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Birthplace Is Associated with More Adverse Dietary Profiles for US-Born Than for Foreign-Born Latino Adults[1,2]

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Abstract

Our objective was to examine the association between ethnicity and birthplace and the percent of energy from selected food groups among Hispanics, the largest growing segment of the US population. We used data from NHANES 1999–2004, collected from Mexican ($n = 3375$) and other Hispanic ($n = 622$) adults (18 y and older), classified as foreign born (FB) or US born (USB). Using University of North Carolina's food-grouping system, we created 24 nutrient- and behavioral-based food groups. We examined percent consuming and per-consumer estimates using logistic and linear regression models, respectively. Predicted mean energy was estimated using marginal effect models. All models were controlled for gender, age, income, and education and were weighted to account for sampling design. FB Hispanics obtained more energy from food groups such as legumes, fruits, and low-fat/high-fiber breads, with differences accounted for by a greater percent consuming these foods rather than higher energy intake among consumers. Conversely, FB Hispanics consumed a lower percentage of energy from foods such as non-Mexican fast food and snacks and desserts. Speaking Spanish also was associated with greater consumption of legumes, rice, fruits, soups, and potatoes. Variation in diet may in part account for the difference in nutrition-related adverse health outcomes observed among USB Hispanics, particularly Mexicans. Targeted dietary interventions are needed to reduce health disparities associated with dietary intake. J. Nutr. 138: 2428–2435, 2008.

Introduction

The United States Latino population, of whom <60% are of Mexican origin, is the largest growing segment of the population with a growth rate almost 4 times that of the total population (1). This increase is partly a function of high fertility levels among this subpopulation but is also due to migration (2); an estimated 37% of the total foreign-born (FB)[5] population living in the US was born in Mexico or Central America (3). This has led to extensive research on the role of acculturation and immigrant status on health.

Researchers have often concluded that living in the US adversely affects the health of Hispanics (4–8). Under the concept of the Hispanic paradox, which refers to the tendency for Hispanics to enjoy relatively good health despite socioeconomic disadvantages (9), it is frequently noted that Hispanics tend to have healthier diets prior to arriving in the US. Furthermore, it has been observed that the longer Hispanics are in the US, the worse their diets become (8). Such shifts in health-related behaviors are associated with the higher rates of obesity and diabetes among US Hispanics (10) and among those who have lived here for ≥15 y (11). The hypothesis is that through exposure to the US environment and lifestyle, there is adoption of the dominant culture's behaviors and norms, including greater consumption of away-from-home foods (particularly fast food) for both lunch and dinner.

In the absence of more rigorous studies of the acculturation process (e.g. national longitudinal studies), researchers have attempted to develop a consensus on the most meaningful operationalization of this process. Language spoken at home and length of time residing in the US are 2 such operationalizations (5,6,8,12–14). More recently, researchers have begun examining the influence of country of origin, which may be particularly important given the diversity of countries represented by Hispanics in the US. Although Mexicans are the largest Hispanic group in the US, estimated at 28.4 million in 2006, there is considerable heterogeneity among Hispanic subgroups (15), including differences in histories of immigration to the US, age, socioeconomic status, and location of residence in the US. For example, Mexican-Americans tend to be younger, less educated, and have lower incomes than Cuban-Americans (16).

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[2] A full list of foods and food groups is available with the online posting of this paper at jn.nutrition.org.
[5] Abbreviations used: FB, foreign born; MEM, marginal effect model; OLS, ordinary least-squares; RTE, ready-to-eat; USB, United States born.
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However, surprisingly few studies have explored dietary differences among Hispanic subpopulations, especially between the most dominant groups, Mexican/Mexican-Americans and other Hispanic subgroups. Additionally, little is known about whether potential differences are modified by birthplace or degree of acculturation. Separating Mexican from other Hispanic subgroups is particularly important because adult residents of Mexico now have obesity levels similar to US residents (71% of Mexican women and 66% of Mexican men were overweight or obese in 2006), whereas rates of overweight and obesity are lower in Cuba, Dominican Republic, and all other Central and South American populations (17–19).

This study seeks to understand this gap by using nationally representative data to: *1*) examine differences in the percent of energy from specific food and beverage groups by ethnicity; *2*) determine whether birthplace modifies the relationship between ethnicity and dietary intake; and *3*) examine the relationship between degree of acculturation (defined as language spoken in the home) and percent of energy from selected food groups.

Methods

Participants and data source. This study uses secondary data collected from adults ≥18 y from 4 consecutive NHANES (1999–2004). These samples contained stratified area probability samples of noninstitutionalized US households. Each survey year was designed to be nationally representative. Detailed information about each survey and its sampling design have been published previously (20–23). From the full NHANES sample, we selected a subgroup of individuals identifying themselves as Mexican/Mexican-American (n = 3375) or other Hispanic (n = 622). Written informed consent was obtained from all participants.

Dietary intake and food groups. Dietary intake information was collected by 24-h dietary recall, which was administered in person by trained interviewers. Respondents reported all foods and beverages consumed in the previous 24-h time period, including names of foods, times consumed, type of meal or snack, and location of food consumption. Instructions and interviews were completed in either English or Spanish. Collection of dietary information was aided by a 4-step automated coding and collection system (Computer Assisted Dietary Interview System, 1999–2001) or the USDA's automated multiple pass method (2002–2004), a 5-step computerized dietary recall instrument used for data collection (21). Although the 4- and 5-step automated systems are very similar, they do introduce a source of methodological variation. However, it is unlikely that differences in the dietary recall methodology would result in differential dietary recalls by ethnicity [i.e. that foreign born (FB) other Hispanics would respond differently than FB Mexicans] and are therefore not expected to differentially affect our results. Because only a single 24-h recall was available for years 1999–2001, we chose to exclude the additional 24-h recalls available in 2002–2004 for the purpose of maintaining consistency within our dataset.

We used a modified University of North Carolina food-grouping system (24) to group all reported foods and beverages into 57 food groups based on nutrient (i.e. fat and fiber content) and behavioral consumption (i.e. snacking) characteristics. Beverage groups are in accordance with the recently suggested Beverage Guidance System (25). Based on this and previous work (26,27), it was determined that many of these food groupings did not facilitate differentiation of dietary intake between ethnic subgroups and thus it was most convenient to create groups comprised of combinations of foods. For example, it was more appropriate to use a combined vegetable group instead of individual green and orange vegetables, low-fiber vegetables, medium-fiber vegetables, and high-fiber vegetables groups. Similarly, given space limitations, it was not possible to present differences for all 57 food groups. Results are presented for foods/food groups that represented at least 2% of total energy intake for at least 1 subgroup [FB or US-born (USB) Mexican or other Hispanic] or for which there was at least a 1% difference between 2 groups (i.e. Mexican FB consumed 2.4% more energy from legumes and soybeans than USB Mexicans).

Our final analyses were conducted on 57 variables, 24 of which are presented here, representing the proportion of energy from each food/beverage group. Examples of the food groups used include: legumes and soybeans (e.g. lentils, pinto, black, soy, and garbanzo beans), low-fat/high-fiber breads (e.g. tortillas, whole-wheat breads, and bread products), fruits (citrus and noncitrus, fresh and dried), vegetables (e.g. lima beans, corn, squash, and tomatoes) snacks and desserts (e.g. cookies, pastries, ice cream sandwiches, crackers, chips, and popcorn), and non-Mexican fast food (e.g. pizza, French fries, hamburgers, and Chinese from fast food restaurants). Additionally, we examined several beverage variables, including low- (1.5% or skim) and high-fat milk (2% or higher and buttermilk), soda and fruit drinks (fruit drinks that are not 100% juice), and fruit and vegetable juice (only 100% juice). Potatoes were grouped separately from all other vegetables and French fries were also grouped independently but later combined with other fast food items (due to negligible differences in consumption) into the non-Mexican fast food group. More detailed descriptions and sample foods for each of the 24 food groups presented in the article can be found in the Online Supplemental Material.

Acculturation variables and additional covariates. All demographic and socioeconomic variables were collected using a combination of in-person and in-home interviews. For the 2 ethnic subgroups, Mexican and other Hispanic, we examined degree of acculturation, which was defined using 2 unique variables: birthplace (USB vs. FB) and language spoken in the home (primarily Spanish speaker, yes/no). Location of mother and father's place of birth (US, Puerto Rico, Cuba, Mexico, Dominican Republic, other country) was examined for descriptive statistics. Covariates used in analyses include gender, age (continuous), total family income (<$20,000 vs. ≥$20,000), and education (highest grade completed).

Statistical analyses. All analyses were completed in Stata 10.0 (Stata Corp) using weighted survey commands to account for study design and sampling methods. Sampling methods have been described in detail elsewhere (23,28,29). Briefly, data are collected using a complex, multistage probability sampling designed to select participants that are representative of the civilian, noninstitutionalized US population. Individuals are selected from households, which are selected from segments, which are selected from counties across the US. Oversampling of certain subgroups is done to increase the reliability and precision of estimates of health status indicators for those groups. Relevant to this article, Mexican-Americans were oversampled in 1999–2004 survey years.

Demographic characteristics were summarized for all ethnic groups and are presented as means and or percentages ± SEM. Comparisons between ethnicity and/or birthplace were conducted using Student's t tests for means or chi-square tests for proportions. All P-values were 2-tailed and significance was defined as $P < 0.05$.

To examine the relationship between acculturation and diet, we generated a weighted mean [using 2-stage marginal effect models (MEM)] of percent energy from each food group on ethnicity and birthplace or being a Spanish speaker. MEM are appropriate where the ordinary least-squares (OLS) assumption of normality is violated. For example, nearly 43% of our sample did not consume high-fat milk, so an OLS estimate of ethnicity/birthplace for percent of energy from high-fat milk would be misestimated.

Using a 2-stage modeling process, MEM first estimate the probability of consuming a given food and then, among consumers, estimate the effect of the exposure on the amount consumed. These values are then multiplied and the resulting estimate is a weighted mean of the effect of the exposure on consumption amount in the full sample. There was a significant interaction between the exposures ethnicity and birthplace (Wald chunk test; $P < 0.05$), so indicator variables [Mexican FB (referent); Mexican USB; other Hispanic FB; other Hispanic USB] were used to model the relationship between this indicator of acculturation and percent of energy from selected foods.

To examine the Spanish language exposure variable, a dichotomous variable was used. A control variable "no language information available" was also included to account for those who did not provide

TABLE 1 Sample characteristics of Hispanic adults ≥ 18 y (NHANES, 1999–2004, n = 3997) by ethnicity and birthplace[1]

	Mexican		Other Hispanic	
	FB	USB	FB	USB
n	1495	1880	403	219
Male, %	54.3 ± 0.9	47.3 ± 1.4*	48.7 ± 2.3*	37.3 ± 4.0*,#
Age, *y*	35.5 ± 0.6	37.1 ± 0.8	42.4 ± 0.9*	35.0 ± 2.4#
Education, %				
More than high school	68.9 ± 1.6	31.8 ± 2.3*	42.8 ± 0.3*	23.3 ± 3.4*,#
High school/GED	16.7 ± 1.4	27.9 ± 1.6*	16.7 ± 1.9	25.1 ± 3.4*,#
Less than high school	14.2 ± 1.3	40.3 ± 3.0*	40.5 ± 2.5*	51.6 ± 4.7*
Parent's place of birth, %				
Father				
United States	2.8 ± 0.6	51.6 ± 4.6*	1.3 ± 0.9	33.9 ± 8.2*,#
Puerto Rico	0.1 ± 0.1	–	18.4 ± 8.4*	20.0 ± 7.3*
Cuba	–	0.1 ± 0.1	22.9 ± 14.0	5.0 ± 3.7
Mexico	96.8 ± 0.6	46.6 ± 5.1*	–	–
Dominican Republic	–	–	13.5 ± 7.3	8.5 ± 3.0#
Other country	0.2 ± 0.2	0.7 ± 0.4	43.9 ± 7.4*	24.8 ± 13.6
Missing	0.2 ± 0.1	1.1 ± 0.6	–	7.9 ± 6.7
Mother				
United States	2.7 ± 1.2	63.0 ± 4.9	1.2 ± 1.1	34.3 ± 9.6*,#
Puerto Rico	0.2 ± 0.2	–	18.8 ± 8.5*	30.7 ± 8.3*
Cuba	–	0.05 ± 0.1	23.1 ± 14.2	8.0 ± 4.9
Mexico	96.7 ± 1.2	36.4 ± 4.9*	0.5 ± 0.4*	–
Dominican Republic	–	–	12.8 ± 7.2	7.3 ± 3.6
Other country	0.3 ± 0.3	0.4 ± 0.0	43.5 ± 7.2*	19.8 ± 9.8
Missing	0.1 ± 0.1	0.1 ± 0.1	–	–
Primary language is Spanish (yes/no), %	24.2 ± 3.4	4.3 ± 1.7*	38.5 ± 10.0	1.9 ± 1.0*,#

[1] Values are means (age) or percent (gender, parent's place of birth, primary language) ± SEM. All results were weighted to account for survey design. *Different than FB Mexican, $P < 0.05$ (t test). #Different than FB other Hispanic, $P < 0.05$ (t test).

information on their primary language used at home. We tested and did not find a significant 3-way interaction between ethnicity, birthplace, and being a Spanish speaker or between birthplace, income, and being a Spanish speaker. Bootstrap estimation, using random sampling from the dataset with replacement, was used to generate standard errors around marginal effect estimates. All models controlled for gender, age, family income, and education.

Logistic regression models were used to estimate the percent of each ethnic group [Mexican USB, other Hispanic USB, and other Hispanic FB vs. Mexican FB (referent)] that consumed food and beverage groups. Finally, we estimated the amount eaten among consumers (persons who actually reported consuming a food or food group) by ethnicity and birthplace (USB vs. FB) using OLS regression. To ease interpretation, we transformed the estimated percent of energy from each food group into absolute predicted mean kilocalories. For example, if 9% of an ethnicity's 2200 daily kcal[6] (9211 kJ) were obtained from soda and fruit drink, we present 198 predicted mean kcal/d (829 kJ/d) from soda. Likewise, if consumers of the legumes and soybeans food group obtained 10% of their 2200 total energy from this food group, we reported 220 predicted kcal/(consumer·d) [921 kJ/(consumer·d)]. Similar to other studies, all models controlled for gender, age, family income, and education (5,11). Differences in percent of energy from food groups were tested using t tests and are considered significant at the $P < 0.05$ level.

Results

FB other Hispanics were slightly older, whereas FB Mexicans were slightly younger than their USB counterparts ($P < 0.05$) (**Table 1**). Regardless of ethnicity, a larger proportion of FB Mexicans (68.9 ± 1.6%) and FB other Hispanics (42.8 ± 0.3%) had less than a high school education compared with USB Mexicans (31.8 ± 2.3%). Among FB other Hispanics, Cuba and "Other Country" represented the top 2 paternal and maternal place of birth categories. Nearly 97% of FB Mexicans had parents who also were born in Mexico. Spanish as the primary language spoken in the home was most prevalent among FB other Hispanics (38.5 ± 10.0%) and least prevalent among USB other Hispanics (1.9 ± 1.0%; $P < 0.05$) (Table 1).

Differences in consumption between USB and FB Mexicans and other Hispanics. Being born in the United States, compared with elsewhere, was associated with greater total energy intake and a lower percent of energy from food groups such as fruits and vegetables (**Table 2**). For example, USB consumed a lower percent of kcal from legumes and soybeans, fruit, high-fat milk, and vegetables than FB Mexicans ($P < 0.05$).

These translated into considerable differences in absolute predicted mean kcal/d. For example, FB Mexicans consumed nearly twice as much energy from legumes and soybeans as USB Mexicans ($P < 0.001$), 32 more kcal (134 kJ) from fruits ($P < 0.01$), and 20 more kcal (84 kJ) from vegetables ($P < 0.001$). FB Mexicans also consumed more energy from low-fat/high-fiber breads than USB Mexicans ($P < 0.001$) (**Table 3**).

Generally, differences in predicted mean kcal/d are the result of differences in the percent consuming rather than per-consumer kcal estimates [predicted kcal/(consumer·d)] (Table 3). For example, 19% more FB (40.0 ± 0.3%) than USB (20.9 ± 0.3%) Mexicans consumed legumes and soybeans (predicted

[6] 1 kcal = 4.187 kJ.

TABLE 2 Adjusted percent energy consumed from each food group in Hispanic adults ≥18 y (NHANES, 1999–2004, n = 3997) by ethnicity and birthplace[1]

	Mexican		Other Hispanic	
	FB	USB	FB	USB
n	1495	1880	403	219
Total energy intake, *kcal/d*	2248 ± 32	2311 ± 38*	2039 ± 62*	2250 ± 122#
UNC food group				
Beverages		*Adjusted % energy intake*		
Low-fat milk	0.58 ± 0.32	0.41 ± 0.10	0.47 ± 0.17	1.09 ± 0.51
High-fat milk	4.17 ± 0.43	2.73 ± 0.27*	3.15 ± 0.38*	2.59 ± 0.41*
Fruit and vegetable juice	3.21 ± 0.44	2.26 ± 0.24*	3.03 ± 0.34	2.23 ± 0.38*
Alcohol	1.76 ± 0.76	2.32 ± 0.36	1.64 ± 0.64	3.00 ± 0.76
Total beverages with nutrients[2]	10.07 ± 1.00	7.93 ± 0.40*	8.43 ± 0.54*	9.12 ± 1.09
Soda and fruit drinks	14.25 ± 0.84	14.79 ± 0.46	12.69 ± 0.66*	15.16 ± 1.13
Other sweetened beverages	1.57 ± 0.22	1.17 ± 0.16*	1.38 ± 0.22	1.12 ± 0.31
Total energy-containing sweetened beverages[3]	16.00 ± 0.87	16.29 ± 0.50	14.32 ± 0.77*	16.59 ± 0.93
Foods				
Dairy[4]	3.02 ± 0.43	3.24 ± 0.20	2.98 ± 0.31	3.84 ± 0.56
Meats	11.24 ± 0.69	11.98 ± 0.60	12.09 ± 1.12	11.31 ± 1.03
Legumes and soy	3.63 ± 0.52	1.09 ± 0.31*	1.94 ± 0.39*	0.98 ± 0.51*
Grains				
Breads	13.20 ± 0.90	8.02 ± 0.63*	5.12 ± 0.77*	5.80 ± 0.89*
Low-fat/low-fiber breads	1.43 ± 0.34	1.44 ± 0.27	1.83 ± 0.48	1.52 ± 0.30
Low-fat/high-fiber breads[5]	5.56 ± 0.55	1.33 ± 0.27*	1.56 ± 0.33*	1.52 ± 0.61*
High-fat/low-fiber breads	1.93 ± 0.23	1.34 ± 0.20*	1.04 ± 0.34*	0.32 ± 0.28*
High-fat/high-fiber breads[5]	4.29 ± 0.72	3.90 ± 0.46	0.69 ± 0.44*	2.45 ± 0.86*,#
Pasta, rice, and RTE cereal	2.77 ± 0.63	2.35 ± 1.21	9.70 ± 1.22*	4.37 ± 0.77*,#
Mixed dishes	3.65 ± 0.59	4.97 ± 0.39*	6.66 ± 0.81*	6.23 ± 1.02*
Fruits and vegetables				
Fruits	1.85 ± 0.30	0.28 ± 0.20*	1.42 ± 0.34	−0.35 ± 0 0.24*#
Potatoes[6]	0.23 ± 0.48	1.37 ± 0.16*	2.26 ± 0.44*	0.94 ± 0.42*
Vegetables	2.11 ± 0.42	1.24 ± 0.15*	1.59 ± 0.36	1.78 ± 0.37
Soups	3.00 ± 0.50	0.81 ± 0.29*	1.45 ± 0.77*	0.18 ± 0.25*
Fats and oils				
Butter, oils, and dressings	1.22 ± 0.26	2.70 ± 0.26*	2.12 ± 0.30*	2.49 ± 0.54*
Snacks, desserts, and candy				
Snacks and desserts	5.48 ± 0.81	7.21 ± 0.45*	6.77 ± 0.76	7.84 ± 1.35
Candy, jellies, and sugars	1.38 ± 0.43	2.55 ± 0.24*	1.75 ± 0.31	3.09 ± 0.75*
Fast food				
Mexican fast food	4.52 ± 0.63	4.90 ± 0.71	3.12 ± 0.62	3.55 ± 1.21
Non-Mexican fast food	9.58 ± 1.09	12.48 ± 0.70*	11.39 ± 1.25	12.61 ± 1.08*

[1] Values are predicted mean ± SEM differences from FB Mexicans, adjusted for age and gender. Values are predicted using weighted survey commands to adjust for sampling design and provide appropriate variance estimates. *Different than FB Mexican, $P < 0.05$ (t test). #Different than FB other Hispanic, $P < 0.05$ (t test).
[2] Sum of low- and high-fat milk, fruit and vegetable juice, and alcohol.
[3] Sum of soda and fruit drinks, sweetened coffee, sweetened tea, and other sweetened beverages.
[4] Including cream, cheese, and other dairy products, but not milk as a beverage.
[5] Includes tortillas; classification depended on fat and fiber content.
[6] Total low- and high-fat potatoes, but not French fries.

percent consuming; $P < 0.001$), but consumers obtained just 37 more kcal/(consumer·d) [155 kJ kcal/(consumer·d); $P < 0.001$]. Similar trends in the percent consuming and predicted kcal/(consumer·d) were observed for fruits, vegetables, and low-fat/high-fiber breads (Table 3). In fact, nearly 23% more FB Hispanics reported consuming fruits compared with their USB counterparts. Only in the case of vegetables was the difference in the percent consuming relatively small between FB (77.5 ± 0.3%) and USB Mexicans (72.1 ± 0.2%; $P < 0.001$).

In both age- and gender-adjusted (Table 2) and fully adjusted predicted means (Table 3), USB other Hispanics consumed significantly less energy from fruits than FB other Hispanics, and nonsignificantly less energy from legumes and soybeans, and low-fat/high-fiber bread (among others, Table 3). For each of these food groups, significantly fewer USB than FB other Hispanics consumed from these food groups, although the percentage was most striking for fruit; 48.1 ± 0.6% FB other Hispanics compared with just 25.6 ± 0.8% USB other Hispanics (Table 3). Unlike FB Mexicans, FB other Hispanics ultimately consumed less energy from legumes and soybeans than USB other Hispanics.

Greater consumption of unhealthy foods by USB than FB. For many foods groups, USB Mexicans and other Hispanics tended to consume greater predicted mean kcal compared with their FB counterparts, with the most significant differences observed for Mexicans. Consider, for example, non-Mexican

TABLE 3 Predicted mean kcal/d, percent consuming, and kcal per consumer from selected food groups in Hispanic adults ≥18 y (NHANES, 1999–2004, $n = 3997$) by ethnicity and birthplace[1–3]

	Mexican						Other Hispanic					
	FB, $n = 1495$			USB, $n = 1880$			FB, $n = 403$			USB, $n = 219$		
Total energy intake, *kcal/d*	2248 ± 32			2311 ± 38			2039 ± 62			2250 ± 122		
	Predicted			Predicted			Predicted			Predicted		
UNC food group	Mean kcal/d	% Consuming	kcal/(consumer·d)	Mean kcal/d	% Consuming	kcal/(consumer·d)	Mean kcal/d	% Consuming	kcal/(consumer·d)	Mean kcal/d	% Consuming	kcal/(consumer·d)
Beverages												
Low-fat milk	16 ± 9	7.4 ± 0.2	162 ± 4	7 ± 2	7.2 ± 0.2	141 ± 7**	8 ± 4	7.9 ± 0.5	122 ± 8	23 ± 9	9.3 ± 0.4#	306 ± 14**
High-fat milk	97 ± 13	46.3 ± 0.2	209 ± 1	74 ± 7	35.2 ± 0.2#	194 ± 2**	75 ± 10	38.7 ± 0.2	184 ± 1	72 ± 18	32.8 ± 0.2#	194 ± 2**
Fruit and vegetable juice	58 ± 4	30.0 ± 0.1	205 ± 1	42 ± 7*	22.9 ± 0.1#	180 ± 2**	49 ± 6	27.9 ± 0.1	169 ± 2	43 ± 9*	22.2 ± 0.4#	187 ± 7**
Soda and fruit drinks	202 ± 70	70.5 ± 0.5	306 ± 2	224 ± 12*	66.2 ± 0.7#	340 ± 2**	161 ± 14	56.0 ± 0.1	257 ± 2	225 ± 23*	66.8 ± 1.9#	356 ± 5**
Foods												
Legumes and soy	99 ± 20	40.0 ± 0.3	250 ± 2	55 ± 7*	20.9 ± 0.3#	213 ± 2**	61 ± 10	25.2 ± 0.5	234 ± 6	59 ± 18*	14.9 ± 0.6#	266 ± 1**
Low-fat/high-fiber breads[4]	146 ± 13	56.1 ± 0.3	259 ± 1	58 ± 7*	28.8 ± 0.6#	180 ± 1**	57 ± 8	30.0 ± 0.4	175 ± 1	54 ± 14*	25.6 ± 1.3#	182 ± 2**
High-fat/high-fiber breads[4]	124 ± 11	37.9 ± 0.1	328 ± 1	125 ± 9*	46.3 ± 0.3#	257 ± 2**	33 ± 12	21.5 ± 0.1	210 ± 2	90 ± 18*	37.8 ± 0.4#	223 ± 7**
Pasta and RTE cereal	81 ± 36	28.1 ± 0.4	274 ± 2	83 ± 12*	28.5 ± 0.2	261 ± 5**	167 ± 10	54.7 ± 1.0	383 ± 6	126 ± 16*	35.6 ± 0.8#	324 ± 5**
Fruits	83 ± 25	52.5 ± 0.4	142 ± 1	51 ± 5*	36.9 ± 0.3#	120 ± 2**	63 ± 6	48.1 ± 0.6	137 ± 2	34 ± 9*	25.6 ± 0.8#	119 ± 1**
Vegetables	65 ± 16	77.5 ± 0.3	79 ± 1	44 ± 5*	72.1 ± 0.2#	60 ± 1**	45 ± 6	61.4 ± 0.7	80 ± 2	61 ± 9*	69.2 ± 0.5#	83 ± 1**
Snacks and desserts	148 ± 31	44.7 ± 0.4	303 ± 1	173 ± 12*	56.5 ± 0.5#	333 ± 1**	147 ± 14	50.4 ± 0.9	306 ± 2	178 ± 23*	53.4 ± 1.2	360 ± 23**
Candy and sugars	49 ± 9	50.2 ± 0.3	88 ± 0	72 ± 7*	59.1 ± 0.3#	125 ± 1**	51 ± 4	59.3 ± 0.7	88 ± 1	83 ± 11*	51.2 ± 0.7#	162 ± 2**
Non-Mexican fast food	110 ± 54	23.7 ± 0.4	515 ± 1	162 ± 14*	34.5 ± 0.5#	529 ± 2**	143 ± 18	27.3 ± 0.9	487 ± 2	158 ± 23*	41.5 ± 1.5#	419 ± 2**

[1] Predicted energy mean ± SEM (mean kcal/d) from marginal-effect model estimates controlling for gender, age, income, and education. *Different between FB and USB, $P < 0.001$ (Student's *t* test).
[2] Predicted percent ± SEM (percent consuming) from logistic regression models controlling for gender, age, income, and education. #Different between FB and USB, $P < 0.001$ (chi-square test).
[3] Predicted mean ± SEM among consumers [kcal/(consumer·d)] from linear regression models among consumers only controlling for gender, age, income, and education. Consumers are defined as persons who reported eating the food/food group. **Different between FB and USB, $P < 0.001$ (*t* test).
[4] Includes tortillas, but classification depended on fat and fiber content.

fast food. Adjusted for age and gender, USB Mexicans obtained a greater ($P < 0.001$) percentage of energy from this food group (Table 2), amounting to a difference of 56 mean kcal/d (234 kJ/d) (Table 3). Significant differences in the predicted mean kcal/d were also observed for soda and fruit drinks ($P < 0.001$), snacks and desserts ($P < 0.001$), and candy and sugars ($P < 0.001$) (Table 3, predicted mean kcal/d).

Differences in the predicted mean kcal/d estimates between USB and FB were largely accounted for by differences in the percent of consumers rather than differences in the amount eaten by consumers (Table 3). For example, 34.5 ± 0.5% of USB Mexicans compared with 23.7 ± 0.4% of FB Mexicans reported consuming non-Mexican fast food ($P < 0.001$), whereas consumers in each group obtained 23 ± 0.5% of their daily energy from this group (data not shown), the equivalent of 515 ± 1 kcal/(consumer·d) for FB and 529 ± 2 kcal/(consumer·d) USB Mexicans (Table 3). Given the differences in the overall energy intake of these 2 groups [2311 ± 38 kcal (9676 ± 159 kJ) vs. 2248 ± 32 (9412 ± 134 kJ) kcal for USB and FB Mexicans, respectively], this amounted to a difference of just 14 kcal (59 kJ) ($P < 0.001$; Table 2). Similarly, for snacks and desserts and candy and sugars, more USB (12%) compared with FB (9%) Mexicans consumed these foods, accounting for between 30 (126 kJ) and 40 (167 kJ) additional kcal/(consumer·d) ($P < 0.001$ for each food group; Table 3).

Patterns were slightly different for other Hispanics. Although significantly more USB other Hispanics reported consuming non-Mexican fast food (+14 ± 0.1%; $P < 0.001$), consumers obtained 5.3% less energy (data not shown) than FB consumers, which translated into 68 fewer kcal/(consumer·d) [285 kJ/(consumer·d)] for USB other Hispanics (Table 3). For candy and sugars, although there were 8% fewer USB consumers, they obtained roughly 74 more kcal/(consumer·d) [310 kJ/(consumer·d)] compared with FB other Hispanics (Table 3).

Small but significant percent of energy from beverages. Although beverages accounted for a smaller proportion of overall energy intake, there were significant differences between ethnic groups and birthplace. USB Mexicans and other Hispanics consumed less energy from high-fat milk and fruit and vegetable juices compared with their FB counterparts, although differences were significant only for Mexicans (high-fat milk and

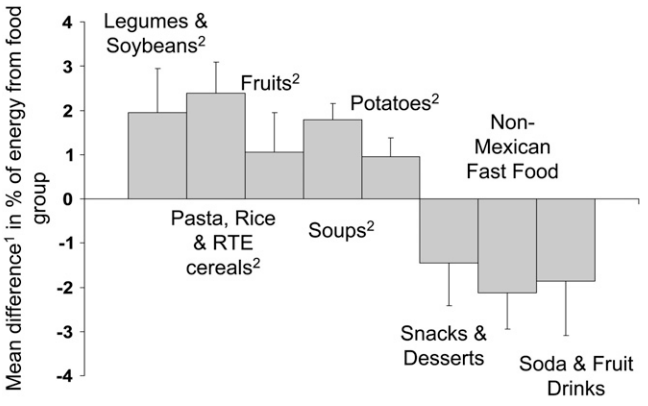

FIGURE 1 Mean difference in percent energy intake from various food groups between Hispanic adults ≥18 y (NHANES 1999–2004, $n = 3997$) who do and do not speak primarily Spanish in the home. Values are predicted mean ± SEM, $n = 3785$. Estimates were derived from MEM of percent energy from selected foods on being a primarily Spanish (vs. non-Spanish) speaker, controlling for age, gender, income, and education. Coefficient (predicted mean difference) for being primarily Spanish speaking vs. non-Spanish speaking differs, $P < 0.05$ (Student's t test).

fruit and vegetable juice; $P < 0.001$). Compared with FB Mexicans, significantly fewer USB Mexicans consumed high-fat milk, but the percentage of energy among consumers was relatively equal (data not shown) and amounted to roughly equivalent predicted kcal/consumer (Table 3).

Low-fat milk consumption differed for other Hispanics. USB consumers obtained 13.6 ± 0.6% of their daily energy from low-fat milk, compared with just 6.0 ± 0.4% among FB, which is the equivalent to 184 ± 0.88 fewer kcal/(consumer·d) (770 ± 3.68 kJ) from low-fat milk for FB other Hispanics.

Similarly, although the predicted mean kcal from soda and fruit drinks did not differ between FB and USB Mexicans (data not shown), USB Mexicans obtain 34 ± 0.07 more daily kcal/d (142 ± 0.29 kJ/d) compared with FB Mexicans (Table 3). The difference between USB and FB other Hispanics is even greater [+100 ± 0.3 kcal/d (419 ± 0.13 kJ/d) than for USB compared with FB other Hispanics (Table 3)].

Spanish and non-Spanish speakers maintain different dietary patterns. As an alternative to birthplace/generation status as an indicator of acculturation, we examined the effect of being a primarily Spanish speaker (compared with a non-Spanish speaker) on dietary intake using MEM controlling for age, gender, family income, and education (**Fig. 1**). As was the case for birthplace/generation status, Spanish speakers tended to consume foods commonly observed among the less acculturated (8). Significant differences in the percentage of total energy were observed for legumes and soybeans ($P < 0.01$), pasta, rice and ready-to-eat (RTE) cereals ($P < 0.01$), soups ($P < 0.05$), potatoes ($P < 0.05$), and fruits ($P < 0.01$).

Discussion

The objective of this study was to examine how ethnicity and acculturation were associated with dietary intake in Hispanic adults living throughout the United States. Specifically, we sought to compare percent of daily energy intake between Mexicans and other Hispanics who were either USB or FB to determine whether birthplace was differentially related to diet within ethnic groups. We found that acculturation, having been born in the US, was associated with a lower percentage of energy from arguably "healthier" food groups, specifically legumes, fruits, and vegetables. At the same time, more acculturated Hispanics seem to consume a greater percent of energy from less healthy foods such as snacks and fast foods. These foods are also those that tend to be associated with increased risk of non-communicable diseases (30–34).

Generally, the greatest differences were observed between FB and USB Mexicans, supporting the hypothesis that acculturation, and not just modernization, might account for differences in diet. Similar results to ours have been reported previously among adults (35), but discrepant findings have been reported among adolescents (5) and may reflect underlying differences in dietary patterns of older compared with younger Mexicans. The lack of significant differences between USB and FB other Hispanics might be due more to the relative heterogeneity of ethnicities represented by this group rather than an actual lack of differences between those born in the US or elsewhere. We were not able to more specifically characterize other Hispanics due to sampling design and the small sample sizes.

Dietary patterns high in fruits, vegetables, and fiber are typically considered "healthier" (36,37) and these consumption patterns tend to be associated with smaller gains in BMI and waist circumference (38) and a reduced risk of other chronic diseases (39,40) compared with other dietary patterns. Our findings, combined with the results from other studies in the same population (41), suggest that USB Hispanics, and Mexicans in particular, might be at increased risk for nutrition-related chronic disease.

Specific health-related consequences of the shifts toward a more nontraditional dietary pattern have been observed in both children and adults. A study of Latino families in San Diego County, CA, found that BMI was positively correlated with frequency of fast food consumption in children and consumption at an "American" restaurant in their parents (42). The degree of acculturation also has been shown to be highly associated with increased risk for obesity. The adjusted odds ratio [95% CI] for obesity in men was 1.43 [1.11, 1.84] and 1.38 [1.19, 1.67] in women. The effect was even stronger for those who were more highly acculturated (defined using 4 measures of linguistic preference) and persons who had lived in the US for the longest time had the highest BMI (11). Physical activity also is likely to play an important role in weight gain and the development of obesity among children and adults (43,44) who are more acculturated, due primarily to changes in occupational- and transportation-related physical activity (7).

There are several limitations to our study. First, our characterization of ethnicity did not permit us to examine subgroups of other Hispanics (i.e. Dominican, Cuban, Puerto Rican, etc.) accurately and the sample size was too small to examine them separately. It is possible that there is considerable heterogeneity among these groups that we could not account for in these analyses. Related to this point, due to missing data, we were unable to accurately classify generational status (beyond 2nd generation, due to missing data on parents' place of birth) or to assess the level of acculturation using the currently recommended multidimensional, bidirectional approach (14). Again, important differences in these groups might exist and warrant further study.

Despite these limitations, the present study has several strengths that allow us to fill important gaps in the literature on the topic of acculturation and diet. Specifically related to the use of NHANES data, we had a strong, nationally representative sample of Mexican-American adults living in the US, comprehensive dietary intake measures, and a validated computer-assisted data collection method that increased the accuracy of dietary intake reports. A notable methodological advantage of this study was our use of modeling strategies that allowed us to account for nonconsumers when estimating the effect of ethnicity and birthplace on diet. This is a standard method used in economics, but rarely do nutrition scholars consider this issue, which can bias results (45,46). The marginal effect approach employed in this study has 2 distinct advantages. First, it accounts for the simultaneity of the probability of consuming a food and the effect of consuming in the function that is being estimated. Second, it does not impose a restriction on the distribution of individual characteristics or the distribution of food intake. This is essential to obtaining unbiased, accurate estimates. Finally, the use of bootstrapping allows for the computation of more precise measures of standard error around these estimates.

Considering the well-established link between diet and disease, and the increased risk of adverse health outcomes observed in more acculturated Hispanics, this work has important implications for the development of culturally and generationally targeted nutrition interventions. For example, improving access through neighborhood interventions might prove a useful strategy for supporting maintenance or increased consumption of foods that have consistently been found to decrease with the acculturation process (8).

In a recent study of primarily first-generation Latino women, most reported shopping at supermarkets and grocery stores that catered to Mexican clientele with respect to store design and items offered (47). Additionally, women in this study who indicated a preference for fast food vs. other restaurants identified distance to the restaurant as one of the most influential factors in determining restaurant choice (47). In a separate immigrant community, low-fat milk represented just a fraction of available milk options in smaller grocery stores and supermarkets (48), but consumption increased significantly in this community when access to low-fat milk increased in school cafeterias (49). Altering access could have potentially positive impacts on healthfulness of the diet.

We report that FB and USB Mexicans and other Hispanics consume foods differently both with respect to percent consuming certain food groups and the amounts consumed among consumers. These findings suggest that Hispanic subgroups have important differences in dietary behaviors that might be obscured if they are studied as a single ethnic group. There are likely important interactions between the process of acculturation and the environment in which this process occurs. Future studies should examine Hispanic subgroups individually and seek to identify additional characteristics, beyond birthplace, which might provide further insight into the differences in health behaviors and health outcomes.

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