship between knowledge and tanning attitudes across gender and ethnicity emerged. Perhaps tanning norms are so strong among adolescents that they use sun safety information to determine how to tan “safely” (ie, without sunburning). This would be an unfortunate misinterpretation of sun safety education.

The path between perceived barriers and sun safety did not reach statistical significance within any of the models. This might be due to some discrepancy between the assessed behaviors. As noted earlier, the barriers construct tapped into convenience of sunscreen use and availability of shade, which were empirically the strongest barrier items. Because of the potential for substitution among the sun protection methods (ie, staying in the shade might obviate the need for applying sunscreen), our models were not jeopardized by retaining sunscreen-related barrier items even though sunscreen was not retained as an outcome. The latter was again dictated by EFA results.

During adolescence, gender-based sun safety standards become apparent;³¹ therefore, the conceptual model was tested within gender. The findings were similar to those obtained on the full sample with a few exceptions. The hypothesized indirect effect of peer norms on sun safety was confirmed only among girls. Also, the influence of peer norms on barriers—significant for both genders—was stronger among boys. For both genders, knowledge and tanning attitudes emerged as the strongest determinants of sun safety, with the latter displaying a stronger influence among girls.

The analyses comparing Hispanics and non-Hispanics revealed similar direct and indirect effects. Again, knowledge emerged as the strongest sun safety predictor for both groups. However, the hypothesized negative correlation between knowledge and peer norms was confirmed only among Hispanics. Another difference between the groups pertained to the effect of peer norms, which had a statistically significantly stronger relationship with sun safety among non-Hispanics. Tanning norms may not be as pronounced in Hispanics, possibly because often (although not always) they have darker skin tones. Thus, when taught about sun safety, they might be more comfortable reducing their sun exposure than are non-Hispanic whites, who may derive greater social benefits from tanning. Nonetheless, peer norms could be quite important regarding skin cancer risk if sun safety seems unnecessary to most Hispanic youth. Overall, our findings indicate that sun safety is a multifactorial

practice, partially determined by sociocultural factors such as ethnicity-and gender-based standards.

Despite the significant, consistent findings and the strengths of the study, which include a relatively simple, theory-driven model supported across gender and Hispanic ethnicity in a large subject sample, several limitations need to be acknowledged. First, the knowledge kappa statistic was low. However, since knowledge was a true/false measure, the kappa was not the most appropriate reliability statistic. Therefore, concordance rates were computed, which were over 80%. It is also reassuring that in EFA, the 2 summary knowledge variables loaded highly on a single factor. Finally, knowledge was an important construct in our study, dictated by social cognitive theory, and demonstrated robust, significant effects in SEM. Nonetheless, future research should replicate the present findings with strong, multiple-category knowledge measures.

Another limitation pertains to the composition of the outcome. As already noted, the construct captured limiting midday sun exposure and use of protective clothing and shade, which were the most reliable sun safety items. Thus, the outcome did not explicitly assess sunscreen use. Whereas sunscreen is a popular method of sun protection among youth,^{6,7} the measures that were used are also important.^{4,32} In addition, our research was strengthened by the use of sun safety items without known disparate prevalence among boys and girls. Sunscreen, however, has been shown to have much higher rates of use among girls.^{6,7}

The use of self-reports constitutes another limitation of the study. Whereas no gold standard for the assessment of sun safety exists, research suggests that adolescent self-reports of sun protection and time spent outdoors are relatively reliable and valid.^{21,33,34} Next, our data were cross-sectional, and the observed relationships should be considered associational and not causal despite implications for directional effects. Further, the time of year when measurements took place might render our findings somewhat conservative. More sun protection was practiced later in the study period due to seasonal increase in ultraviolet radiation.²⁰ Generalizability of the results is also somewhat limited because our sample was composed predominantly of young white adolescents in the western United States. Melanoma, however, is primarily a disease of whites, whose rates are over 10 times higher than those in blacks.³⁵ Finally, clustering Hispanics into a single ethnic group represents another limitation. Future studies should replicate the findings with well-defined multiethnic samples, longitudinally, and with older adolescents who may have different peer norms and social circumstances.

Overall, using SEM, the study expanded knowledge about concurrent psychosocial predictors of adolescent sun safety. This statistical method represents a confirmatory approach to multivariate analysis whose advantages include modeling observed and latent constructs, simultaneous testing of several directional hypotheses, and capacity to produce unbiased estimates by controlling for measurement error.

In conclusion, sun exposure and tanning seem to represent an aspect of a continuum of different health risk behaviors prevalent among school-aged youth, which are associated with self-presentation motives.³⁶ Research with Connecticut schoolchildren, for example, demonstrated that those who did not use sun protection were more likely to smoke cigarettes and consume alcohol.⁵ In order to ensure health-promoting school environments, it is necessary to continue implementing multicomponent programs where peer norms and knowledge are salient and to deal with sun safety individually and together with other risk behaviors. According to behavioral theory, it is easier to acquire sun-safe habits during the school years than to undo harmful habits later.³⁷ If sun safety is successfully addressed in school curricula, a reduction in skin cancer incidence later in life might be likely to follow.

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Figure 1.
Conceptual Structural Model of Sun Safety Among Middle School Youth

Figure 2.
Effect Sizes in the Structural Model of Sun Safety Among Middle School Youth (Full Sample; Standardized Solution)

Figure 3.
Effect Sizes in the Structural Model Comparing Boys and Girls (Standardized Solution;
Results for Boys in Parentheses)

Figure 4.
Effect Sizes in the Structural Model Comparing Non-Hispanic and Hispanic Students
(Standardized Solution; Results for Hispanics in Parentheses)

Table 1

Demographic Characteristics of Sample With Complete Data (N = 1782)

	N	%
Gender		
Girls	1011	57
Boys	771	43
Age (years)		
11	52	3
12	450	25
13	874	49
14	402	23
15	4	0
Ethnicity		
Hispanic	437	25
Non-Hispanic	1345	75

Table 2

Exploratory Factor Analysis Results (N = 2038)

	Factor Loading
Sun safety (outcome)	
Protective clothing	0.64
Limit midday sun exposure	0.73
Use of shade	0.68
Tanning attitudes	
Importance of tan	0.71
Attractiveness of tan	0.86
Desire for tan	0.87
Perceived peer norms	
Friends' attitude about sun avoidance	0.71
Friends' attitude about using sunscreen	0.65
Friends' attitude about wearing long sleeves/pants	0.55
Friends' attitude about wearing hat	0.69
Knowledge	
Knowledge about sunburns	0.86
Knowledge about skin cancer	0.86
Barriers to sun safety	
Not enough shady places	0.42
Hard to choose sunscreen	0.79
Sunscreen inconveniently located	0.69