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Moderated Mediation Regarding the Sun-Safe Behaviors of U.S. Latinos: Advancing the Theory and Evidence for Acculturation-Focused Research and Interventions

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Abstract

Recent studies revealed a negative association between acculturation and sun-safe behaviors, possibly mediated by education level, health status, and social networks. We sought to elucidate this relationship by exploring the moderating effects of gender and health insurance on each mediated path. We used data from 496 Latino respondents to the 2005 Health Information National Trends Survey. Acculturation, assessed by a four-item index, was the primary predictor; use of sunscreen and protective clothing were the primary outcomes, assessed by frequency scales. Moderated mediation was tested with an established causal moderation method. The mediated association between acculturation, education level and sunscreen use might be stronger among women than men ($P < 0.08$). We found no evidence of moderated mediation for use of protective clothing. The findings suggest ways of refining the theoretical and empirical rationale for sun safety research and interventions with Latinos. Studies should replicate these models with longitudinal data.

Keywords

Acculturation; Sun-safe behaviors; Latinos; Moderated mediation; Sociodemographic factors

Background

Acculturation is considered an independent risk factor for a number of health practices including sun-safe behaviors [1–4]. Sun safety constitutes actively taking precautions against overexposure to ultraviolet (UV) radiation—by means of applying sunscreen, seeking shade, wearing protective clothing, and avoiding midday sun exposure— and is important for the primary prevention of skin cancer [5]. Among U.S. Latinos, there is some evidence that sunscreen use might be mediated by one's education, perceived physical health status and involvement with social networks [6]. The same study also indicated that the relationship between acculturation and wearing protective clothing might be mediated by the level of formal education. Currently, no racial/ethnic group seems to meet national sun safety recommendations [7, 8]. Moreover, findings from the 1988-2001 California Cancer Registry highlighted steadily increasing invasive melanoma incidence among Latinos [9]. Considering the size and rapid growth of the U.S. Latino population, its sun-safe behaviors and skin cancer risk will have important public health education and policy implications and merit better understanding [10]. However, comprehensive sun safety research with Latino samples is currently scarce.

Health Insurance

Both the acculturation and sun safety literatures contain sufficient evidence about the importance of health insurance regarding health and risk practices, including UV radiation exposure and sun-safe behaviors [2, 11, 12]. For example, in adjusted models insured individuals were 15% more likely to report 1 sunburn episodes during the preceding year, compared to those without health insurance [12]. Also, insured individuals were more likely to report engaging in cancer screening compared to their uninsured counterparts [13]. Since no evidence for mediation of the link between acculturation and sun-safe behaviors by healthcare access has been reported, it is possible that health insurance might act as a moderator. Insured individuals might have more opportunities to join provider-based health promotion groups/networks, and to use preventive services [13, 14], thus improving self-perceptions of health, compared to their uninsured counterparts.

Gender

Evidence suggests that women experience more unfavorable acculturation effects than men [3, 15, 16], which has been attributed to baseline differences in certain behaviors (e.g., smoking) as well as gender-based social norms in the countries of origin as well as the U.S. [17, 18]. Again, due to lack of support for a differential impact of gender on the association between Latinos' acculturation and their sun-safe behaviors [6], gender merits attention in moderated mediation analyses. For example, gender might moderate the relationship between acculturation and involvement with social networks, since social network dynamics have been shown to differ for men and women during the mainstream integration process [19]. Also, consistent with findings among non-Latino whites [20, 21], the relationship between education and sun-safe behaviors might be moderated by gender.

Conceptual Framework

We aimed to further the theoretical and empirical understanding of the potential causal mechanisms associated with Latinos' sun-safe behaviors. We assessed how potential mediated paths between acculturation and several sun-safe behaviors varied as a function of health insurance and gender. Specifically, we hypothesized that the relationship between acculturation and social networks would be stronger among men than women, while the relationship between social networks and sun-safe behaviors would remain constant across gender. In turn, we hypothesized that the relationship between education and sun-safe

behaviors would be stronger among women than men. Regarding health insurance, we expected that the association between acculturation and perceived health status and involvement with social networks, respectively, would be stronger among insured compared to uninsured participants. The selected constructs were grounded mainly in Bandura's Social Cognitive Theory [22] and the full theoretical model is presented in Fig. 1.

Methods

Participants and Data Collection

We analyzed cross-sectional data from the 2005 Health Information National Trends Survey (HINTS), developed and implemented by the National Cancer Institute. The instrument had undergone extensive pre-testing and expert review before field-testing and subsequent implementation. Data were collected between February and August 2005 via geographic stratification and list-assisted random-digit dialing from a probability-based sample of the U.S. civilian, non-institutionalized population. The survey employed a computer-assisted telephone interviewing system. During the screening section of the survey, one adult (aged 18 years) was selected at random within each household and was recruited for the extended interview with the option of responding in English or Spanish. Using skip logic and question paths depending on gender, age, and previous responses, survey items progressed from questions about use of communications media to more specific questions about health knowledge and behaviors. Thus, no individual was asked all questions. The Spanish language version of the questionnaire was developed by a team of bilingual translators using back-translation techniques. Among the 5,586 individuals who completed the full interview, 496 answered affirmatively to the question, "Are you Hispanic or Latino?" and thus were eligible for this study. Further details on the survey's concept, testing, and implementation are published elsewhere [23, 24]. The questionnaire is available at: <http://hints.cancer.gov/instrument.jsp>. The HINTS, which contains de-identified data, has been assigned an "exempt" status by the Institutional Review Board of the National Cancer Institute and has received additional review and clearance from the U.S. Office of Management and Budget. No further ethics committee clearance has been required for the present study.

Measures

Primary Outcome—Sun-safe behaviors constituted the primary outcome in this study and were assessed by five-point frequency scales (1 = always; 5 = never). Respondents were told that the questions pertained to sun protection practices and were asked how often they used sunscreen, wore long-sleeved shirts, and long pants when outside for 1 h on a warm, sunny day. These items were comparable to the standardized set of survey measures of sun exposure and sun protection habits, and are considered applicable across different populations [25]. The variables were reverse-coded, thus higher scores reflected higher endorsement of the behaviors.

Primary Predictor—We assessed acculturation with an index which encompassed four items: a dichotomous measure for language of interview (English or Spanish), a six-level item for perceived comfort with the English language (1 = completely comfortable; 6 = does not speak English), a continuous measure for age at U.S. arrival (assessed among the foreign-born and calculated by subtracting the year of birth from the year of arrival), and a continuous measure for the duration of U.S. residence (also assessed among the foreign-born and calculated by subtracting the year of arrival from the year of data collection, 2005). That index had a mean value of 0.15 (SD = 0.83) and a Cronbach's alpha of 0.75.

Mediators—Perceived health status was assessed by a single item with response options ranging from 1 = excellent to 5 = poor. This item was reverse-coded, thus a higher score

corresponded to better health. The level of formal education was also assessed with a single item with response options ranging from 1 = never attended school to 11 = professional or graduate degree. The social networks construct was measured by the mean of two items: one assessed community organization membership (0 = no membership; 1 = membership in a non-health organization; 2 = membership in a health-related organization) and the other assessed having family or friends with whom to discuss health (0 = no family/friends to 3 = have family/friends and talk to them very frequently).

Moderators and Covariates—Moderating variables included gender and having health insurance (yes/no). Covariates included age and Census region of residence. Finally, the few “refused” and “don’t know/other” responses were coded as missing.

Analysis

In recent years, moderated mediation analyses have received attention in the literature as useful tools for broadening the theoretical and empirical understanding of causal mechanisms [26–29] and were applied in the present study. We followed the procedures outlined by Muller and colleagues [26]. Specifically, moderated mediation effects were assessed by creating interaction terms between each hypothesized moderator and acculturation in three equations

$$Y = \alpha_{10} + b_{11}X + b_{12}Z + b_{13}X * Z + e_1 \quad (1)$$

$$M = \alpha_{20} + b_{21}X + b_{22}Z + b_{23}X * Z + e_2 \quad (2)$$

$$Y = \alpha_{30} + b_{31}X + b_{32}Z + b_{33}X * Z + b_{34}M + b_{35}M * Z + e_3 \quad (3)$$

In these equations, Y represents the primary outcome (sun-safe behaviors), X represents the primary predictor (acculturation), M represents a mediator, Z represents a moderator, α represents an intercept, and e represents an error term. Equation 1 assessed the overall effect of acculturation on sun-safe behaviors, as well as whether this effect was moderated by Z . Equation 2 assessed whether the effect of acculturation on the mediator (M) differed across levels of the moderator (Z). Equation 3 assessed the moderated effect of the mediator on sun-safe behaviors, and the residual moderated effect of acculturation on sun-safe behaviors, after controlling for the mediator. According to Muller and colleagues, in order to establish that moderated mediation exists, the following three criteria must be met: (1) in Eq. 1, acculturation should have a significant effect on the sun-safe behavior, but this overall effect should not be moderated (e.g., $b_{11} \neq 0$; $b_{13} = 0$); (2) in Eqs. 2 and 3 the effect of acculturation on the mediator must depend on the moderator, and/or the partial effect of the mediator on the sun-safe behavior must depend on the moderator (e.g., both b_{23} and $b_{34} \neq 0$ or both b_{21} and $b_{35} \neq 0$); and (3) the residual direct effect of acculturation on the sun-safe behavior after controlling for the mediator must be moderated (e.g., b_{33}), however, statistical significance is not necessary. Moderated mediation analyses entail the assumptions that the predictor and moderator are independent, and the residuals are independent and normally distributed [26].

We conducted analyses estimating Eqs. 1, 2 and 3 separately for each combination of the posited mediators and moderators. To avoid redundancy, only Eq. 3 was adjusted for age and region of residence. The model with sunscreen use as the dependent variable was hypothesized to include all three mediators (education, perceived health status, and social networks) and the two moderators (gender, health insurance). We computed the mean of the

long-sleeved shirt and long pants items and used it as a protective clothing outcome variable. That model was hypothesized to include only one mediator (education) and the two moderators. All continuous variables were first centered on their respective means. All statistical procedures were performed with SAS Version 9.1 [30].

Results

The mean age of the participants in this study was 41.3 years ($SD = 15.5$) and 61% were women. About a third (35.7%) of the participants were U.S.-born, slightly over half (54.6%) were interviewed in Spanish, and about 42% reported having less than high school education. Results of the univariate and bivariate analyses of the mediating and outcome variables, stratified by the levels of each moderator, are summarized in Table 1. Independent-sample *t*-tests revealed statistically significant differences in use of sunscreen, long pants (both $P < 0.0001$) and long-sleeved shirts ($P < 0.02$) by gender. Specifically, women were more likely to report sunscreen use, while men were more likely to report wearing protective shirts or pants. No gender-related differences were observed in any of the three hypothesized mediators (all $P > 0.34$).

In contrast, participants without health insurance reported lower health status ($P < 0.02$), lower education ($P < 0.0001$), and less availability or contact with social networks regarding health matters ($P < 0.001$) compared to their insured counterparts. Health insurance status also produced statistically significant differences in the sun-safe behaviors. Unlike the uninsured, insured participants were more likely to report using sunscreen ($P < 0.02$) but less likely to report wearing long pants ($P < 0.0001$) when outdoors in the sun.

Results of the three-step approach for assessing moderated mediation are summarized in Table 2 for sunscreen use and Table 3 for wearing protective clothing. In Eq. 1, we observed statistically non-significant interaction effects between acculturation and gender and health insurance, respectively (all $P > 0.16$). Thus, the first criterion for moderated mediation was met. The results from Eqs. 2 and 3 for sunscreen use revealed marginally significant support for the second criterion for moderated mediation. Specifically, the partial effect of education on sunscreen use appeared to be moderated by gender (e.g., $b_{35} = -1.12$, $P < 0.08$), with an overall statistically significant effect of acculturation on education level ($b_{21} = 1.38$; $P < 0.0001$). In this model, the association between education and sunscreen use was stronger among women than men.

Also in the model for sunscreen use, we found some evidence of moderated mediation by health insurance and social networks. In particular, the effect of acculturation on involvement with social networks depended on health insurance status ($b_{23} = 0.16$, $P < 0.08$), with a statistically significant, partial effect of social networks on sunscreen use ($b_{34} = 0.54$, $P < 0.001$). Among insured participants, the relationship between acculturation and involvement with social networks regarding health matters was stronger than among uninsured participants. No support was obtained for any of the other hypothesized paths in Fig. 1. Finally, we found no evidence of moderated mediation regarding wearing protective clothing in our sample of Latinos.

Discussion

We aimed to extend the theoretical and empirical understanding regarding the potential causal mechanisms of Latinos' sun-safe behaviors. Our findings suggested the presence of moderated mediation regarding the relationship between acculturation and sunscreen use. In particular, the impact of acculturation on sunscreen use was mediated by one's level of formal education and this mediating pathway varied by gender. As hypothesized, the link

between education and sunscreen use was stronger in women than in men. This is consistent with findings among non-Latino white college students. Specifically, compared to men, women were more likely to use sunscreen [20], to have more positive attitudes and intentions towards sun-safe behaviors [21], but also more likely to use tanning salons [31, 32]. Women in general have been shown to be more knowledgeable about skin cancer and sun-safe behaviors [21, 33, 34]. It is possible that women are more likely than men to attend to sun safety/skin cancer information in order to determine how to tan “safely.” Therefore, sunscreen interventions with low- or high-acculturated Latinos might have better potential for success if they are gender- and education level-targeted.

Further, the results revealed that the impact of acculturation on sunscreen use was mediated by involvement with social networks and this mediating pathway varied by health insurance status. Also as hypothesized, the link between acculturation and social networks was stronger for insured than uninsured participants. Insured individuals might have more opportunities to join provider-based health promotion groups or networks, compared to their uninsured counterparts. Thus, our findings could inform future sunscreen use efforts with Latinos by suggesting the importance of targeting individuals at the same health insurance status and the importance of capitalizing on social network characteristics, such as availability and frequency of contact regarding health matters.

In terms of wearing protective clothing when outdoors in the sun, we did not find any evidence of moderated mediation. The model, however, included only one mediator (education). As suggested by prior research, for this sun-safe behavior it might be necessary to explore the potential mediating effects of psychosocial constructs such as appearance motivation and social norms [35, 36], which were not available in the HINTS 2005 dataset.

Finally, in addition to the three-step linear regression approach used in this study, other methods for assessing moderated mediation exist, such as the piecemeal approach, the subgroup approach, and moderated path analysis [28]. Whereas each method has certain deficiencies [28], Muller and colleagues’ method appears to be flexible and well defined, and has few known important limitations.

Limitations

Despite using roughly 9% of the HINTS sample, representativeness concerns are somewhat mitigated because many of the demographic characteristics of our participants paralleled those in nationally-representative health behavior research [37, 38]. Nonetheless, we acknowledge the inability to distinguish among Latino subgroups or among skin types. Studies have suggested that skin color might be a confounding factor in acculturation (which could not be assessed with HINTS data) because it might affect an individual’s motivation or ability to acculturate due to perceived socioeconomic discrimination against dark-skinned people [39, 40]. Further, psychometric and non-response analyses for HINTS 2005 have been planned but are not currently available [41]. It is possible that some of the measures used in this study might have poor reliability coefficients, which could weaken associations and account for some of the null effects (e.g., in the model for wearing protective clothing).

Also, there might be a certain degree of violation of one of the assumptions for moderated mediation analyses. Specifically, the moderator and predictor are assumed to be independent [26], however, in our sample acculturation and health insurance had a Pearson correlation coefficient = 0.45. In order to assess the potential collinearity between these two constructs, we computed their tolerance values. Generally, tolerance values range between 0 and 1, with lower values indicating increasing collinearity. In our models the tolerance values were relatively high (0.79). The conceptual distinction between acculturation and health

insurance, as well as the fact that their correlation was not very strong suggested that the lack of complete empirical independence might not pose a serious threat to our findings.

Another limitation related to the use of cross-sectional data pertains to the inability to disentangle causation. It is possible that education, which we modeled as a potential mediator, might precede or cause acculturation. Education may have occurred before coming to the U.S. or, among the foreign-born Latinos, education could affect the degree to which they are able to acculturate. Whereas there is strong evidence that acculturation and education are positively associated [3, 37, 42, 43], and our data were consistent with the hypothesized models, it is important for future research to re-assess these models with longitudinal data. Nonetheless, cross-sectional datasets have been used in a number of mediation studies in the psychosocial literature, including studies on acculturation [43, 44] and sun-safe behaviors [35, 45, 46]. It has been noted that correlation analyses are valuable for theoretical and empirical rationale development and for indicating possible points of intervention [47].

Contribution to the Literature

Our aim was to advance the acculturation and sun safety literatures by highlighting potential associations of moderated mediation. Following replication, our findings could inform sun safety research and interventions with Latinos by suggesting potential mediating constructs (e.g., education level, social networks) and the populations (e.g., women, insured) for which such mediators might have an increased impact. For example, interventions aimed at increasing sunscreen use could be tailored on the participants' acculturation status, could be gender- and insurance status-specific, and could capitalize on health-related social networks to correct perceptions about "safe" tanning. Considering the fact that Latinos constitute the fastest growing segment of the U.S. population [10, 48], the public health impact of their health behaviors in general and their cancer-related outcomes in particular is likely to intensify. Hence, such behaviors and outcomes merit continued investigation and improved understanding.

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Fig. 1.
Hypothetical model of moderated mediation of sunsafe behaviors among U.S. Latinos

Table 1
Univariate and bivariate analysis of the hypothesized mediating and outcome variables ($N = 496$)

	Gender				Health insurance			
	Male (<i>n</i> = 191)		Female (<i>n</i> = 305)		Yes (<i>n</i> = 299)		No (<i>n</i> = 196)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Sunscreen	1.13 *	1.32	1.69 *	1.54	1.61 *	1.45	1.26 *	1.51
Long-sleeved shirt	1.71 *	1.46	1.39 *	1.36	1.41	1.32	1.68	1.52
Long pants	3.11 *	1.25	2.55 *	1.38	2.54 *	1.38	3.11 *	1.26
Education	5.20	2.39	5.33	2.42	5.88 *	2.47	4.38 *	2.00
Health status	1.87	0.99	1.79	1.06	1.91 *	1.04	1.69 *	1.02
Social networks	1.02	0.74	1.09	0.69	1.16 *	0.68	0.92 *	0.73

* $P < 0.05$ from independent-sample t -tests; each sun-safe behavior coded on a 5-point scale: 0 = never use to 4 = always use; formal education assessed on an 11-point scale: 1 = never attended school to 11 = professional/doctoral degree; perceived health status assessed on a 5-point scale: 0 = poor to 4 = excellent; social networks assessed by the mean of two items: organization membership (0 = no membership; 1 = membership in a non-health organization; 2 = membership in a health-related organization) and having family/friends with whom to discuss health (0 = no family/friends to 3 = have family/friends and talk to them very frequently)

Table 2

Analysis of moderated mediation between acculturation and sunscreen use among U.S. Latinos

	Equation 1			Equation 2			Equation 3		
	b	SE	t	b	SE	t	b	SE	t
X: Acculturation	0.30	0.10	2.93[^]	1.38	0.14	9.71[*]	0.09	0.11	0.80
Z: GE	-0.56	0.14	-4.11[*]	-0.11	0.19	-0.59	-0.54	0.13	-4.03[*]
X × Z: Acculturation × GE	-0.16	0.17	-0.97	0.32	0.23	1.38	-0.02	0.19	-1.10
M: Education							0.16	0.04	4.20[*]
M × Z: Education × GE							-1.12	0.07	-1.76^Δ
X: Acculturation	0.30	0.10	2.93[^]	0.29	0.07	4.18[*]	0.27	0.10	2.59[#]
Z: GE	-0.56	0.14	-4.11[*]	0.09	0.09	0.93	-0.56	0.13	-4.22[*]
X × Z: Acculturation × GE	-0.16	0.17	-0.97	-0.07	0.11	-0.60	-0.15	0.17	-0.90
M: Health status							0.19	0.08	2.30[#]
M × Z: Health status × GE							-0.03	0.13	-0.20
X: Acculturation	0.30	0.10	2.93[^]	0.18	0.05	3.75[^]	0.21	0.10	2.09[#]
Z: GE	-0.56	0.14	-4.11[*]	-0.06	0.06	-0.91	-0.54	0.13	-4.13[*]
X × Z: Acculturation × GE	-0.16	0.17	-0.97	-0.05	0.08	-0.61	-0.09	0.16	-0.54
M: Social networks							0.58	0.12	4.70[*]
M × Z: Social networks × GE							-0.24	0.19	-1.30
X: Acculturation	0.33	0.15	2.15[#]	1.10	0.21	5.26[*]	0.23	0.16	1.45
Z: HI	0.18	0.16	1.11	0.50	0.22	2.31[#]	0.16	0.16	0.98
X × Z: Acculturation × HI	-0.23	0.19	-1.21	0.47	0.26	1.79^Δ	-0.36	0.21	-1.74
M: Education							0.08	0.06	1.48
M × Z: Education × HI							0.06	0.07	0.89
X: Acculturation	0.33	0.15	2.15[#]	0.16	0.10	1.54	0.28	0.15	1.88^Δ
Z: HI	0.18	0.16	1.11	0.06	0.11	0.53	0.23	0.16	1.45
X × Z: Acculturation × HI	-0.23	0.19	-1.21	0.16	0.13	1.23	-0.22	0.19	-1.18
M: Health status							0.18	0.11	1.73
M × Z: Health status × HI							-0.03	0.14	-0.21

	Equation 1			Equation 2			Equation 3		
	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>
X: Acculturation	0.33	0.15	2.15[#]	0.02	0.07	0.35	0.28	0.15	1.97[#]
Z: HI	0.18	0.16	1.11	0.18	0.07	2.39[#]	0.16	0.16	1.03
X × Z: Acculturation × HI	-0.23	0.19	-1.21	0.16	0.09	1.77 ^{&}	-0.26	0.18	-1.40
M: Social networks							0.54	0.15	3.70[^]
M × Z: Social networks × HI							-0.09	0.19	-0.47

GE gender, *HI* health insurance

^{*} *P* < 0.0001

[^] *P* < 0.01

[#] *P* < 0.05

[&] *P* < 0.08

Table 3

Analysis of moderated mediation between acculturation and wearing protective clothing among U.S. Latinos

	Equation 1			Equation 2			Equation 3		
	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>
X: Acculturation	-0.30	0.08	-3.98 [*]	1.38	0.14	9.71 [*]	-0.27	0.08	-3.17 [^]
Z: GE	0.43	0.10	4.27 [*]	-0.11	0.19	-0.59	0.45	0.10	4.49 [*]
X × Z: Acculturation × GE	-0.17	0.12	-1.41	0.32	0.23	1.38	-0.06	0.15	-0.43
M: Education							-0.01	0.03	-0.48
M × Z: Education × GE							-0.08	0.05	-1.70
X: Acculturation	-0.38	0.11	-3.29 [^]	1.10	0.21	5.26 [*]	-0.36	0.12	-2.95 [^]
Z: HI	-0.15	0.12	-1.29	0.50	0.22	2.31 [#]	-0.19	0.12	-1.51
X × Z: Acculturation × HI	-0.08	0.14	0.57	0.47	0.26	1.79 ^{&}	0.19	0.16	1.21
M: Education							-0.01	0.04	-0.23
M × Z: Education × HI							-0.05	0.05	-1.05

GE gender, *HI*/health insurance^{*} $P < 0.0001$ [^] $P < 0.01$ [#] $P < 0.05$ [&] $P < 0.08$