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Abstract

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Keywords

among, adolescents, exposure, ultraviolet, indicators, simultaneously, relationship, their, testing, behaviors, exposing, protecting, sun

Disciplines

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Sun Protecting and Sun Exposing Behaviors: Testing Their Relationship Simultaneously with Indicators of Ultraviolet Exposure Among Adolescents

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Abstract

The aim of this study was to build on existing understanding of adolescent sun-related behavior by combining sun protecting and sun exposing behaviors and testing their relationship simultaneously with indicators of ultraviolet (UV) exposure. Data were collected for 692 adolescents aged between 12 and 18 years. General linear modeling was undertaken to test the relationship of sun-related behaviors with indicators of UV exposure. Overall, the combined sun protection and sun exposing behaviors accounted for 13.8% of the variance in the number of sunburns, 28.1% of the variance in current tan and 57.5% of the variance in desired tan, respectively. Results indicated that having a strong desire for a tan was significantly associated with spending time tanning, delaying the use of sun protection, wearing brief clothing and using no sun protection; whereas the number of sunburns was significantly associated with sunscreen use, avoiding peak hours and delaying sun protection. Current tan was significantly associated with wearing sunglasses, shade use and time spent tanning. In examining sun-related behaviors among adolescents, consideration needs to be given to both sun exposing and sun protecting behaviors. This research has important implications for conceptualizing outcomes in programs designed to reduce UV exposure.

Introduction

Adolescents may choose to both protect their skin and expose their skin to the sun. For example, a young person who wears a hat may also deliberately wear brief clothing to get a tan. Existing literature on ultraviolet (UV) exposure among adolescents has seldom focused on the interaction between sun protecting and sun exposing behaviors. Understanding the relationship between sun exposing and sun protecting behaviors can inform the development of effective interventions targeting reduced UV exposure among adolescents and facilitate the evaluation of programs through a more detailed understanding of adolescent UV exposure. In this article, we combine specific sun exposing behaviors with sun protecting behaviors and determine their relationship simultaneously with indicators of UV exposure.

‘‘Sun exposing’’ and ‘‘sun protecting’’ are related, but conceptually different behaviors, not simply opposite ends of a continuum from protection to exposure. An increasing body of evidence has identified different psychosocial pathways for sun exposing behaviors and sun protecting behaviors (1–4), suggesting that adolescents make separate choices to protect their skin from the sun and to expose their skin to the sun. Both sun protecting and sun exposing behaviors have been related to perceived susceptibility to skin cancer and premature aged skin. However, sun protecting behaviors are also related to peer sun protection behaviors, perceived barriers to use of sunscreen and self-efficacy of sunscreen use (1,5–8). Sun exposing behaviors have been associated with peer sunbathing norms, relaxation and appearance concerns (1,4,9,10).

Surveys of sun protection behaviors among adolescents have shown generally low compliance with recommended guidelines for sun protection (11,12). Despite extensive investigation into sun protection behaviors, there has been limited analysis of the elements of sun exposing behaviors and, specifically, the differentiation between intentional and incidental sun exposure (13). Intentional sun exposure is defined as ‘‘exposure to the sun with the primary purpose of achieving a biologic response such as a tan, usually with limited attention to sun protection and maximal concern for extended exposure’’ (14, p. 211) and incidental sun exposure as ‘‘a result of being outdoors without adequate protection, whereas pursuing activities not directed exclusively at obtaining a tan’’ (14, p.

211). The aim of this study was to assess specific sun protecting and sun exposing behaviors, and test their relationship simultaneously with indicators of ultraviolet (UV) exposure.

Materials And Methods

Participants. The study adopted a convenience sampling strategy to recruit adolescents aged 12–18 years. A third of the participants were aged 14 years (31%) (M = 15.0, SD = 1.65), and the majority were female (64%).

Sample selection. Three methods of recruitment were used: schools, online and via a regional Australian university's promotional events. Schools were selected based on their geographic location. All schools were located within a single local government area of a coastal community in eastern Australia. Ethics approval was sought from the representing education office for each school. All schools meeting the eligibility criteria were invited to participate in the study (a total of six independent and Catholic secondary schools); two schools agreed to participate, one independent school and one Catholic school. An advertisement for the survey was placed on the social networking site, Facebook. The advertisement was promoted to individuals with a Facebook account who were aged between 12 and 18 years of age. To avoid individuals from the school sample completing the survey online, the online promotion was limited to individuals whose location, as defined by Facebook, was within a 25 kilometer radius of the city of Sydney in eastern Australia, *ca* 80 km north of the regional city. Participants were also recruited at information evenings held by the regional university for year 12 students; none of these students were from the participating schools. Significant differences existed in age ($\chi 2$ [14] = 574.18 P = 0.000) and gender ($\chi 2$ [2] = 10.12 P = 0.006) profile by sample selection method.

All participants, irrespective of the method of recruitment, were made aware prior to providing their consent that the survey related to sun protection. Participation was voluntary, with participants advised prior to the commencement of the survey of their option to withdraw at any time. The study protocol was approved by the University's Human Research Ethics Committee.

Measures. A preliminary version of the survey instrument was developed for pretesting with adolescents to guide the final selection of measures. The preliminary survey included specific sun

exposing and sun protecting behaviors that were considered relevant to UV exposure among adolescents. Specific sun protection behavior items were based on the recently recommended standardized US measures of adolescents' habitual sun protection during summer (15). Additional items were included to increase the specificity of the assessment of sun protection behaviors, including measures of lower body protective clothing and avoidance of peak UV. Five new items were developed for sun exposing behaviors; these related to time spent tanning, as well as delaying, reducing or avoiding sun protection. The preliminary survey was pretested with 24 adolescents and seven skin cancer prevention experts from three Australian State Cancer Councils (West Australia, Victoria and New South Wales) to ensure the survey captured the range of sun exposing and sun protecting behaviors performed by adolescents and recommended by the Cancer Councils. Adjustments were made to question wording and response options based on the results of pretesting the survey.

The final sun-related behavior items included in the survey are shown in Table 1. Both sun exposing and sun protecting behaviours were assessed across four contexts: at school, on the weekend, during the holidays and during summer in general. These contexts were identified as relevant to adolescent UV exposure during the qualitative pretesting of the survey and subsequent work by the research team, which confirmed that adolescents exhibit different behaviors across these contexts (16).

Table 1. Sun-related behavior items.

Sun protection behavior items*
1. When you are outside on a warm sunny day how often do you usually … wear sunscreen?
2. Wear a hat?
3. Stay in the shade?
4. Wear a shirt with sleeves that covers your shoulders?
5. Wear long pants/skirt that cover your legs at least to your knees?
6. Wear sunglasses?
7. Spend most of the time inside during peak UV hours in the middle of the day?

Sun exposing behavior items*
1. Spend time in the sun to get a tan?
2. Wear a reduced SPF sunscreen, oil or lotion to get a tan?
3. Delay applying sun protection to get some sun on your skin?
4. Wear brief clothing so as to get some sun on your skin?
5. Wear no sun protection at all to get a tan?

*Response options: Never (1), rarely, sometimes, often, always (5).

Two key indicators of UV exposure (number of sunburns and current level of tan) were included in the survey. These were assessed by ‘‘In the past 12 months, how many times did you have a red or painful sunburn that lasted a day or more?’’ with response options ranging from ‘‘0’’ to ‘‘8 or more’’ and ‘‘What is your current level of tan?’’ with response options ranging from ‘‘no tan’’ through to ‘‘a very dark tan.’’ As the survey was administered in spring time and current level of tan would be expected to be low, an additional UV indicator measure was included, referred to as ‘‘desired tan’’; this item was: ‘‘Do you like to get a suntan?’’ with response options ranging from ‘‘no tan’’ to a ‘‘very dark tan.’’

Statistical analysis. Three general linear models were tested in this study. The first model examined the extent to which sun protecting behaviors predicted the outcome measures or indicators of UV exposure (number of sunburns, perceived degree of current tan and perceived desired depth of tan). The second model examined the extent to which sun exposing behaviors predicted the outcome measures. In the third model, sun exposing and sun protecting behaviors were included in the same model. We tested a general linear model that assessed the extent to which the six protecting and five exposing behaviors predicted the outcome measures (number of sunburns, current tan and desired tan). The general linear model approach allows a linear combination of the multiple outcome measures to be tested and was more appropriate over a multiple regression. A factor analysis of the survey items revealed factors that corresponded to the six protecting and five exposing behaviors. Factor scores were derived and used as indicators of these behaviors in the models

described. The impact of skin tone and gender was also controlled for as fixed factors in modeling the indicators of UV exposure.

Results

The results of three general linear models tested are reported separately. The first model examined the extent to which protecting behaviors predicted the indicators of UV exposure, the second model explored sun exposing behaviors and the third model combined both sun protecting and sun exposing behaviors. The univariate results for each of the general linear models are shown in Table 2.

Model 1

At the multivariate level in Model 1, wearing protective clothing (Wilks' λ = 0.942, P = 0.000), wearing a hat (Wilks' λ = 0.979, P = 0.011), using sunscreen (Wilks' λ = 0.984, P = 0.033), avoiding peak UV hours (Wilks' λ = 0.977, P = 0.006) and using shade (Wilks' λ = 0.940, P = 0.000) were significantly associated with a linear combination of the indicators of UV exposure. Skin tone was also significantly associated (Wilks' λ = 0.791, P = 0.000).

At the univariate level, results indicated the number of sunburns had the strongest relationship with skin tone (Partial η^2 = 0.019), avoiding peak UV hours (Partial η^2 = 0.017) and using sunscreen (Partial η^2 = 0.011). Current level of tan was most strongly associated with skin tone (Partial η^2 = 0.035), using shade (Partial η^2 = 0.028), wearing protective clothing (Partial η^2 = 0.016) and wearing sunglasses (Partial η^2 = 0.009). Desired tan was most strongly associated with wearing protective clothing (Partial η^2 = 0.055), using shade (Partial η^2 = 0.054), wearing a hat (Partial η^2 = 0.012) and avoiding peak UV hours (Partial η^2 = 0.009).

Model 2

At the multivariate level in Model 2, spending time tanning (Wilks' λ = 0.762, P = 0.000), delaying the use of sun protection (Wilks' λ = 0.962, P = 0.000), wearing no sun protection to tan (Wilks' λ = 0.977, P = 0.008) and wearing brief clothing (Wilks' λ= 0.956, P = 0.000) were all significantly

associated with a linear combination of the indicators of UV exposure. Skin tone was also significantly associated (Wilks' $\lambda = 0.830$, $P = 0.000$).

Table 2. Univariate results for the general linear modeling.

UV Indicator	Behavior, skin tone and gender	Model 1 B (SE)	Model 2 B (SE)	Model 3 B (SE)
Number of sunburns	Wearing protective clothing	-0.197 (0.102)	_	-0.136 (0.114)
	Wearing sunglasses	-0.081 (0.094)	_	-0.165 (0.099)
	Wearing a hat	-0.088 (0.095)	_	-0.088 (0.100)
	Using sunscreen	**-0.245 (0.102)**	_	**-0.409 (0.114)**
	Avoiding peak UV hours	**-0.302 (0.098)**	_	**-0.262 (0.105)**
	Using shade	0.039 (0.102)	_	-0.029 (0.110)
	Spending time in sun to tan	_	_	-0.065 (0.110)
	Using a low SPF sunscreen	_	_	-0.027 (0.100)
	Delaying use of sun protection	_	**0.421 (0.124)**	**0.467 (0.124)**
	Using no sun protection	_	0.082 (0.131)	0.077 (0.135)
	Wearing brief clothing	_	0.134 (0.119)	0.077 (0.124)
	Skin tone	**1.808 (0.557)**	**1.845 (0.589)**	**1.805 (0.573)**
	Gender	0.492 (0.659)	0.362 (0.684)	-0.994 (0.769)
Current tan	Wearing protective clothing	**-0.117 (0.040)**	_	-0.061 (0.045)
	Wearing sunglasses	**0.079 (0.037)**	_	**0.077 (0.039)**
	Wearing a hat	0.033 (0.037)	_	0.050 (0.040)
	Using sunscreen	0.014 (0.040)	_	0.002 (0.045)
	Avoiding peak UV hours	-0.043 (0.038)	_	-0.046 (0.041)
	Using shade	**0.157 (0.040)**	_	**0.110 (0.043)**
	Spending time in sun to tan	_	**0.215 (0.040)**	**0.173 (0.043)**
	Using a low SPF sunscreen	_	0.037 (0.038)	0.011 (0.040)
	Delaying use of sun protection	_	0.015 (0.048)	0.009 (0.046)
	Using no sun protection	_	0.010 (0.051)	0.023 (0.054)
	Wearing brief clothing	_	0.053 (0.046)	0.011 (0.049)
	Skin tone	_	**-0.891 (0.228)**	**-0.870 (0.227)**
	Gender	**-0.964 (0.218)**	-0.281 (0.265)	-0.172 (0.272)
Desired tan	Wearing protective clothing	**-0.248 (0.045)**	_	-0.046 (0.040)
	Wearing sunglasses	0.025 (0.041)	_	-0.006 (0.035)
	Wearing a hat	**-0.106 (0.041)**	_	-0.056 (0.035)
	Using sunscreen	0.062 (0.044)	_	0.030 (0.040)
	Avoiding peak UV hours	**-0.094 (0.043)**	_	-0.021 (0.037)
	Using shade	**0.248 (0.045)**	_	**0.134 (0.039)**
	Spending time in sun to tan	_	**0.457 (0.036)**	**0.404 (0.039)**
	Using a low SPF sunscreen	_	-0.003 (0.035)	-0.012 (0.036)
	Delaying use of sun protection	_	**0.132 (0.044)**	**0.119 (0.044)**
	Using no sun protection	_	**0.149 (0.046)**	**0.125 (0.048)**
	Wearing brief clothing	_	**0.199 (0.042)**	**0.175 (0.044)**
	Skin tone	-0.342 (0.243)	-0.151 (0.207)	-0.165 (0.203)
	Gender	-0.469 (0.288)	-0.137 (0.240)	-0.175 (0.245)

Items in bold $P \leq 0.05$.

At the univariate level, delaying use of sun protection (Partial η^2 = 0.022) and skin tone (Partial η^2 = 0.019) had the strongest association with sunburns. Desire for a tan was associated with spending time in the sun to tan (Partial η^2 = 0.237), delaying the use of sun protection (Partial η^2 = 0.17), using no sun protection at all (Partial η^2 = 0.020) and wearing brief clothing (Partial η^2 = 0.042). Current level of tan was associated with the factor spending time in the sun to tan (Partial η^2 = 0.053) and skin tone (Partial η^2 = 0.029).

Model 3

At the multivariate level in Model 3, spending time tanning (Wilks' λ = 0.815, *P* = 0.000), delaying the use of sun protection (Wilks' λ = 0.958, *P* = 0.000) and wearing brief clothing (Wilks' λ = 0.964, *P* = 0.001) were significantly associated with a linear combination of the indicators of UV exposure. Of the sun protection behaviors, wearing sunscreen (Wilks' λ = 0.972, *P* = 0.003) and seeking shade (Wilks' λ = 0.972, *P* = 0.003) were significantly associated with UV exposure indicators. Both skin tone (Wilks' λ = 0.837, *P* = 0.000) and gender (Wilks' λ = 0.983, *P* = 0.040) were also significant at the multivariate level.

At the univariate level, results indicated the number of sunburns had the strongest relationship with delaying the use of sun protection (Partial η^2 = 0.028), using sunscreen (Partial Eta ^{2} = 0.026), avoiding peak UV hours (Partial η^2 = 0.013) and skin tone (Partial η^2 = 0.020). Current level of tan was most strongly associated with spending time in the sun (Partial η^2 = 0.032), skin tone (Partial η^2 = 0.030), using shade (Partial η^2 = 0.013) and wearing sunglasses (Partial η^2 = 0.008). Desired tan was most strongly associated with spending time in the sun to tan (Partial η^2 = 0.183), wearing brief clothing (Partial η^2 = 0.032), using shade (Partial η^2 = 0.024), delaying sun protection (Partial η^2 = 0.015) and wearing no sun protection to tan (Partial η^2 = 0.014).

The extent to which the behaviors included in each of the three models predicted the outcome measures (number of sunburns, current tan and desired tan) is presented in Table 3. Overall, the combined sun protection and sun exposing behaviors, controlling for skin tone and gender, accounted

for the largest amount of variance (i.e. 13.8%) in the number of sunburns, 28.1% of the variance in current tan and 57.5% of the variance in desired tan, respectively (see Table 3).

When assessed independently from sun exposing behaviors, sun protecting behaviors accounted for 9.0% of the variance in number of ‘‘sunburns,’’ 26.2% of the variance in ‘‘current tan’’ and 32.9% of the variance in ‘‘desired tan.’’ That is, simultaneously considering both protecting behaviors and exposing behaviors marginally improved the explanatory power of the model rather than assessing sun protection behaviors alone.

Table 3. Adjusted R^2 for three separate general linear models testing the extent behaviors predict indicators of UV exposure, each model controls for skin tone and gender.

	Model 1. Sun protecting behaviors Adjusted R^2	Model 2. Sun exposing behaviors Adjusted R^2	Model 3. Combined sun protecting and sun exposing behaviors Adjusted R^2
Number of sunburns	0.090	0.116	0.138
Current tan	0.262	0.257	0.281
Desired tan	0.329	0.549	0.575

Discussion

Whereas sun protection behaviors among adolescents are frequently explored in the literature, less frequently explored is the extent to which sun protection and sun exposing behaviors, in combination, related to UV exposure. The expanded assessment of sun-related behaviors marginally improved the explanatory power for the three indicators of UV exposure among adolescents (Sunburn: adjusted R^2 = 0.138, Current tan: adjusted R^2 = 0.281, Desired tan: adjusted R^2 = 0.575), and offers a more detailed understanding of the influence of specific types of sun-related behaviors on indicators of UV exposure, particularly sun exposing behaviors. Intervention programs are frequently evaluated in the context of their impact on sun protecting behaviors. The results highlight that both sun exposing and protecting behaviors uniquely contribute to indicators of UV exposure, and when compared with the assessment of sun protecting behaviors alone modestly improve the explanation of indicators of UV exposure; ‘‘sunburn’’ Adjusted R^2 increased by 0.048, ‘‘current tan’’ Adjusted R^2 increased by 0.019

and ‘‘desired tan’’ Adjusted R^2 increased by 0.246. This research has implications for both conceptualizing and operationalizing the behavioral outcomes of interest in programs designed to reduce UV exposure among adolescents, suggesting that measures of adolescent sun-related behavior could benefit from considering both exposing and protecting behaviors. The opportunity to further explore the ability to influence the identified sun exposing behaviors through targeted interventions among adolescents is a direction for future research.

Important limitations of our study warrant discussion. Due to the study occurring in spring, it was decided to include ‘‘desired tan’’ as an indicator of UV exposure. Whereas it is established that UV radiation stimulates pigmentation in human skin, commonly known as tanning, the lack of data available on the natural history of tanning makes it difficult to determine the best times for measurement of tanning (17). Recently, Zonios and Dimou (18,19) developed a method for the estimation of skin concentrations of melanin of human skin in vivo. This noninvasive technique using light scattering spectroscopy, provides a promising robust method for better estimation of tanning in vivo. Less is known regarding the reliability of self-report of indicators of tanning. A recent study exploring alternate methods for measuring skin color and sun damage (20) reported moderate to high correlation ($r = 0.70$ $P < 0.01$; $r = 0.71$ $P < 0.01$) between self-report of current skin color and skin reflectance spectrophotometry indicating that these measures have convergent validity. All information in this study is self-reported, and no independent validation of self-reported current tan or sunburn can be made. However, there is no reason to believe that these variables are measured with less accuracy than in other studies. Cumulative, self-report summer sunburn has been the most common measure of sunburn used in population studies (14). Using level of tan as an indicator of UV exposure is complex due to individual differences in skin type and the skin’s propensity to burn; however, the general linear modeling controlled for skin type, as measured by Fitzpatrick (21). Given expected differences in sun-related behaviors of male and female respondents, the general linear modeling also controlled for gender; however, a more detailed exploration of the impact of gender is beyond the scope of this study. The influence of gender on sun protecting and sun exposing behaviors provides an interesting topic for future studies to explore. A further limitation of the study is the

nonrandom nature of the sample, which limits the ability to generalize these results to the total adolescent population. Nonetheless these results are important as they highlight new opportunities for interventions among a high-risk population.

Our findings support other data that adolescents make separate choices both to protect their skin from the sun and to expose their skin to the sun (2). The potential for adolescents to concurrently both expose and protect their skin highlights the complexity of sun-related behaviors among adolescents. A relatively new line of research in skin cancer prevention has explored the use of sunscreens to aid sun exposure, with some data indicating sunscreens are used as tanning aids to avoid sunburn and extend UV exposure (22–24). Whereas our data shows an association between sunscreen use and ''sunburns'' it does not show an association between sunscreen use and ''current tan'' or ''tan desire''; furthermore no association was found between using a ''reduced SPF sunscreen'' and indicators of UV exposure. In this study, the lack of association may reflect cultural differences in the nature of tanning behaviors between Australian adolescents and those in European countries.

Additional to knowing that adolescents attempt to tan, our data provides further understanding of the behaviors adolescents perform to obtain a tan, defining the specific behaviors within the construct of intentional sun exposure. The more detailed exploration of tanning behaviors has recently emerged in the literature with the categorization of tanning subtypes (25–27); these subtypes have been developed based on skin cancer risk, sun protection practices and tanning motivations, and highlight specific subgroups or segments who would benefit from targeted interventions, our data facilitates the identification of tanning subtypes among adolescents to which programs can be targeted. Furthermore, an increased understanding of the specific sun exposing behaviors adolescents perform to obtain a tan, as identified here, highlights the complexity of sun-related behaviors.

The current findings add to this growing body of evidence on adolescent sun-related behaviors. Overall, the data provide a more detailed understanding of the relationship between specific types of sun-related behaviors and indicators of UV exposure among adolescents. The results highlight that an expanded view of sun-related behavior; one which includes sun exposing behaviors as well as sun protection behaviors, provides a modest increase in explanatory power of UV exposure among

adolescents. Thus, program development as well as measurement instruments could benefit from considering both behavioral elements.

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