Obesogenic Behaviors among Adolescents: The Role of Generation and Time in the United States

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Objectives: To examine how obesogenic behaviors (consumption of sugary drinks, physical activity, and/or sedentary behaviors) differ among adolescents within and across generation.

Design: Data come from the 2008 Boston Youth Survey, a population-based sample of 9th-12th-graders in 22 public high schools in Boston, MA. We used self-reported information to calculate generation and obesogenic behaviors (i.e. physical activity in past 7 days, consumption of sugar-sweetened beverages in past 7 days, and TV/computer/video game use on an average school day). Multivariable models were conducted to estimate the association between generation and obesogenic behaviors, adjusting for race/ethnicity, sex, age, family structure, and school.

Results: Relative to first generation youth, 1.5 generation (RR=1.74, 95% CI= 1.10, 2.77) and second generation (RR=1.45, 95% CI=1.02, 2.07) youth were more likely to consume soda. Second (RR=1.60, 95% CI=1.20, 2.14) and third generation (RR=2.29, 95% CI=1.43, 3.65) youth were significantly more likely to consume other sugary drinks. Only third generation youth were more likely to watch ≥2 hours/day of TV when compared to first generation youth (RR=1.53, 95% CI=1.07, 2.18). No differences were seen by generation for levels of moderate-to-vigorous physical activity or computer/video games.

Conclusions: Greater consumption of sugary drinks is seen across generation among adolescents. Sugary drinks, which are aggressively marketed to immigrant youth, may contribute to excess weight gain seen among foreign-born youth upon arrival in the United States. (*Ethn Dis.* 2015;25[1]:58-64)

Key Words: Obesogenic Behaviors, Body Mass Index, Generation, Time in the United States, Adolescents

Introduction

Adolescence is a critical period for establishing dietary and exercise patterns,[1] and for the development of obesity.[2] Obesity among youth has more than tripled in the past 30 years, with 18.1% of adolescents in the United States now considered obese.[3] There are important health and social implications of obesity for adolescents, including risk of an array of cardiometabolic diseases,[4] and psychological consequences related to stigmatization and poor self-esteem.[5] Obesity among adolescents is a global public health issue; however, the rate of obesity among youth in the United States is among the highest worldwide.[6,7]

Although immigrant youth weigh less than their US-born peers, generation and nativity status are correlated with obesity, with most studies demonstrating a higher risk of obesity with increased generation and with US-born offspring of foreign-born parents.[8–10] While the notion that obesity markedly increases from first generation (foreign-born) to second generation (US-born offspring of ≥1 foreign-born parent) is well-established,[6,9] more recent research has begun to show that convergence of weight between foreign- and US-born no longer takes a full generation.[8] Rather, the process by which the risk of obesity among foreign-born youth becomes indistinguishable from their US-born peers occurs within a matter of years.

Little is known about the factors or mediating mechanisms that contribute to/underlie the increase in weight that occurs in the first few years after arrival in the United States.[2,8] Many studies have shown that risk behaviors, including sexual activity, substance use, and perpetration of violence among immigrant youth, increase with more time spent in the United States.[11–13] However, fewer studies have explored whether this pattern is true of obesogenic behaviors such as diet, physical activity, and sedentary behaviors that are precursors of obesity.[14–16] Moreover, most studies have examined changes either between US- and foreign-born or across first, second, and third generation youth. Consequently, they have overlooked the fact that rates of obesity and other risk behaviors among foreign-born youth converge with US-born peers within a generation, rather than across a generation.[8,11,13] Similarly, foreign-born youth may adopt the obesogenic behaviors of their US-born peers soon after immigrating to the United States; however, this pattern of adoption remains understudied.

Because immigrant children and children of immigrant parents are the fastest growing segment of the US youth population,[17] there is an urgent need to understand how adoption of obesogenic behaviors influence the sharp increase in obesity observed among immigrant youth shortly after arrival in the United States. Dietary factors, such as sugar-sweetened beverage intake, physical activity, and sedentary behaviors, are important determinants of obesity and are potential mediators of the association between increased generation status and obesity. These modifiable behaviors

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To fill the gaps in knowledge, we sought to examine how obesogenic behaviors, specifically sugar-sweetened beverage consumption, physical activity, and sedentary behaviors, differ across generation and time in the United States among a sample of youth in Boston, Massachusetts.

could represent an opportunity for treating and preventing the increase in weight seen with increased time in the United States. To fill the gaps in knowledge, we sought to examine how obesogenic behaviors, specifically sugar-sweetened beverage consumption, physical activity, and sedentary behaviors, differ across generation and time in the United States among a sample of youth in Boston, Massachusetts.

METHODS

Data for the current study come from the 2008 Boston Youth Survey (BYS), a survey of 9th–12th grade students in the Boston Public Schools district. All 32 traditional public high schools in Boston were invited to take part in the study and 22 participated. There were no statistically significant differences between the schools that participated and those that did not with regard to school characteristics (eg, drop-out rate). To acquire a random sample of students within participating schools, we generated a list of unique humanities classrooms within each school. Classrooms were then stratified by grade and randomly selected for survey administration. Each student within the selected classrooms was invited to participate. Selection of classrooms continued until the total number of students to be surveyed ranged from 100–125 per school. We sought passive consent from students' parents and obtained informed assent from participants prior to survey administration. Surveys were administered during a 50-minute class period with study staff in the classroom to answer any questions. Of the 2,725 students enrolled in the selected classrooms, 1,878 completed a survey (response rate = 68.9%). Students who did not complete a survey either: a) chose not to participate (3.6%); b) were not permitted by their parent to take the survey (1%); or c) were absent from school on the day of survey administration (26.6%). The Human Subject Committee at the Harvard School of Public Health approved study protocols.

Obesogenic Behaviors

Items assessing obesogenic behaviors were adapted from the Youth Risk Behavior Surveillance System. Two items assessed consumption of sugar sweetened beverages: "In the past 7 days, how often did you drink soda (1 can or glass)", and "In the past 7 days how often did you drink Hawaiian punch, lemonade, Kool-Aid or another sweetened fruit drink?" Response options to both questions included: never or <1 can, 1 can in the past 7 days, 2–4 cans in the past 7 days, 5–6 cans in the past 7 days, 1 can per day, 2 cans per day, 3 or more cans per day. Consumption of soda and other sugary drinks was operationalized as a binary variable (never vs any). Moderate to vigorous physical activity was assessed with the question, "In the past 7 days, on how many days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard?" Response options ranged from 0 to 7 days. Consistent with US guidelines for physical activity, we operationalized this as a binary variable, <5 days/past week vs ≥5 days/past week.[18] Sedentary behaviors were assessed with two items related to screen time. The first, "On the average school day, how many hours do you spend watching television?" and the second "On the average school day, how many hours do you play video or computer games, or use a computer for something other than school work?" Response options include (in number of hours): none, <1, 1–2, 3–4- and ≥5. Consistent with the American Academy of Pediatrics guidelines,[19] we operationalized sedentary behavior as a binary variable "TV viewing ≤2 hours/day vs. >2 hours/day and "video game and computer use ≤2 hours/day vs. >2".

Generation

Students self-reported whether they were born in the United States or not. Foreign-born youth then indicated whether they had been in the United States for ≥4 years or <4 years, and all students reported whether each parent was born in the United States or not. Foreign-born students who had been in the United States for <4 years were classified as first generation, and those who had been in the United States for ≥4 years were classified as 1.5 generation. US-born students who had at least one foreign-born parent were classified as second generation, and those with two US-born parents were classified as third generation; this group also includes youth who are higher than third generation. Similar measures have been used in previous research.[8,11,13]

Covariates

We controlled for factors known to be associated with obesity including age (≤14, 15, 16, 17, ≥18), sex (male/female), race/ethnicity (non-Hispanic black, Hispanic, non-Hispanic Asian/South Asian, non-Hispanic other, non-Hispanic white), and family structure

(single vs. dual-headed household), which were all self-reported by students.

Statistical Analysis

We used a three-sample strategy in which the sample size was maximized for each outcome to increase statistical power. Sample one was composed of adolescents who completed the sugary drinks survey items (n=1438). Sample two was composed of adolescents who completed the physical activity item (n=1453), and sample three was composed of adolescents who completed the sedentary behavior survey items (n=1409). Using the three-sample strategy helped us minimize any bias associated with conducting a complete case analysis. Because the percent missing on the main predictor (generation) and all covariates was <5%, and was not systematically patterned, we deleted these observations for all three samples. First, we estimated the bivariate relationship between the each obesogenic behavior and covariates across generation using Chi-Square goodness of fit statistics. We then used multivariable logistic regression to examine the association between generation obesogenic behaviors. Rather than estimate odds ratios, we generated relative risks (ie, prevalence ratios) because the outcomes of interest were common in the study population (ie >10%). We fit GEE models using PROC GENMOD in SAS 9.3 with school (the cluster variable) specified as the subject in the REPEATED statement (SAS Institute, 2008) using an exchangeable correlation matrix. We then ran a series of two regression models to estimate the unadjusted and adjusted associations of generation and risk of each obesogenic behavior. In Model 1, we estimated the crude association between generation and each outcome, and in Model 2 we adjusted for all covariates. Additionally, we examined physical activity as a count variable using Poisson regression, but results were identical to those from the logistic regression models.

RESULTS

The sample was 55% female and the majority of students were racial/ethnic minorities; 41% identified as Black (non-Hispanic), 34% identified as Hispanic, and 9% were Asian/South Asian (Table 1). Obesogenic behaviors were common; the majority of respondents consumed soda (76.8%), and other sugary drinks (80.9%). Almost half of students watched TV ≥2 hours/day (45.1%), and 38% played computer/video games ≥2 hours/day. In contrast, engagement in moderate-to-vigorous physical activity was relatively uncommon (27.2%). In bivariate analyses, differences is obesogenic behaviors were seen across generation; there was a clear pattern of increasing consumption of other sugary drinks from first to third generation youth (P=.006). Although there was an increase in prevalence of soda consumption across generation, the association did not reach statistical significance. While there were statistically significant differences in playing computer/video games, and 1.5 generation youth had the highest prevalence (43.5%), there was no clear pattern across generations (P=.03). However, engagement in moderate-to-vigorous activity was most common among third generation youth (33.1%, P=.004).

Consumption of Sugary Beverages

In crude models, second and third generation youth were significantly more likely to consume soda in the past week relative to first generation youth. However, in fully-adjusted models only 1.5 generation (RR=1.74, 95% CI= 1.10, 2.77), second generation (RR=1.45, 95% CI=1.02, 2.07) youth were more likely to consume soda relative to first generation youth (Table 2). A similar pattern emerged for consumption of other sugary drinks in the crude and adjusted models. In adjusted models second (RR=1.60, 95% CI=1.20, 2.14) and third generation (RR=2.29, 95% CI=1.43, 3.65) youth were significantly more likely to consume other sugary drinks compared to first generation youth (Table 2). There were also racial/ethnic differences in consumption of other sugary drinks; non-Hispanic Black (RR=3.58, 95% CI=2.22, 5.79), Hispanic (RR=3.58, 95% CI=2.40–5.33), and non-Hispanic other (RR=3.29, 95% CI=1.60, 6.76) were each more likely to consume other sugary drinks relative to their non-Hispanic White peers (data not shown in table).

Physical Activity

In the crude and adjusted models second and third generation youth were more likely to engage in moderate to vigorous physical activity than were first generation youth, but differences did not reach statistical significance (Table 3). Additionally, Asian (RR=0.41, 95% CI=0.21, 0.81) and non-Hispanic other youth (RR=0.51, 95% CI=0.29, 0.88) were significantly less likely to engage in moderate-to-vigorous physical activity relative to non-Hispanic White youth (data not shown in table).

Sedentary Behaviors

In fully-adjusted models, only third generation youth were more likely to watch ≥2 hours/day of TV (RR=1.53, 95% CI=1.07, 2.18) compared to first generation youth (Table 4). Racial/ethnic differences emerged as well; non-Hispanic Blacks and Hispanics were both significantly more likely to watch ≥2 hours/day of TV a day (RR=2.25, 95% CI=1.33, 3.81 and RR=2.01, 95% CI=1.11, 3.68, respectively) compared to non-Hispanic White youth (data not shown in table). No significant differences in playing computer/video game use were seen across generation (Table 4). However, Hispanic (RR=1.35, 95% CI=1.04, 1.75) and Asian youth (RR=2.40, 95% CI=1.27, 4.56) were more likely to play ≥2 hours/day of computer/video games compared

Table 1. Prevalence of obesogenic behaviors and risk factors across generation among Boston public high school students, 2008

	Total	First Generation	1.5 Generation	Second Generation	Third Generation	
	n (%) or μ (std)	*n* (%) or μ (std)	*n* (%) or μ (std)	*n* (%) or μ (std)	*n* (%) or μ (std)	*P*[d]
Sugary drink consumption[a]						
Soda	1105 (76.8)	83 (69.1)	213 (74.7)	446 (78.1)	363 (78.6)	.11
Other sugary drinks	1163 (80.9)	86 (71.7)	221 (77.5)	467 (81.8)	389 (84.2)	.006
Physical activity[b]						
≥5 days/past week	395 (27.2)	28 (23.5)	64 (22.2)	148 (25.7)	155 (33.1)	.004
Sedentary behaviors[c]						
TV	635 (45.1)	48 (41.4)	122 (44.2)	244 (43.9)	221 (47.8)	.48
Computer/video games	534 (37.9)	44 (37.9)	120 (43.5)	217 (39.1)	153 (33.1)	.03
Sex						.27
Male	658 (45.3)	58 (48.7)	142 (49.1)	259 (45.0)	199 (42.4)	
Female	795 (54.7)	61 (51.3)	147 (50.9)	317 (55.0)	270 (57.6)	
Race/ethnicity						<.0001
White (non-Hispanic)	146 (10.1)	65 (4.2)	13 (4.5)	21 (3.6)	107 (22.8)	
Black (non-Hispanic)	594 (40.9)	52 (43.7)	107 (37.0)	194 (33.7)	241 (51.4)	
Hispanic	495 (34.1)	34 (28.6)	123 (42.5)	268 (46.5)	70 (14.9)	
Asian/South Asian	126 (8.7)	26 (21.8)	33 (11.5)	66 (11.5)	1 (.2)	
Other, bi/multiracial	92 (6.3)	2 (1.7)	13 (4.5)	27 (4.7)	50 (10.7)	
Age						<.0001
≤14	122 (8.4)	13 (11.0)	21 (7.3)	49 (8.5)	39 (8.3)	
15	276 (19.0)	19 (15.9)	48 (16.6)	115 (19.9)	94 (20.0)	
16	407 (28.0)	19 (15.9)	79 (27.3)	169 (29.3)	140 (29.9)	
17	389 (26.8)	25 (21.1)	85 (29.4)	148 (25.8)	131 (27.9)	
≥18	259 (17.8)	43 (36.1)	56 (19.4)	95 (16.5)	65 (13.9)	
Family structure						.003
Dual-headed	812 (55.9)	76 (63.9)	170 (58.8)	335 (58.2)	231 (49.3)	
Single-headed	641 (44.1)	43 (36.1)	119 (41.2)	241 (41.8)	238 (50.7)	

[a] *n*=1438.
[b] *n*=1453.
[c] *n*=1409.
[d] based on Chi Squared goodness of fit statistic.

to non-Hispanic white youth (data not shown in table).

DISCUSSION

Our study examined whether obesogenic behaviors, including consumption of sugary drinks, engagement in physical activity, and sedentary behaviors, change within or across generation among a population-based sample of public high school students in Boston, Mass. Although previous rates of obesity and other risk behaviors among foreign-born youth converge with US-born peers within a generation, rather than across a generation,[8,11,13] we did not observe this same pattern across all obesogenic behaviors we studied. Instead, the adoption of obesogenic behaviors among foreign born youth appeared to differ by behavior.

We found no significant differences in engagement in moderate-to-vigorous physical activity across generation. Other studies of this topic have been somewhat inconclusive. One study among Hispanic and Asian youth showed that acculturation to the US was significantly associated with a lower frequency of physical activity.[16] Another study found no change in physical activity across generation among Hispanic youth, but found that levels of physical activity improved across generation among Asian youth.[15,20] Similarly, a recent study among Mexican American adolescents reported a positive correlation between level of vigorous activity and generation/time in the United States with highest participation in vigorous physical activity seen in third generation youth.[17] Differences in the strength and direction of the association found among these studies may be due to the different ways in which exposure to the United States (eg generation, nativity, acculturation) was measured. Additionally, the relationship between generation and physical activity may differ by race/ethnicity, but due to sample sizes, we were unable to examine any variability. With regard to sedentary

Table 2. Relative risk of sugary drink consumption during past 7 days, by generation, among Boston public high school students, *n*=1438

	Soda	
	Model 1	**Model 2[a]**
Parameter	RR (95% CI)	RR (95% CI)
Generation/time in United States		
Third generation	1.76 (1.16, 2.20)	1.21 (.78, 1.88)
Second generation	1.69 (1,19, 2.42)	1.45 (1.02, 2.07)
1.5 generation (FB in US >4 years)	1.40 (.88, 2.20)	1.74 (1.10, 2.77)
First generation (FB in US <4 years)	1.0	1.0
	Other sugary drinks	
Generation/time in United States		
Third generation	2.36 (1.36, 4.09)	2.29 (1.43, 3.65)
Second generation	1.99 (1.28, 3.10)	1.60 (1.20, 2.14)
1.5 generation (FB in US >4 years)	1.43 (.97, 2.13)	1.22 (.92, 1.63)
First generation (FB in US <4 years)	1.0	1.0

FB, first born.
[a] Adjusted for sex, age, race/ethnicity and family structure.

behavior, we saw differences for TV viewing only when comparing first generation youth to third generation youth and we observed no differences in computer/video playing. One study of a nationally representative sample of Hispanic youth found that TV and video viewing increased with generation of US residence,[2] while the recent study of Mexican American adolescents reported no association in bivariate analyses.[17] In another study, hours of television viewing or video game playing decreased across generations among Asian youth, but were stable across generations among Hispanics.[16] Taken together, findings suggest changes in sedentary behavior across generation may be slow and modest and may differ by race/ethnicity.

Among our sample, consumption of soda was significantly higher among 1.5 generation relative to first generation youth; however, difference in risk of consuming other sugary drinks only became significantly higher with second generation youth. Results of studies that assessed changes in diet across generation have been fairly definitive. For example, a study of a nationally representative sample of Hispanic adolescents found significant differences in dietary patterns between foreign and US-born Mexicans, Puerto Ricans and Cubans, with first generation Hispanics, particularly Mexicans consuming less fast food and more low-fat, nutritious foods than second and higher generation youth.[12] Another study among Hispanic and Asian youth found that increased acculturation was associated with higher frequency of fast food consumption.[18] Most studies, however, have examined diet or consumption of fast foods generally, while fewer have specifically evaluated consumption of sugary drinks or separated it out from consumption of fast foods.[16,18,20] A few studies have found an increase in sugary drink consumption across generation, especially among Hispanics.[12,18,20] Even fewer studies have examined consumption of soda and other sugary drinks separately.[17] This is an important gap in knowledge given the known association between consumption of sugary drinks and increased calorie intake, weight gain, obesity, and diabetes,[5] as well as the observation that Hispanic youth may be particularly susceptible to the weight-related consequences of sugary drink consumption.[21] Aggressive marketing of sugary drinks by beverage companies to minority populations may explain observed differences across generations. Beverage companies are targeting Black and Hispanic teens in their marketing efforts because they have been identified as a source of future growth for sugar drink product sales.[22] For example, Hispanic teens saw 99% more ads for sugary drinks and energy drinks on Spanish-language TV from 2008 to 2010.[23]

Table 3. Relative risk of moderate to vigorous physical activity during past 7 days, by generation, among Boston public high school students, *n*=1453

	Model 1	**Model 2[a]**
Parameter	RR (95% CI)	RR (95% CI)
Generation/time in United States		
Third generation	1.60 (.92, 2.78)	1.48 (.94, 2.34)
Second generation	1.13 (.74, 1.72)	1.04 (.75, 1.46)
1.5 generation (FB in US >4 years)	.94 (.61, 1.43)	.85 (.55, 1.31)
First generation (FB in US <4 years)	1.0	1.0

FB, first born.
[a] Adjusted for sex, age, race/ethnicity and family structure.

Several limitations should be considered when interpetring our findings. Measurement of obesogenic behaviors is subject to recall bias and limitations imposed by the use of self-reported single-item measures of obesogenic behaviors. Although we examined physical activity with a singular item, which might be considered a crude measure, the Youth Risk Behavior Surveillance System survey, administered by the Centers for Disease Control and Prevention, assesses physical activity with this question, and it has been correlated with other self-report and physiological measures of physical activity.[24] Additionally, assessment of physical activity and consumption of sugar sweetened

Table 4. Relative risk of sedentary behaviors by generation, among Boston public high school students, *n*=1409

	TV Viewing	
	Model 1	**Model 2[a]**
Parameter	RR (95% CI)	RR (95% CI)
Generation/time in United States		
Third generation	1.51 (.98, 2.34)	1.53 (1.07, 2.18)
Second generation	1.30 (.86, 1.96)	1.18 (.81, 1.71)
1.5 generation (FB in US >4 years)	1.25 (.78, 2.0)	1.17 (.75, 1.85)
First generation (FB in US <4 years)	1.0	1.0
	Computer/video game use	
Generation/time in United States		
Third generation	.82 (.49, 1.35)	.62 (.39, 1.00)
Second generation	1.06 (.73, 1.54)	1.05 (.68, 1.61)
1.5 generation (FB in US >4 years)	1.24 (.85, 1.80)	1.25 (.84, 1.88)
First generation (FB in US <4 years)	1.0	1.0

FB, first born.
[a] Adjusted for sex, age, race/ethnicity and family structure.

beverages was during the previous week. Because our study was cross-sectional and these behaviors can vary week-to-week, our estimates may lack stability over time. Moreover, our study was conducted among youth in Boston, and it is possible that associations observed would differ in other geographic regions and areas with a different socio-demographic makeup. Our study contributes to the current understanding of obesogenic behaviors among immigrant youth; however, longitudinal intergenerational studies are needed to optimally examine the adoption of obesogenic behaviors over time and across generation. Although overweight and obesity is especially common among some racial/ethnic groups, including Hispanics and Blacks,[4] in the United States, studies of how obesity or obesogenic behaviors vary across generation among youth rarely include Black immigrants.[16] An important strength of our sample was that it included Black immigrant youth.

CONCLUSION

In order to prevent the health, social, and economic consequences of obesity, greater attention must be paid to preventing rather than treating obesity and research must focus on understanding the obesogenic behaviors that are proximate causes of obesity.[25] Although a rise in obesity prevalence is universally seen from adolescence into adulthood,[2] foreign-born adolescents are an important target for obesity prevention efforts because they are particularly susceptible to this onset of obesity.[4] We found that consumption of sugary drinks was the behavior that differed most substantially across generation. While working against aggressive marketing of sugary drinks by beverage companies, obesity prevention programs targeted at immigrant youth should emphasize limiting consumption of these beverages.

We found no significant differences in engagement in moderate-to-vigorous physical activity across generation.

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