

Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health

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Abstract

Little is known about the factors underlying the striking increase in overweight occurring between first and second generation US immigrants. Using data from the National Longitudinal Study of Adolescent Health, this study addressed two goals. First, we determined which measures of acculturation (defined as the acquisition of dominant cultural norms by members of a non-dominant group) were important. Second, we determined how the acculturation process affected differences in overweight and its proximate determinants (e.g., physical activity, diet, and smoking) as immigrants acculturated to American society. In addition, we sought to elucidate the role of underlying structural factors (e.g., family income and crime) and acculturation factors (e.g., language spoken at home and proportion of foreign-born neighbors) in generation differences in overweight. Results showed clear structural and acculturation differences between foreign and US-born immigrants to the US. Foreign-born immigrants were more likely to have lower family income and maternal education, and to live in areas of higher immigrant density and greater linguistic isolation. In addition, results suggested rapid acculturation of overweight-related behaviors, such as diet, smoking, and inactivity, in US-born relative to foreign-born immigrants. Multivariate analysis indicated that longer US residence was associated with increased overweight among Puerto Ricans and Cubans. Predicted probabilities showed that controlling for acculturation and proximate factors increased overweight among foreign-born adolescents, but had minimal impact for US-born adolescents. Thus, without the beneficial pattern of: acculturation factors, diet, and physical activity, first generation Hispanic adolescents would have higher overweight prevalence. We found important generation differences in structural, acculturation, and proximate overweight determinants. These lifestyle differences between foreign- and US-born Hispanic adolescent immigrants are likely to underlie the striking increase in overweight prevalence between first and subsequent generation of US residence.

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Introduction

First and second generation immigrants comprise the fastest growing segment of the US child population, including approximately 60% of all Hispanic-American children (Zhou, 1997). Language barriers, low socioeconomic status (SES), cultural differences, and limited

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health care access (Wolfe, 1994) place immigrants at risk for low SES (Gordon, 1964; Lieberman, 1980), diminished health and well being. These difficulties decrease with each generation (Hirschman, 1996). However, immigrant populations are diverse and there are paradoxes in health by acculturation across populations (Park, 1950; Portes, 1996). For some populations and some health outcomes, first generation immigrants have better health despite lower SES [e.g., low birth weight, perinatal mortality (Guendelman, 1988; Guendelman & Abrams, 1995; Scribner & Dwyer, 1989; Scribner, 1996; Harris, 1998)] than the native population. Where this paradox is shown, the relative advantage declines with length of residence in the US (Committee on the Health and Adjustment of Immigrant Children and Families, 1998).

Over time, immigrant children adopt American behavioral norms for health status and risk (Harris, 1999a, b). However, reinforcement of native ethnic group values and norms can slow the acculturation process (Harris, 1999a, b). While these studies offer insights into the role that acculturation might play in enhancing health inequality, they do not identify potential mechanisms. Despite difficulties faced by US immigrant children, little research has examined the effects of immigration on health status (e.g., Harris, 1999a, b; Hernandez, 1993; Jasso & Rosenzweig, 1990; Lieberman, 1980; Portes & Zhou, 1993).

Immigrants and patterns of overweight

Adolescent obesity has important health, social, and economic consequences and is a major antecedent of adult obesity (e.g., Dietz, 1994; Serdula et al., 1993; Siervogel, Roche, Guo, Mukherjee, & Chumlea, 1991). The acculturation process is related to a striking increase in obesity between first and second generation Hispanic (Popkin & Udry, 1998) and Mexican-American (Mendoza & Dixon, 1999) adolescents. Furthermore, CVD and CVD-related risk factors are higher in US-born relative to foreign-born immigrants and particularly higher in immigrants who are more acculturated [e.g., in Mexican-Americans (Sundquist & Winkleby, 1999)].

Low physical activity levels and high inactivity, important biological determinants of obesity (Gortmaker, Sobal, Peterson, Colditz, & Dietz, 1996; Epstein et al., 1995; Epstein, Saelens, Myers, & Vito, 1997; USDHHS, 1996) that track over the lifecycle (Raitakari et al., 1994), tend to be high in Hispanic-Americans (Gordon-Larsen, McMurray, & Popkin, 1999). Although there is minimal dietary data on Hispanic immigrants (Hernandez & Charney, 1998), researchers have generally found healthier dietary intakes among foreign- versus US-born Hispanics (Schaffer, Velie, Shaw, & Todoroff, 1998; Guendelman & Abrams,

1995; Winkleby, Albright, Howard-Pitney, Lin, & Fortmann, 1994).

Although there is limited literature on this topic, structural factors, such as income and education may determine level of access to an American lifestyle, with decreased physical activity opportunities and increased availability of high-fat energy-dense foods, and thus higher obesity among low SES populations. Where immigrants settle has substantial implication for dietary and activity patterns, given availability of markets that supply foreign versus American goods and services. Furthermore, the contextual setting to which immigrants acculturate will have considerable impact on socioeconomic attainment (Portes & Zhou, 1993), particularly given the spatial concentration of affluence and poverty (Massey, 1996).

The objective of our study was to explore mechanisms that may explain the overweight differential across immigrant generations among three large subpopulations of Hispanic (Mexican, Puerto Rican, and Cuban) youth in the US. We define acculturation as the acquisition of dominant cultural norms by members of a non-dominant group. We aim to understand how the acculturation process affects differences in overweight and its proximate determinants as immigrants acculturate to American society. In addition, we aim to understand the role of underlying structural factors in generation differences in overweight prevalence.

Data

Survey design. The study population included over 20,000 adolescents enrolled in the National Longitudinal Study of Adolescent Health (Add Health), a longitudinal, nationally representative, school-based study of US adolescents in grades 7–12, supplemented with minority special samples and collected under protocols approved by the Institutional Review Board of the University of North Carolina-Chapel Hill. The survey design and sampling frame have been described in detail elsewhere (Popkin & Udry, 1998; Gordon-Larsen et al., 1999; Harris, 1999a, b).

Our final analysis sample included 8613 adolescents (Table 1) from four ethnic groups (Non-Hispanic Whites ($N = 6727$), Mexican/Chicanos ($N = 1151$), Puerto Ricans ($N = 398$), and Cubans ($N = 337$) from Waves I (1995) and II (1996) of Add Health.

Dependent variable

Overweight. Height and weight were measured in Wave II during in-home surveys; body mass index (BMI; kg/m^2) was calculated as a measure of adolescent adiposity (Himes & Dietz, 1994; WHO, 1995). Overweight status was defined as a BMI \geq 85th percentile of

Table 1

Sample Characteristics

Characteristic	Percentage or mean (SE)	Number
<i>Age</i>		
Mean age	15.93 (0.13)	8613
<i>Sex</i>		
Male	50.5	4267
Female	49.5	4346
<i>Ethnicity</i>		
White (ref)	78.1	6727
Mexican	13.4	1151
Puerto Rican	4.6	398
Cuban	3.9	337
<i>Generation</i>		
1st generation	4.5	392
2nd plus generation	95.5	8221
<i>Ethnicity and generation</i>		
<i>White</i>		
1st generation	0.6	44
2nd plus generation	99.4	6683
<i>Mexican</i>		
1st generation	16.3	187
2nd plus generation	83.8	964
<i>Puerto Rican</i>		
1st generation	5.8	23
2nd plus generation	94.2	375
<i>Cuban</i>		
1st generation	41.0	138
2nd plus generation	59.1	199

age and sex-specific cut-points from the 2000 CDC/NCHS growth charts (Centers for Disease Control and Prevention, 2000). Age- and sex-specific reference data, rather than cutpoints, are necessary during the adolescent growth period.

Independent variables

Acculturation variables. Acculturation data were collected from adolescents and parents in the in-home surveys. Immigrant generation was based on questions about adolescent's and parents' place of birth. *Generation one* includes children not born in the US and *Generation two or greater* includes children born in the US but with at least one parent who is foreign-born or children who were born in the US to US-born parents. In general, second generation adolescents are closer to third and greater generation than first generation adolescents on health-related measures examined here (Harris, 1999a, b). Due to their smaller sample size, we did not retain generation two adolescents as a separate group. The analysis sample included a substantial percentage of first generation, or foreign-born Hispanic adolescents (e.g., 16% of Mexicans, 6% of Puerto Ricans, and 41% of Cubans).

Acculturation data were also taken from the Add Health contextual database, which links geocoded respondent addresses and census areas. We used data from the 1990 Census of Population and Housing by census block group on percent of Hispanic population, proportion of the population that is foreign-born, dispersion in ethnic population, and proportion of households that are linguistically isolated (a measure of non-English speakers in the household). From self-reports we used reported language spoken at home (English or non-English) and years the respondent has lived in the US (0–5; 6–10).

Proximate determinants. Physical activity and inactivity patterns are important determinants of overweight and potential mediators of immigrant generation, as well as important avenues for treating and preventing overweight (Epstein et al., 1995; Epstein, Saelens, Myers, & Vito, 1997; USDHHS, 1996). Physical activity and inactivity data were collected using a standard set of recall questions over a 7-day period that are relevant for epidemiologic research (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Baranowski, 1988; Pate, Heath, Dowda, & Trost, 1996; Sallis, Buono, Roby, Micala, & Nelson, 1993). Activity is reported in bouts per week. Moderate to vigorous physical activities included skating and cycling, exercise and active sports, with an estimated energy cost of 5–8 METs (metabolic equivalent values; 1 MET = 3.5 ml O₂/kg body weight/min). Low intensity activity (2–3 METs) included house cleaning, hobbies, and “hanging out with friends”. We used two separate categories of inactivity, TV/video viewing (1 MET) and computer/video game use (1 MET).

Baseline and 1-yr change (Waves I–II) in physical activity/inactivity were monitored. Wave I baseline measures included: hours/week of TV/video viewing (> 26 h/wk), hours/week of computer/video game use (> 1 h/wk), weekly bouts of moderate–vigorous physical activity (> 4 bouts/wk) and bouts/week of low intensity physical activity (> 5 bouts/wk). One-year change (Waves II–I) measures included: TV/video viewing (≥ 7 h/wk), computer/video game use (≥ 1 h/wk), moderate–vigorous physical activity (≥ 1 bout/wk), and low intensity physical activity (≥ 1 bout/wk).

Dietary data were collected in Wave II. We used specific foods with relevance for acculturation (e.g., dairy, beans, rice, and fast foods) including meal patterns (Siega-Riz & Popkin, 2001). Respondents reported whether or not they ate a given food “yesterday” as part of a meal or snack. Although quantities of food consumed were not collected, data were sufficient for descriptive analysis of dietary patterns by immigrant generation and for examination of the contribution of diet to overweight. Diet variables included consumption of: milk, cheese, ready-to-eat cereal, rice, beans, pizza, lowfat foods (selects low fat

options of sweets, dairy, or meat), fruit (≥ 2 times/wk), vegetables (≥ 2 times/wk), fast foods (≥ 2 times/wk), breakfast (7 days/wk, versus 0–6 days/wk), lunch (7 days/wk versus 0–6 days/wk), and dinner (7 days/wk versus 0–6 days/wk).

Smoking is a well-known determinant of overweight. French, Perry, Leon, & Fulkerson (1994) and French, Story, Downes, Resnick, & Blum (1995) showed a relationship of dieting behaviors and smoking, suggesting a clustering of risk factors related to body weight. Smoking is viewed as a weight control method (Camp, Klesges, & Relyea, 1993). Smoking cessation has long been associated with weight gain in adults (Flegal, Troiano, Pamuk, Kuczmarski, & Campbell, 1995). Whether or not an adolescent was a current smoker was thus included in the models of overweight.

Structural variables. We included structural factors to control for differences in social structure by generation and ethnicity. Structural characteristics included: total family income (high, low, ref: medium), maternal education (college educated or greater, less than high school, ref: high school–some college), region (Northeast, South, Midwest, ref: West), proportion of households at the Census block level within an urbanized area, total reported incidents of serious crime per 100,000 at the county level [a spatial contextual variable (low: 0–4796; ref: 4800–7139, high: 7170–16,855)].

Key control variables. We also included key control variables shown to have substantial impact on overweight. These variables included: gender (male, ref: female), age (16, 17 yr, 18+ yr, ref: 12–15 yr), and current pregnancy status (yes, no).

Analysis plan

We examined differentials in structural characteristics and acculturation by generation for Mexican, Puerto Rican, and Cuban youth. Then we documented differentials in overweight status and its proximate determinants (e.g., physical activity, inactivity, diet, and smoking) across generation in our three ethnic groups.

Logistic regression models of overweight were used to investigate ethnicity and generation interactions in relation to acculturation, sociodemographic, contextual, physical activity, and diet correlates. We asked the question: Does the *ethnicity* effect on overweight status vary by generation? Although our focus was on the Hispanic groups, we included all youth in our models (Whites as the reference group) and specified first generation, ethnicity, and a series of generation and ethnicity interaction terms. We structured the models in this manner to facilitate within-ethnicity comparisons by generation.

Significance of interaction terms was tested using a χ^2 test of the difference in log likelihoods between a model

with and without the interaction terms. Model fit was significantly improved with interaction terms ($\chi^2 = 16.44$; $\text{Prob} > \chi^2 = 0.0057$). Overweight prevalence varied significantly by generation for Mexican and Cuban youth (see Appendix).

Statistical analyses were carried out using STATA (Stata Corp, 1999). All models were weighted for national representation and standard errors were corrected for survey design effects of multiple stages of cluster sampling.

Results

Descriptive results: determinants of overweight

We examined overweight and its proximate, acculturation, and structural determinants by generation and ethnicity. These descriptive analyses revealed the extent to which there was apparent acculturation in these correlates of overweight that explained the differential in overweight by generation of US residence.

Structural and acculturation-related characteristics varied by ethnicity and generation (Table 2). First generation adolescents had lower income and maternal education and lived in urban areas of higher crime, higher linguistic isolation, higher ethnic dispersion, and higher minority population. Statistically smaller proportions of foreign-born Mexicans and Puerto Ricans spoke English at home. Reverse patterns were seen for Puerto Ricans on income, education, and ethnic dispersion measures; however, it must be kept in mind that there was a substantially small percentage of first generation (island-born) Puerto Ricans in the study sample.

Overweight prevalence was higher, although not statistically significant, among US-born versus foreign-born immigrants, with the exception of Mexicans who had similar overweight prevalence across generation (Table 3). In comparison, activity and inactivity varied less by generation (Table 3). Relative to US-born Mexicans, foreign-born Mexicans watched significantly less TV and videos and had fewer weekly bouts of low intensity physical activity. US-born Cubans spent more hours engaged in computer/video game use than their foreign-born counterparts.

Dietary patterns varied substantially by ethnicity and generation (Table 4). First generation Mexicans reported lower intake of cheese and fast foods, and greater intake of rice, beans, fruits, and vegetables. Foreign-born adolescents had significantly greater intake of fruits (Puerto Ricans) and vegetables (Cubans) than their native-born counterparts. More US-born, relative to foreign-born, Mexican adolescents consumed low fat foods. In general, daily breakfast and lunch intake was higher among foreign-born adolescents.

Table 2

Structural characteristics and acculturation variables by ethnicity and generation

Characteristics	Mexican		Puerto Rican		Cuban	
	G.1	G.2+	G.1	G.2+	G.1	G.2+
<i>Structural characteristics</i>						
Low crime	2.4	8.3	14.3	17.9	0.0	3.2
High crime	35.6	24.6	60.7	58.1	100.0	84.2
Low income	74.4*	47.6	17.8*	49.6	77.9*	55.3
High income	4.4*	13.0	55.2*	16.1	0.91*	17.9
Low maternal educ.	87.4*	71.6	20.7*	62.8	70.0	64.7
High maternal educ.	1.3	2.9	33.2*	2.9	0.65	6.5
Urban ^a	91.7*	80.0	83.8	94.6	99.6	95.2
Northeast	5.3	2.6	47.4	65.6	0.0	7.6
Midwest	0.56	13.5	12.5	9.0	0.0	4.1
West	39.5	46.6	5.6	12.0	0.0	3.4
South	54.7*	37.3	34.6	13.4	100.0	84.9
<i>Acculturation-related characteristics</i>						
Linguistic isolation** ^a	87.5*	59.4	41.3	55.1	87.4	79.4
Proportion of Pop. foreign-born ^a	81.6*	48.2	39.0	49.0	87.2	83.3
Proportion of population is White ^a	0.0*	6.8	0.0	3.0	2.5	8.5
Proportion of population is Black ^a	14.5	13.8	7.9	9.6	6.0*	33.7
Proportion of population is Asian ^a	51.4*	39.0	8.2	5.3	29.4	48.1
Proportion of population is Hispanic ^a	95.1*	69.3	87.2	79.5	20.3	42.6
Dispersion in race composition ^a	67.0*	48.0	9.7	5.6	23.7	43.0
Speak English language at home	16.4*	66.2	15.2*	43.4	62.8	80.4

*Within ethnicity generation differences $p < 0.05$.

**The Bureau of the Census defines “linguistic isolation” as a household “in which no person age 14 yr or over speaks only English and no person age 14 yr or over who speaks a language other than English speaks English ‘Very well.’ All the members of a linguistically isolated household are tabulated as linguistically isolated, including members under age 14 yr who may speak only English.”

^aContextual variable generated from Bureau of the Census data.

Table 3

Descriptive statistics for overweight and activity-related factors by generation of residence in US and ethnicity

	BMI \geq 85th (% of sample)	BMI \geq 95th (% of sample)	TV & video (h/wk)	Games (h/wk)	M-V PA (bouts/wk)	Low PA (bouts/wk)
<i>Mexican</i>						
Gen 1	29.3	15.8	16.7*	2.0	3.4	4.7*
Gen 2+	29.6	13.2	22.0	3.0	3.7	5.1
<i>Puerto Rican</i>						
Gen 1	16.8	14.3	28.0	7.0	4.2	5.8
Gen 2+	31.0	14.4	24.9	3.1	3.9	5.1
<i>Cuban</i>						
Gen 1	29.9	11.7	21.3	1.7*	3.6	4.8
Gen 2+	35.5	21.9	21.2	3.4	3.2	5.2

*Within ethnicity, generation differences statistically significant $p < 0.05$.

Smoking patterns varied considerably for foreign-versus US-born immigrants (Table 4). Statistically significant differences were found for Mexicans (total and females). In general, dietary habits were healthier and smoking rates lower for foreign-born versus US-born immigrants.

Modeling overweight status: *Are generation contrasts in obesity and its determinants significant within ethnic group?*

We used a series of successive logistic regression models of overweight using generation–ethnicity interaction terms and a series of important mediators

Table 4

Percent of sample to consume foods related to acculturation and percent of sample to smoke cigarettes by ethnicity and generation

Characteristics	Mexican		Puerto Rican		Cuban	
	G.1	G.2+	G.1	G.2+	G.1	G.2+
<i>Foods</i>						
Milk	72.8	71.1	94.3*	70.3	45.9	61.7
Cheese	39.3*	50.3	33.7	45.8	33.3	44.6
Ready-to-eat cereal	58.8	55.3	53.5	50.5	33.8	52.3
Rice	40.7*	26.8	60.9	45.7	75.2	53.5
Beans	51.3*	29.6	34.9	27.3	59.1	44.6
Fruits $\geq 2x/day$	72.1*	57.0	88.3*	51.0	60.6	55.8
Vegetables $\geq 2x/day$	74.7*	62.7	64.4	57.1	52.5*	41.5
Low fat version foods	25.0*	37.3	37.8	32.8	26.7	33.9
Fast foods $\geq 2x/wk$	48.1*	65.4	60.8	51.9	51.4	48.4
Pizza	17.8	23.9	42.2	31.8	32.5	30.1
<i>Meal pattern</i>						
Breakfast 7 d/wk	48.4	32.7	78.3*	30.8	50.7	48.7
Lunch 7 d/wk	74.6*	55.5	80.0*	52.5	75.3	74.0
Dinner 7 d/wk	50.8*	71.7	96.5*	81.9	84.1	74.8
<i>Smoking</i>						
Do smoke—Total	8.5*	17.8	16.0	21.4	9.7	16.5
Do smoke—Males	10.7	16.7	21.4	20.7	16.9	18.0
Do smoke—Females	6.3*	19.1	7.0	22.3	1.8	15.2

*Within-ethnicity generation differences $p < 0.05$.

(coefficients and T values are shown in Appendix). We used successive models to explore the separate impact of the sets of explanatory variables (e.g., acculturation factors, structural factors, proximate determinants) on overweight.

We began with a basic model of the relationship between overweight and generation-ethnicity interactions (the fundamental exogenous variables). Model 1 (Appendix) includes key controls (e.g., age, sex, and pregnancy status). Model 2, includes structural characteristics (e.g., family income, maternal education, region, and neighborhood crime), which we know place immigrant youth at greater risk for poor nutritional and activity outcomes. Model 3 includes acculturation variables (e.g., proportion of foreign-born neighbors, proportion of Hispanic, White, and Black population in neighborhood, and English language spoken at home), which either tie youth to their ethnic background and values or integrate youth into American society. Model 4 (Appendix) includes proximate determinants (e.g., physical activity, inactivity, dietary, and smoking). Model 5 (Appendix 1) includes all variables, but removes the set of acculturation characteristics.

We ran simulations and calculated predicted probabilities of overweight status using coefficients from the logistic regression models. These simulations indicate the likelihood of overweight at an assigned level of

ethnicity and generation, allowing all covariates to vary by individual.

Predicted probabilities for the basic model (Model 1) are shown in Table 5. Results were similar to the unadjusted overweight prevalence data (Table 3). Overweight prevalence among US-born adolescents was substantially higher than that for foreign-born adolescents (except among Mexican-Americans).

Adding the key economic and other structural characteristics measures had minimal impact on likelihood of overweight (Model 2). Simulated probabilities of overweight remained comparable, with increased predicted overweight for first generation Puerto Ricans (Table 5). There was a slight narrowing of the effect for Puerto Ricans. Conversely, differences among Cubans increased.

We found a major shift in predicted overweight prevalence with the addition of the measures of acculturation (Model 3). When adjusted for acculturation, predicted overweight prevalence increased for all foreign-born immigrants. Generation differences in predicted overweight decreased among Cubans and Puerto Ricans, but increased among Mexicans relative to Model 2 (Table 5). None of the acculturation covariates were statistically significant; however, the total effect of the full set of acculturation measures was important.

Table 5
 Predicted probabilities for overweight by generation and ethnicity*

	Model 1 ^a	Model 2 ^b	Model 3 ^c	Model 4 ^d	Model 5 ^e
<i>White</i>					
Gen 1	4.8	5.3	7.3	7.9	5.3
Gen 2+	24.0	24.2	23.8	23.7	24.0
<i>Mexican</i>					
Gen 1	29.9	26.6	34.1	37.8	29.0
Gen 2+	29.1	27.7	27.8	27.3	27.6
<i>Puerto Rican</i>					
Gen 1	16.2	18.2	20.2	24.5	20.9
Gen 2+	31.0	28.2	27.8	27.3	27.6
<i>Cuban</i>					
Gen 1	31.0	26.0	34.3	39.1	30.3
Gen 2+	35.8	32.4	34.1	35.3	34.9

*All models correct for survey design and effects of multiple stages of cluster sampling.

^aModel 1: Controls for key covariates (sex, age, pregnancy) with ethnicity, Generation 1, and ethnicity by Generation 1 interaction term.

^bModel 2: Adds structural characteristics (income, education, urban residence, region, neighborhood crime).

^cModel 3: Adds acculturation characteristics (proportion of foreign-born neighbors, population of Hispanics and Whites in neighborhood, English spoken in home, years in US).

^dModel 4: Adds physical activity, inactivity (baseline and 1-yr change in: TV and video viewing, video/computer games, moderate-vigorous physical activity, low intensity physical activity), diet variables (consumption of: milk, cheese, ready-to-eat cereal, rice, beans, fruit, vegetables, lowfat version foods, fast foods, pizza, breakfast, lunch, dinner), and smoking.

^eModel 5: Removes acculturation characteristics but retains all physical activity, inactivity, diet, and smoking variables.

In Model 4, proximate overweight determinants were added (e.g., physical activity, inactivity, dietary intake, and smoking measures). In these models, the significant effects for Cubans (US- and foreign-born) and Mexicans (foreign-born) remained. Using the additional measures, some of which were themselves highly statistically significant [e.g., TV and video viewing (positive) and smoking, cereal, fast food and pizza intake, and breakfast and lunch patterns (negative)] did not dramatically alter the sign and significance of the ethnicity-generation coefficients. We found increased predicted overweight prevalence among all foreign-born Hispanics with the addition of proximate determinants into the model (Table 5). Thus, part of the explanation for increasing overweight with US residence was due to changes in the proximate overweight determinants (in particular TV and video viewing and dietary practices) with acculturation to US lifestyle.

To assess the impact of acculturation on overweight over and above the impact of proximate determinants, we removed the acculturation variables from Model 4 (results from Models 4 and 5 are shown in Appendix). Without controlling for acculturation, predicted overweight prevalence was similar to that in the model with only key covariates (Table 5). Thus, acculturation did have a major impact on overweight among all foreign-born Hispanics. In fact, across all of the models there is very little change in overweight prevalence among the

US-born adolescents, the impact is only seen for foreign-born.

Discussion

This study capitalized upon a large sample of Hispanic immigrant adolescents and detailed socio-demographic and contextual data. We investigated within-ethnicity generation differences in overweight among three important Hispanic subpopulations (Mexicans, Puerto Ricans, and Cubans). We specifically investigated the relationship between overweight, acculturation factors, structural factors, and proximate determinants in the process of acculturation to an American lifestyle. We found that acculturation and proximate factors consistently explained the lower likelihood of overweight among first generation Hispanic adolescents of all backgrounds.

Descriptive findings: determinants of overweight

Foreign-born adolescents were more likely to settle in urban areas of high crime, and with the exception of Puerto Ricans, were likely to have lower family incomes and maternal education than their US-born counterparts. Low SES has been shown to lead to higher overweight prevalence in Whites, but not Black or

Mexican American youth (Kimm et al., 1996; Patterson et al., 1997; USDHHS, 1998). Other research shows a decrease in overweight with increasing SES among White and Hispanic, but not black, female adolescents (Gordon-Larsen, Adair, & Popkin, 2003). These findings fill a gap in the literature. Little is known about the impact of SES on lifestyle behaviors among youth (Lowry, Kann, Collins, & Kolbe, 1996), and much less on how acculturation mediates the SES–ethnicity–overweight relationship (Winkleby, 1997).

Foreign-born Hispanic-American adolescents had a healthier dietary pattern, consuming more rice (Mexicans), fruits (Mexicans, Puerto Ricans), and vegetables (Mexicans, Cubans) than their US-born counterparts. This is similar to findings from other studies contrasting acculturation status and dietary patterns among Hispanics (Schaffer et al., 1998; Guendelman & Abrams, 1995; Winkleby et al., 1994; Dixon, Sundquist, & Winkleby, 2000; Mendoza & Dixon, 1999; Siega-Riz & Popkin, 2001). Healthy low fat foods such as beans, tortillas and rice are a crucial part of traditional (i.e., foreign-born) Hispanic cuisine.

Inactivity (e.g., TV/video and computer/video game use) and low intensity physical activity increased with generation of US residence among Mexicans and Cubans. However, differences in physical activity and inactivity patterns were not as striking, and perhaps less malleable, as those for dietary pattern. Research on this topic has shown substantially higher levels of physical activity among foreign- versus US-born Pima Indians (Esparza et al., 2000) and Mexican adults (Stern et al., 1992).

The final proximate determinant, smoking, increased dramatically for Mexican adolescents with longer US residence, and although not statistically significant, rates also increased among the other sex and ethnicity groups. Our finding is similar to what has been shown in the literature on acculturation and smoking among Hispanic adolescents (Parker, Sussman, Crippens, Elder, & Scholl, 1998; Epstein, Botvin, & Diaz, 1998; Dusenberry, Epstein, Botvin, & Diaz, 1994).

There is likely to be substantial interplay between acculturation, structural, and proximate determinants in development of overweight. For example, structural factors, such as income and education may determine the level of access to an American lifestyle, with decreased physical activity opportunities and increased availability of high-fat energy-dense foods, and thus higher obesity among low SES populations. One might hypothesize that immigrants who are not able to move out from these areas and into higher SES neighborhoods are more likely to live in environments that may discourage the adoption of healthier lifestyle patterns. However, retention of traditional lifestyle patterns may buffer this relationship. For example, low SES immigrants who speak their native language and live in

neighborhoods with high immigrant density (e.g., our findings for Mexican immigrants) and availability of traditional goods and services might be buffered against the adoption of American lifestyle patterns related to overweight.

Does the ethnicity effect on overweight status vary by generation?

Our multivariate results showed significant effects of ethnicity and generation on overweight after controlling for sociodemographic and acculturation factors and a range of dietary- and activity-related covariates. The predicted probabilities indicate that controlling for acculturation and proximate factors increased overweight among foreign-born adolescents, but had minimal impact for US-born adolescents. Thus, without the beneficial pattern of acculturation factors, diet, and physical activity, first generation Hispanic adolescents would have higher overweight prevalence. When we removed acculturation factors from the model (Model 5) we found that overweight decreased for the first generation adolescents; thus indicating that acculturation factors had a greater impact than proximate factors and were protective against overweight.

Although we found a protective effect of acculturation on overweight among all foreign-born Hispanic adolescents, we found that overweight prevalence was substantially higher among foreign-born versus US-born Mexicans when acculturation and proximate factors were controlled. Mexico has higher prevalence of obesity and diet-related non-communicable diseases than found in Latin America, and the Caribbean (e.g., Popkin, 1998; Gonzalez-Cossio et al., 2001; Rivera et al., 2002). Dixon et al. (2000) found that nutrition profiles were similar for US-born Mexican-American women regardless of whether they spoke Spanish (less acculturated) or spoke English (more acculturated). The authors suggest that their findings, which differ from others, may be due to the difficulties in differentiating populations based on only one characteristic of acculturation without adjusting for others. Most research on this topic has been on adults, with very little published data on adolescents.

Acculturation in relation to sociodemographic, contextual, and behavioral factors

Immigrant adolescents are likely to be influenced by the “obesigenic” environment of the US, including sedentary lifestyles, large portion sizes, heavy advertising of high-fat, energy-dense foods, and mass media. Acculturation during adolescence may be intensive, given social development and the social development and the heightened influence of peers who may represent what it is to be an American adolescent. In addition, socioeconomic differences in the selectivity of who

Table 6

Correlates of overweight for Hispanic immigrants to the US^a

Variables	Model 1 results ^b		Model 4 results ^c		Model 5 results ^d	
	Coef	(<i>t</i> values)	Coef	(<i>t</i> values)	Coef	(<i>t</i> values)
Gen 1	-1.84	(-3.38)**	-1.32	(-2.31)*	-1.77	(-3.46)**
Mex. ethnicity	0.26	(2.51)**	0.20	(1.54)	0.20	(1.68)
Mex. & Gen 1	1.88	(2.96)**	1.83	(2.94)**	1.85	(3.00)**
PR ethnicity	0.35	(1.76)	0.20	(0.88)	0.20	(0.89)
PR & Gen 1	1.00	(1.02)	1.17	(1.20)	1.39	(1.44)
Cuban ethnicity	0.57	(2.68)**	0.59	2.43*	0.55	(2.64)**
Cuban & Gen 1	1.62	(2.98)**	1.50	(2.88)**	1.55	(2.98)**
Sex	-0.22	(-3.41)**	-0.31	(-4.34)**	-0.31	(-4.33)**
Age 16,17 yr	-0.21	(-2.43)*	-0.23	(-3.15)**	-0.23	(-3.15)**
Age 18+ yr	-0.34	(-3.16)**	-0.38	(-3.50)**	-0.38	(-3.48)**
Pregnancy	0.62	(1.91)	0.61	(1.90)*	0.61	(1.93)
Low income			0.10	(1.09)	0.10	(1.09)
High income			-0.10	(-1.10)	-0.10	(-1.12)
Low maternal education			0.12	(1.40)	0.12	(1.43)
High maternal education			-0.39	(-2.61)**	-0.39	(-2.58)**
Urban residence			-0.02	(-0.23)	-0.03	(0.39)
Midwest region			0.25	(1.83)	0.24	(1.81)
South region			0.18	(1.66)	0.21	(1.88)
Northeast region			0.26	(2.18)	0.25	(2.17)*
Low neighborhood crime			0.09	(1.20)	0.05	(0.58)
High neighborhood crime			-0.02	(-0.16)	-0.02	(-0.12)
Smoker			-0.16	(-2.07)*	-0.16	(-2.01)
TV/video (> 26 h/wk)			0.41	(4.66)**	0.41	(4.68)**
1-yr TV/video (≥ 7 h/wk)			0.15	(2.00)*	0.15	(2.01*)
IA games (> 1 h/wk)			0.04	(0.53)	0.04	(0.51)
1-yr games (≥ 1 h/wk)			0.05	(0.61)	0.05	(0.65)
M-V PA (> 4 bouts/wk)			-0.11	(-1.32)	-0.11	(-1.33)
1-yr. M-V PA (≥ 1 b/wk)			0.07	(0.93)	0.07	(0.96)
Low PA (> 5 bouts/wk)			0.06	(0.71)	0.06	(0.72)
1-yr low PA (≥ 1 b/wk)			0.12	(1.61)	0.12	(1.60)
Milk intake			0.11	(1.36)	0.11	(1.34)
Cheese intake			0.08	(1.14)	0.08	(1.18)
Ready-to-eat cereal intake			-0.28	(-4.48)**	-0.27	(-4.50)**
Rice intake			-0.09	(-0.88)	-0.09	(-0.85)
Bean intake			-0.07	(-0.92)	-0.07	(-0.88)
Fruit intake (≥ 2x/wk)			0.13	(1.39)	0.13	(1.40)
Veget. intake (≥ 2x/wk)			0.07	(0.86)	0.06	(0.87)
Low fat option intake			0.01	(0.06)	0.00	(0.00)
Fast Food (≥ 2x/wk)			-0.27	(-3.94)**	-0.27	(-3.91)**
Pizza intake			-0.31	(-3.68)**	-0.31	(-3.71)**
Breakfast intake (7 d/wk)			-0.43	(-4.76)**	-0.43	(-4.78)**
Lunch intake (7 d/wk)			-0.19	(-2.37)**	-0.18	(-2.32)**
Dinner intake (7 d/wk)			0.05	(0.71)	0.05	(0.70)
% Foreign-born neighbors			-0.06	(-0.37)		
% White population			-0.10	(-0.92)		
% Hispanic population			0.05	(0.43)		
0-5 yr in US			-0.73	(-1.74)		
6-10 yr in US			-0.35	(-0.68)		
Speak English at home			0.04	(0.27)		

* $p < 0.05$ ** $p < 0.01$ ^aModel corrects for survey design effects of multiple stages of cluster sampling.^bModel 1: Controls for key covariates (sex, age, pregnancy) with Hispanic, Generation 1, and Hispanic by Generation 1 interaction term^cModel 4: Adds structural characteristics (income, education, urban residence, region, neighborhood crime), acculturation characteristics (proportion of foreign-born neighbors, population of Hispanics, and Whites in neighborhood, English spoken in home, years in US), and activity and diet variables [physical activity, inactivity (baseline and 1-yr change in: TV and video viewing, video/computer games, moderate-vigorous physical activity, low intensity physical activity), and diet variables (consumption of: milk, cheese, ready-to-eat cereal, rice, beans, fruit, vegetables, lowfat version foods, fast foods, pizza, breakfast, lunch, dinner)] and smoking.^dModel 5. Identical to Model 4, but removes the acculturation characteristics (proportion of foreign-born neighbors, population of Hispanics and Whites in neighborhood, English spoken in home, years in US).

chooses to immigrate to the US may also influence the effects of acculturation on overweight and activity patterns.

Our results suggest a rapid acculturation of a series of obesity-related behaviors with first to subsequent generation of US residence. In particular, we found markedly higher rates of overweight in second generation immigrants, with the exception of Mexican-Americans. We found important sociodemographic and contextual structural differences between US- and foreign-born adolescents that are likely to underlie the large increase in overweight prevalence between the first and subsequent generation of US residence. The incorporation of a full set of measures of acculturation allowed us to reduce the generation effect in all groups, except Mexican-Americans. Indeed, acculturation had a major impact on overweight among all foreign-born Hispanics.

Conclusion

We have demonstrated the importance of structural, acculturation, and proximate determinants in the increase in overweight with generation of US residence. These results suggest that there are several avenues for prevention of overweight through modifications in dietary and physical activity patterns. In addition, this paper has shown that there are specific patterns of acculturation and structural factors that may encourage the development of overweight and are thus important in delineating groups at risk for overweight. Given the substantial increase in overweight and the considerable morbidity and mortality associated with overweight, it is imperative to determine the factors most associated with the marked increase in overweight over generation of residence among US immigrants.

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Appendix

See Table 6.

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