Published in final edited form as:

J Acad Nutr Diet. 2015 May ; 115(5): 759–766. doi:10.1016/j.jand.2014.10.015.

Ecological Momentary Assessment of Urban Adolescents' Technology Use and Cravings for Unhealthy Snacks and Drinks: Differences by Ethnicity and Gender

Nicholas Borgogna^a, Ginger Lockhart, Ph.D.^a, Jerry L. Grenard, Ph.D.^b, Tyson Barrett^a, Saul Shiffman, Ph.D.^c, and Kim D. Reynolds, Ph.D.^b

^aDepartment of Psychology, Utah State University, 2810 Old Main Hill, Logan, UT 84322-2810, USA

^bSchool of Community and Global Health, Claremont Graduate University, 675 West Foothill Blvd. Suite 310, Claremont, CA 91711-3475, USA

^cDepartment of Psychology, University of Pittsburgh, 130 N. Bellefield Avenue, Suite 510, Pittsburgh, PA 15260, USA

Abstract

Background and Purpose—Adolescents' technology use is generally associated with food cravings, but it is not clear whether specific types of technology elicit particular types of cravings, and whether personal characteristics play a role in these associations. We examined whether momentary associations between four technology types (television, video games, computer messaging, and phone messaging) and cravings for unhealthy snack foods and sweetened drinks were moderated by youths' gender, ethnicity, BMI, and age.

Methods—Urban adolescents ($N=158$) aged 14–17 provided momentary information about their technology use and food cravings over the course of one week and completed survey reports of their personal characteristics. We used multilevel modeling to determine momentary associations and interactions.

Results—Non-Hispanic adolescents showed stronger associations between television exposure and cravings for sweet snacks, salty snacks, and sweetened drinks. Being Hispanic was associated with stronger associations between phone messaging and cravings for sweet snacks, salty snacks, and sweetened drinks. Males showed stronger associations between video game use and salty snack cravings.

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Corresponding author: Ginger Lockhart, Ph.D. ginger.lockhart@usu.edu Phone: 435-932-0174 Fax: 435-797-1448. Nicholas Borgogna and Ginger Lockhart contributed equally to the manuscript and share first authorship.

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Conflict of Interest Disclosure

None of the authors of this manuscript report any conflicts of interest.

Conclusions—As the public health field continues to monitor the effects of technology use on adolescents' eating and overall health, it will be important to determine the extent to which these groups are differentially affected by different forms of technology.

Keywords

Adolescent; Sedentary Behaviors; Snack Cravings; Ecological Momentary Assessment; Technology

Introduction

Adolescent obesity is a public health concern of increasingly serious and far-reaching consequences, contributing to a wide range of comorbid disorders^(1,2) and early death^(3–7). The recent surge in adolescent obesity is due, in part, to a substantial increase in sedentary behaviors in the past 20 years, most notably those behaviors involving technology use⁽⁸⁾. Media consumption in particular is not only sedentary, and may substitute for physical activity, but may also expose teens to cues that promote unhealthy eating. Though television is still a prominent medium for youths' sedentary behaviors, other media, including video games, computers, and handheld devices, have become increasingly popular sources of entertainment. Television viewing in particular has been linked to poor eating habits, including unhealthy snack consumption⁽⁹⁾; it is less well understood, however, how other modes of technology may accelerate the pace of unhealthy weight gain.

Earlier work has already established that television viewing can be differentiated from other sedentary behaviors (e.g. doing homework) because it involves receiving images, chiefly through advertising, that promote unhealthy food consumption⁽⁹⁾. In response to substantial increases in communication-based (CB) technology use among adolescents in recent years, an emerging line of research has begun to examine the extent to which CB tech use is a problematic sedentary behavior⁽¹⁰⁾. Though CB tech use appears to be negatively related to physical activity level⁽¹⁰⁾, little is known about other specific mechanisms by which this sedentary behavior may contribute to eating behavior. To understand these mechanisms and to yield recommendations for prevention programs, it is important to 1) closely examine internal states that may be precursors to unhealthy eating; 2) determine the differential effects of EB and CB technology use on these internal states and 3) identify which personal characteristics may increase or decrease the effects of EB and CB technology use on youths' responses. In this study, we examined momentary relations between EB and CB technology use and unhealthy food and drink cravings in a sample of urban adolescents. We also estimated the extent to which ethnicity, gender, age, and BMI moderated the strength of these momentary associations.

Food cravings are important to study because they increase the likelihood of consuming unhealthy foods⁽¹¹⁾, often in larger quantities than intended⁽¹²⁾. The intense desires associated with cravings are challenging to measure with retrospective self-reports because they reflect a desire for a specific food or type of food and are often variable and fleeting. Thus, the difficulty of recalling levels of cravings for different types of foods in the presence of environmental stimuli may lead to biased results. To capture the real-time reports of

youths' technology use and food cravings, we collected data using ecological momentary assessment (EMA), in which youth were prompted to respond to questions concerning their environments and internal states using a handheld Palm Pilot over the course of 7 days. EMA approaches have produced reliable and valid measures of sedentary and food-related behavior^(13,14), the results of which can provide rich, detailed assessments of many data points.

To examine momentary relations between technology use and cravings, we chose two forms of EB (television and video games) and two forms of CB (computer messaging and phone messaging) technology that are commonly used among adolescents. Additionally, we measured three targets of cravings: 1) salty/fatty snacks; 2) sweet snacks, and 3) sweetened drinks. EB technology use has been linked to a host of mental and physical health problems^(15–17), including obesity^(18–21). Television can be particularly problematic for youth because it is a major vehicle for transmitting unhealthy snack advertisements, but increasing numbers of embedded snack and drink advertisements in video games⁽²²⁾ highlights the need to examine the role of gaming in food cravings more closely.

CB technology use in general has been implicated in reduced physical activity levels among adolescents, but very little is known about the extent to which it may also promote unhealthy eating behavior. In addition to the content of the messages themselves, peer-to-peer platforms, such as G-chat and Facebook produce targeted advertisements to youth based on their messaging content and demographics. As a result of the pervasiveness of food advertising in communication platforms, adolescent health researchers have justifiably called for close examination of how CB technology use may contribute to poor eating⁽²³⁾.

In addition to examining the momentary associations among EB and CB technology use and cravings, we also sought to determine whether personal characteristics either increased or reduced these momentary relations. Specifically, we tested whether gender, ethnicity, BMI, and age predicted the strength and direction of technology use and cravings. Prior research with adults assessing gender-related qualitative differences in food cravings in response to screen-based stimuli indicated that women showed stronger responses to sweet food cues than men^(24–26), though studies among adolescent populations are sparse. Findings related to ethnic group differences also do not provide enough evidence to draw solid conclusions. Given that Hispanic youth have higher rates of obesity than non-Hispanic youth⁽²⁷⁾, and that major food companies incorporate strategies to target Hispanic/Latino consumers, it is important to determine how they may be differentially affected by different forms of technology use. Finally, we included BMI and age as predictors of the momentary relations among technology use and cravings due to past research indicating that 1) adolescents with higher BMIs tend to engage with screen media with more focused attention than youth with normal BMIs⁽²⁸⁾ and 2) engagement with cell phones increases significantly from earlier to later high school years⁽²⁹⁾.

Summary

In this study, we measured momentary relations among EB and CB technology use and cravings for salty foods, sweet foods, and sweetened drinks in a sample of urban

adolescents. Additionally, we determined whether these relations were different according to youths' gender, ethnicity, BMI, and age.

Method

Participants

The data for this study come from a larger research project on adolescent dietary behavior. See Grenard et al.,⁽¹⁴⁾ for a detailed description of the participants and procedures. Briefly, students were eligible to participate if they were between the ages of 14 and 17 years of age, spoke English, did not have a major illness, were not being treated for obesity, and were attending a high school in which a minimum of 25% of students receive free or reduced school lunch in Los Angeles County. In addition, a parent or guardian must have been willing to come to the initial session with the student. Students were recruited using fliers distributed on school grounds with consent of the school administrators. Eligibility for the study was determined during a telephone interview. A total of 158 participants from 13 schools met the criteria and were recruited into the study. The participants were predominantly female and Hispanic/Latino; remaining groups include Non-Hispanic Caucasian (5.1%); Non-Hispanic African-American (4.4%), Asian (2.5%), Native-American (2.5%), mixed (15.8%), and other (1.1%). Twenty-five percent of the participants were obese according to the BMI percentiles calculated per CDC guidelines.

Procedures

Each participant came to a university facility with one of their parents or a guardian for assessment and training. See Grenard, et al.⁽¹⁴⁾ for details of procedures and consent; the research procedures were approved by the Claremont Graduate University Institutional Review Board. Participants completed a series of assessment and training tasks including: (a) measurement of weight and height, (b) interviews about afterschool activities, (c) training on the EMA protocol, and (d) a baseline computer-based questionnaire.

A standardized procedure was used to train participants on how to operate the PDA⁽¹⁴⁾. Palm E2 PCA devices were programmed to project specifications (invivodata, Inc., Pittsburgh, PA) to display a series of questions about physical location, social environment, activities, mood, cravings, and foods consumed. Participants were instructed to initiate the questions each time they drank or ate something. Prompts (alarms) were randomly issued by the PDA (2 times on weekdays after school and 4 times on weekend days) for the participants to complete the same set of questions, to capture states and settings when the participants were not drinking or eating. Finally, participants responded to a series of questions each evening about things that might change daily (e.g., kitchen cabinet inventory of snacks) but were unlikely to change from moment to moment. These data were not included in the current investigation. Data from the self-initiated eating event questions (69% of the momentary responses) were combined with the data from the random prompts to include both eating events and non-eating events. The PDA devices were de-activated on school days between 8am and 3pm to avoid potential disruption of activities at school. After training and practice with the PDA, participants were instructed to continue to use the device for 9 days with the first 2 days as practice and the following 7 days as critical test days.

Participants were compensated \$200 for the time they spent at the baseline session and for completing the 9 days of EMA.

Measures

Baseline Measures—Gender (Female=1), age in years, and ethnicity (Hispanic/Latino=1) were measured using a self-report questionnaire along with other characteristics that are not relevant to the current study. Adolescents' BMI percentile was determined using the CDC BMI Percentile Calculator based on date of birth and measured height and weight.

EMA: Technology Use—At each momentary assessment, participants indicated whether they were or were not using electronic media. If they were, they were asked what type of media with the following options: “watching TV”, “computer/video games”, “working on a computer”, “IM/email on computer”, “texting”, “listening to music”, and “other”. Because we were interested in leisure time screen-based sedentary technology use, we limited the analysis in the current paper to: 1) television viewing; 2) playing video games on either a television or computer; 3) messaging on a computer; 4) text messaging on a phone. Though listening to music is often a sedentary activity, we did not include this variable to reduce the responses during which youth may have been concurrently engaged in a physical activity (e.g. jogging with an MP3 player).

EMA: Cravings—Adolescents responded to momentary measures of snack/drink cravings adapted from Greeno et al.⁽³⁰⁾ The question asked whether the participants were craving a sweet snack, salty snack, sweetened drink, non-sweetened drink, fruit or vegetables, or a meal (or no craving). The items of interest to the current study included craving for a sweet snack, salty snack, or a sweetened drink. Responses for each item ranged from 0 (not at all) to 100 (very much).

Analysis

A single multilevel, multivariate path model was used to test the associations among adolescents' personal characteristics, their momentary media use, and their momentary cravings. Multilevel analysis accounts for nesting of repeated measurement occasions within individuals. For the level 1 (measurement occasions) component of the analysis, the random slopes of the relations between momentary media use and cravings were estimated. We also examined relations among individuals' characteristics and their estimated slopes (i.e. a ‘between-level effect’). Thus, the between-level effects show the extent to which person-level characteristics (i.e. gender, age, ethnicity, and BMI percentile) moderate the strength of the momentary relations between technology use and cravings.

Results

Table 1 presents descriptive statistics of the study variables. Of the 3976 total responses, adolescents indicated that they were using some form of electronic media 34% of the time. The multilevel analysis is therefore based on 1686 cases at the momentary level. The youths' time spent using technology was dominated by watching television, followed by phone messaging. Playing video games accounted for slightly less than a quarter of

responses and computer messaging was the least common activity. Note that these percentages do not add to 100 because the response choices allow for more than one 'yes' response in a single measurement occasion and other forms of media (e.g. listening to music) are not included in the current analysis. On average, youth reported the strongest cravings for sweetened drinks.

Preliminary ANOVAs revealed several differences in the reported frequencies of technology use by gender. Girls reported significantly more instances of texting and less television watching and video game playing than boys ($F(1, 1667) = 15.40, 41.69, \text{ and } 34.23$ respectively, $p < .05$; see Figure 1 below for technology use percentages by group characteristics). There were no significant differences in technology use by ethnicity or age. Means of BMI percentile were higher for girls ($M = 73.27$) than boys ($M = 70.58$; $F(1, 157) = 12.83, p < .05$), and higher for Hispanic ($M = 74.11$) than non-Hispanic youth ($M = 63.26$; $F(1, 157) = 125.41, p < .05$).

Table 2 shows the results of the relations among momentary technology use and snack cravings (i.e. the 'Level 1' analysis). The slopes in this table represent mean differences in level of cravings for moments of engagement vs non-engagement with various technology types. Both watching TV and gaming were associated with increased craving for both salty snacks and sweetened drinks. Phone messaging was associated with lower craving for sweetened drinks. No other associations were significant; computer messaging was not associated with cravings.

Table 3 shows the between-level results, that is, the extent to which person-level characteristics moderate momentary relations among media use and cravings. The slopes in this table represent the change in the momentary-level slope that corresponds with changes in the respondents' personal characteristics. Ethnicity was the most common significant predictor of the random slopes. Specifically, Hispanic teens showed smaller associations between television exposure and cravings for sweet snacks, salty snacks, and sweetened drinks. Conversely, Hispanic teens had stronger associations between phone messaging and cravings for sweet snacks, salty snacks, and sweetened drinks. Females showed significantly smaller associations between video game use and salty snack cravings. Finally, adolescents with higher BMI percentiles showed weaker associations between television viewing and sweetened drink cravings. No significant results were found for age.

Discussion

The purpose of this paper was to examine 1) momentary relations between EB and CB technology use and cravings for sweet snacks, salty snacks, and sweetened drinks and 2) the extent to which personal characteristics moderate the relation between momentary technology use and cravings in a sample of urban adolescents. Potential environmental triggers of unhealthy food and drink cravings are important to investigate because researchers can use this information to extract avenues for preventing unhealthy snack consumption. Specifically, understanding the extent to which adolescents' personal characteristics change momentary relations among technology use and snack and drink cravings can reveal which youth are most vulnerable to which types of media.

We found that when teens were involved in television viewing and playing video games they experienced more intense cravings for salty snacks and sweetened drinks, but not for sweet snacks. Prior research has shown generally that these sedentary activities contribute to increased risk for overweight and obesity; television viewing in particular is a risky environmental cue due to the prominence of unhealthy food advertising, much of it targeted to children and adolescents. It is not yet clear why watching television and playing video games is related to cravings for salty snacks and sweetened drinks, but not sweet snacks. This finding may reflect an age-related shift in food preferences; as youth enter adolescence, their preferences shift somewhat away from intensely sweet foods and more toward salty/fatty foods, and the marketing approaches to this demographic may reflect that shift⁽³¹⁾. Moreover, high school age youth are major consumers of sweetened caffeinated drinks such as soda and energy drinks, and may simply experience cravings during sedentary activities as a result of caffeine dependence⁽³²⁾. We did not find any effects of age on these associations within the age range we examined, but the age-related shifts may have occurred earlier. More research is needed to understand the specific media cues that may play a role in specific types of cravings.

Our findings from the between-level analysis revealed that, in relation to males, female adolescents showed a weaker relation between playing video games and cravings for salty snacks. Thus, boys appear to be more vulnerable to video games as a craving-inducing cue for salty foods. Though adolescent girls' use of video games is on the rise, boys play for longer hours and tend to engage in the activity with more focused attention⁽³³⁾. Longer and deeper engagement may also cause males to receive more images from embedded food advertisements, which could trigger boys' cravings.

The between-level analysis also revealed interesting differences by ethnic group. First, being non-Hispanic was associated with a stronger relation between watching television and craving salty snacks, sweet snacks, and sweetened drinks. This potential sign that non-Hispanic youth may be more vulnerable to television as a cravings-eliciting cue may reflect differences in advertising content of products targeted to teens of different cultures. For example, recent research has shown that Spanish-language programming contains fewer advertisements for unhealthy snacks than English programming⁽³⁴⁾. Though the Hispanic youth in our sample spoke English, their television viewing may include Spanish-language and Hispanic-directed programming. Because the study did not measure the amount of exposure to language-specific programming, future work in this area should examine these culturally relevant characteristics in more detail.

We also found a greater relationship between phone messaging and cravings for salty/fatty snacks and sweet snacks among Hispanic adolescents. Youths' use of handheld communication devices has recently gained attention as a potentially problematic sedentary behavior⁽¹⁰⁾. Time spent texting and messaging, for example, has recently increased substantially for adolescents in general and Latino adolescents in particular⁽³⁵⁾. Understanding the processes behind ethnic differences in the role of text-based communication requires additional research. Given recent technological advances of cell phones and other handheld devices, texting has become an increasingly complex behavior, in which youth may simultaneously transition between texting and web-based applications

and games, contributing to problems in accurately measuring specific phone-related behaviors. Free game applications for handheld devices, for example, are often sponsored by major snack- and drink-producing food companies, many of which have developed strategies for targeting Hispanic youth. It would be interesting and important in future work to more thoroughly assess additional factors of cell phone use that may play a role in eliciting food cravings among Hispanic youth.

Interestingly, adolescents with higher BMI percentiles had significantly weaker relationships between watching television and craving sweetened drinks; in no case was a higher BMI associated with greater craving response to any technology type. Though overweight adults show attentional bias to food cues in laboratory settings⁽³⁶⁾, the adolescents in the current study may be exposed to a wider variety of competing cues in their natural environments, such as available food, or cravings-inducing mood states, which may have been more salient than the technology-delivered cues. More research is needed to further understand how EB and CB technology use, within the context of other potentially cravings-inducing cues, may operate differently in overweight adolescents within their natural environments.

The findings of our study should be considered in light of some limitations. First, each of the relations we tested was correlational in nature, such that contemporaneous relations between technology use and cravings represented the level 1 effect. Thus, the results cannot be used to infer cause. Second, though EMA provides a rich, data-intensive account of real-time cue-response processes, the study period reflects only one week of the youths' lives; the type and quality of media cues may shift over time, resulting in different findings. Also, the information collected via EMA only captured adolescents' use of various devices, and did not characterize the devices' content, including the presence of cue-relevant content. Finally, though our sample included urban Hispanic youth, who are understudied and at elevated risk for obesity, the comparison group of non-Hispanic youth was racially and ethnically varied and small. Further investigations of the relation of media use to food cravings should include larger samples with participants from other cultural groups and socioeconomic status. On the other hand, the study had significant strengths, notably the inclusion of a substantial Hispanic cohort, and the use of EMA to gather real-time data on technology-craving associations outside the laboratory, in adolescents' everyday lives.

Conclusions

This study builds on previous work examining the role of technology use in adolescent snacking behavior. We found that boys appear to show heightened vulnerability to video games as a potential cravings-inducing cue for salty snacks. We also found that non-Hispanic youth showed stronger relations between watching television and cravings for all categories of food and drinks. Hispanic youth, however, appear to be more vulnerable to CB technologies, namely mobile phone texting. As the public health field continues to monitor the effects of EB and CB technology use on adolescents' eating and overall health, it will be important to determine the extent to which these groups are differentially affected as technology continues to change.

Acknowledgements

This project was supported by Grant Number U01HL097839 from the National Heart, Lung, & Blood Institute and the National Institute of Child Health & Human Development. We thank James Pike for his work on coordinating the authors' efforts across multiple sites and Jared Chapman for his help with compiling sources.

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Figure 1.

Table 1

Descriptive Statistics of Adolescents' Personal Characteristics, Tech Use, and Cravings.

	Mean	SD	Min	Max
Personal Characteristics: <i>n</i> =158				
Female (%)	57%	--	--	--
Age	15.98	1.03	14.00	18.00
Hispanic (%)	67%	--	--	--
BMI Percentile	72.05	26.08	8.00	100.00
Momentary Tech Use ^a : <i>n</i> =1686				
TV	52%	--	--	--
Gaming	24%	--	--	--
Messaging (Computer)	.6%	--	--	--
Messaging (Phone)	38%	--	--	--
Momentary Cravings <i>n</i> =1686				
Salty Snack	18.99	28.20	0.00	100.00
Sweet Snack	27.94	35.16	0.00	100.00
Sweetened Drink	37.68	37.98	0.00	100.00

^a All tech use variables are coded such that 1=use and 0=nonuse. Means of Momentary Tech Use items are proportions of 'yes (1)' responses.

Table 2
Associations Between Adolescents' Momentary Tech Use and Momentary Cravings ($n=1686$).

Tech Use ^b	Cravings												
	Salty Snacks				Sweet Snacks				Sweetened Drinks				
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL	
TV	4.00		1.44	1.64	6.37	2.15	1.81	-0.83	5.13	4.97	1.95	1.76	8.18
Gaming	4.30		1.67	1.55	7.05	-3.09	2.11	-6.57	0.38	4.91	2.27	1.17	8.65
Messaging: Computer	-0.71		2.85	-5.40	3.99	2.77	3.60	-3.14	8.71	4.61	3.87	-1.76	10.98
Messaging: Phone	-2.35		1.45	-4.74	0.03	-2.94	1.82	-5.95	0.07	-4.07	1.97	-7.30	-0.84

^a Betas in bold face are significant at $p < .05$.

^b All tech use variables are coded such that 1=use and 0=nonuse.

Results of Person-Level Characteristics ($n=158$) as Moderators of the Relationship between Momentary Tech Use ($n = 1686$) and Momentary Cravings ($n = 1686$).

Table 3

	Salty/Fatty Snack Cravings											
	TV			Gaming			Messaging (Computer)			Messaging (Phone)		
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL
Gender ^b	1.36	4.87	-2.71	8.64	-8.99	4.56	-16.49	-1.49	3.12	12.22	-21.36	2.38
Age	-0.41	1.43	-2.72	2.91	-0.85	2.11	-5.57	2.20	3.65	3.01	-5.67	4.76
Ethnicity ^c	-0.42^a	0.04	-0.34	-0.19	-0.29	14.96	-7.42	7.53	0.06	15.02	-24.64	24.76
BMI Percentile	-0.02	0.06	-0.25	0.00	-0.01	0.09	-0.21	0.07	0.04	0.24	-0.15	0.14
Sweet Snack Cravings												
	TV			Gaming			Messaging (Computer)			Messaging (Phone)		
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL
Gender ^a	2.97	3.45	-2.71	8.64	0.45	4.19	-6.45	7.35	-9.49	7.22	-21.36	2.38
Age	0.09	1.71	-2.72	2.91	-1.69	2.36	-5.57	2.20	-0.46	3.17	-5.67	4.76
Ethnicity ^b	-0.26	0.04	-0.34	-0.19	0.06	4.55	-7.42	7.53	0.07	4.53	-7.38	7.51
BMI Percentile	-0.13	0.08	-0.25	0.00	-0.07	0.09	-0.21	0.07	0.01	0.11	-0.17	0.19
Sweetened Drink Cravings												
	TV			Gaming			Messaging (Computer)			Messaging (Phone)		
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL
	β	SE	LCL	UCL	β	SE	LCL	UCL	β	SE	LCL	UCL
Gender ^a	1.41	3.65	-4.59	7.41	0.96	8.16	-12.46	14.39	-0.93	23.79	-49.06	38.20
Age	-0.78	2.56	-4.99	3.44	0.29	7.10	-11.39	11.96	-1.06	6.31	-11.44	9.33
Ethnicity ^b	-0.25	0.05	-0.33	-0.16	0.13	21.15	-34.66	34.91	0.12	21.47	-35.20	35.43
BMI Percentile	-0.21	0.09	-0.35	-0.07	-0.08	0.07	-0.19	0.04	0.03	0.24	-0.36	0.43

^a Betas in bold face are significant at $p < .05$.

^b Female=1, Male=0.

^c Hispanic=1, non-Hispanic=0.