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Acculturation and Sociocultural Influences on Dietary Intake and Health Status among Puerto Rican Adults in Massachusetts

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Abstract

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Background—Previous studies have shown negative consequences of acculturation on lifestyle factors, health status, and dietary intake of Hispanic immigrants in the US. Despite prevalent type 2 diabetes and low socioeconomic status (SES) among Puerto Rican adults living on the US mainland, little is known about acculturation in this group.

Objective—We investigated associations among acculturation, lifestyle characteristics, health status, and carbohydrate nutrition in Puerto Rican adults. A secondary objective was to investigate possible confounding and/or effect modification on these associations by SES.

Design—Cross-sectional data from the Boston Puerto Rican Health Study, which included 1219 Puerto Ricans in the Boston area, aged 45–75 years.

Statistical analyses—Characteristics were compared using ANCOVA, linear trend and Pearson's chi-square tests across quartiles of acculturation. Tests for interaction by poverty status were conducted. Proportional contributions of foods to intake of total carbohydrate and fiber were assessed using SAS RANK.

Results—Levels of acculturation were low, despite young age at first arrival to the US mainland (25.4 ± 12.3 y) and long length of stay (34.2 ± 12.2 y). Greater English language use was associated with higher SES, alcohol consumption, physical activity, better perceived health, and less central obesity. Acculturation was associated with lower legume fiber and greater cereal fiber intake. Among those above the poverty threshold, acculturation was associated with lower dietary glycemic index and starch intake, and greater fruit and non-starchy vegetable intake.

Conclusions—In contrast to studies with Mexican Americans, the association of acculturation with dietary quality in these Puerto Rican adults was mixed, but tended toward better carbohydrate quality. Dietary recommendations should include maintenance of traditional, healthful dietary practices including consumption of legumes, but also reduction in refined grains, and greater inclusion of fruit, non-starchy vegetables, and whole grains. Interventions to improve access to better quality carbohydrate sources are necessary for this group disproportionately affected by diabetes.

Keywords

acculturation; glycemic index; dietary fiber; Puerto Rican

Hispanics are the largest and fastest growing ethnic group in the United States (US), and are expected to comprise 30% of the population by the year 2050 (1). Puerto Ricans are the second largest Hispanic subgroup and constitute 49% of Hispanics in Massachusetts (2). Despite evidence of higher psychosocial stress (3), prevalent type 2 diabetes (T2D) (4–6), and generally lower socioeconomic status (SES) than other ethnic groups (7), the Puerto Rican population remains understudied.

Studies of US Hispanics have documented harmful effects of assimilation into the mainstream US culture on many lifestyle/behavioral characteristics (8). However, most studies have been conducted with Mexican Americans (9). A mortality advantage, termed the “Hispanic Health Paradox”, has been noted, characterized by better health status of new immigrants, despite lower SES than the general US population (10). However, epidemiologic associations vary by Hispanic subgroup; whereas Mexican Americans have shown health “advantages,” which deteriorate with acculturation, Puerto Ricans have generally shown health disparities, with improved health with acculturation (11). It is critical to consider the role of SES in these findings, given that low language-acculturation among Spanish-speakers has been linked to economic disadvantage relative to English-speaking Hispanics (12), and direct associations have been seen between social status and physical and mental health (13).

With acculturation, US Hispanics, primarily Mexican Americans, have been shown to abandon traditional, healthful dietary practices in favor of processed convenience foods (14, 15). More frequent intake from fast food restaurants (16, 17), consumption of more saturated fat (18), more simple sugars (15), fewer fruits and vegetables (15, 19–21) and lower dietary fiber (18, 21), have all been reported with acculturation among Mexican Americans. Moreover, acculturation has been associated with increased obesity (22), despite increased physical activity (8, 9, 23), in this group.

In contrast to Mexican Americans, available data for Puerto Ricans suggest that diet quality, and possibly variety, may improve with acculturation (7, 24). Carbohydrate quality is particularly important because of direct effects on T2D risk – higher intake of dietary fiber has been associated with improved metabolic control (25, 26), while diets with a higher dietary glycemic index (GI) have been associated with poor control (27, 28). Boston area Puerto Rican adults have been found to consume proportionally more carbohydrate than other ethnic groups, primarily from high-GI foods, including white rice and bread (24, 29). Further, the traditional Puerto Rican dietary pattern has been associated with significantly greater BMI and waist circumference (24), metabolic syndrome and low HDL-C (30), relative to other dietary patterns. Although few studies have been conducted with this ethnic group, acculturation has been associated with greater intake of dietary fiber and lower intake of complex carbohydrate, albeit with higher simple sugars (29), primarily through greater consumption of breakfast cereals and fruit (24).

There remains a scarcity of information on acculturation and lifestyle factors, health status, and carbohydrate nutrition in Puerto Rican adults. Further, dietary GI, glycemic load (GL), and food sources of dietary fiber have not previously been investigated in this group. Therefore, the aim of the present analysis was to investigate associations among measures of acculturation and lifestyle/behavioral characteristics, health status, dietary GI and GL, and dietary fiber in Puerto Rican adults. A secondary aim was to investigate the contributing role of SES, particularly poverty status, in these associations.

METHODS

Study Population and Data Collection

Analyses were conducted with baseline data from the Boston Puerto Rican Health Study, a longitudinal study of 1,500 Puerto Rican adults, aged 45–75 y, in the Greater Boston area. Participants were recruited primarily (77%) through door-to-door enumeration of high Hispanic-density neighborhoods identified using year 2000 US Census data, as well as from community events (10%), referrals (7%), and calls to the study office (6%) (31). Individuals were eligible to participate if they were of Puerto Rican origin based on self-report, aged 45–75 y, scored > 10 points on the Mini-Mental State Examination, and were planning to stay in Massachusetts for at least 2 years. Only one eligible individual per household was interviewed. Of the 2084 eligible individuals invited to participate between June 2004 and October 2009, 1500 (72%) completed the baseline interview.

Bilingual interviewers conducted 3–4 hour home interviews in the language of the participant's choice, which included questions on socio-demographic characteristics, health behaviors, and medication use. In addition, a culturally-specific food frequency questionnaire (FFQ) was administered, and anthropometric and blood pressure measurements were taken. On a separate day, participants provided a fasting blood sample. Additional details on study methodology have been previously described (31). The present analysis used baseline data from the first 1219 participants (345 (28%) men and 874 (72%) women) with complete data on acculturation and dietary intake. The study protocol was

approved by the Institutional Review Board of Tufts Medical Center, and all participants provided written informed consent.

Acculturation, Lifestyle, and Health Status Variables

Proxy measures of acculturation included the Psychological Acculturation Scale (PAS) (32), a language-based modified bi-dimensional acculturation scale for Hispanics (BAS) (33), and length of stay (LOS). The modified BAS scale asks which language(s) individuals typically use for 7 usual activities, including watching TV, reading newspapers/books, speaking with neighbors, at work, listening to the radio, with friends, and with family. Responses were recorded on a 5-point Likert scale, with 1 being “only Spanish” and 5 being “only English”, and a summary score was constructed. Length of time on the US mainland was calculated based on year of first arrival, with consideration of periods of circular migration. Circular migration was defined as living in Puerto Rico for more than 3 months at a time since immigrating to the US mainland.

Socio-demographic questions included past and current employment, household income, and highest grade completed in school. Alcohol use and smoking status were defined as never, past, or current. Poverty was defined from U.S. Department of Health and Human Services poverty guidelines (34). Physical activity was assessed with a modified Paffenbarger Harvard Alumni Questionnaire (35). Physical activity scores were categorized as sedentary (score < 30), light (score ≥ 30 to < 40), moderate (score ≥ 40 to < 50), or heavy activity (score ≥ 50). Height (cm), weight (lbs), waist circumference (cm), and seated blood pressure (BP) were obtained, in duplicate, using standard procedures (36, 37). Participants were classified as having T2D if their fasting plasma glucose concentration was ≥126 mg/dl (7.0 mmol/L) and/or they were using oral diabetes medication or insulin (38). Hypertension was defined as systolic BP ≥140 mmHg, diastolic BP ≥90 mmHg, or use of anti-hypertensive medication (37). Presence of depressive symptoms was defined as a Center for Epidemiological Studies Depression Scale score ≥16 (39), and perceived stress was measured using the Perceived Stress Scale (40).

Dietary Assessment

Dietary intake was estimated using a FFQ that was designed and validated for this population (41). Detailed questions captured frequency and portion sizes of consumption of 246 individual foods and mixed items, beverages, and dietary supplements over the previous 12 months, with additional questions on food preparation. The relative validity of this FFQ for dietary carbohydrate is high, with a Pearson correlation of 0.92 and intraclass coefficient of 0.96 between data coded into the FFQ and a 24-hour recall conducted in a representative group of Hispanics (41). Additional validation of the FFQ has been performed against blood measures of lipids (42), carotenoids (43), vitamin E (44), and B vitamins (45, 46). For these analyses, individuals with implausible energy intakes of <600 or >4800 kcal and/or those missing 7 or more frequency items were excluded (n=66).

A database of GI and GL values was created, using decision criteria to assign the most appropriate GI values to FFQ food items. First, foods and beverages with <5 g of carbohydrate per portion were assigned a GI of zero (~33% of foods), as employed by other investigators (47, 48). Then, wherever possible, foods were directly matched (42%) to foods listed in the 2008 International Tables (49). GI values used glucose as the referent. If multiple values were available, we applied the mean value. If the exact FFQ food item was not available in published sources (23%), we imputed the GI of the most closely related food, based on macronutrient and fiber content, cooking method, and degree of ripeness. To calculate GI values for mixed meals, the following formula was used: $GI_{\text{mixed meal}} = \sum GI_a * AvCHO_a / AvCHO_{\text{tot}}$, where GI_a = GI of the a^{th} food, $AvCHO_a$ = g of available

carbohydrate in ath food, $AvCHO_{tot} = g$ of available carbohydrate in entire meal. Approximately 2% of GI values in the database were calculated for mixed meals. To calculate the glycemic load (GL) for each food, and average dietary GL and GI for each participant, the following formulas were used: GL per food: $GI * AvCHO/100$, where $AvCHO$ = grams of available carbohydrate in one serving; dietary GL (summed over all foods) = $\sum [GL * (\# \text{ servings}/d)]$; dietary GI = $\text{Dietary GL}/\text{total } AvCHO * 100$.

Statistical Analyses

Nutrient intakes were computed from FFQ data using Nutrition Data System for Research software (version 2007, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN), and statistical analyses were conducted using SAS (version 9.1.3, 2002–2003, SAS Institute Inc., Cary, NC). All P values were two-sided. Lifestyle and health characteristics across quartile categories of three proxy measures of acculturation were compared using ANCOVA with Tukey's adjustment for continuous variables, and Pearson's chi-square test for categorical variables; adjustment variables included age, sex, and education level. Because acculturation is so closely correlated with SES, confounding is likely in associations with health status and dietary intake (50, 51); therefore, we performed regression models before and after adjusting for poverty status.

Food sources of dietary fiber were categorized as: fruit, non-starchy vegetable, starchy vegetable, legume/nut, refined grain cereal, and whole grain cereal. Differences in fiber category intakes between less acculturated and more acculturated individuals were assessed using Student's t-test. To obtain adjusted mean intake of selected dietary characteristics, including nutrients and dietary GI and GL, across quartile categories of acculturation, we first winsorized the data (52) to avoid undue influence by outliers. Dietary intake means were then computed with ANCOVA using untransformed data, adjusting for age, sex, education level, total energy intake, and T2D. The significance of differences by acculturation quartile was assessed using log-transformed data, for all variables except dietary GI. For continuous lifestyle, health, and dietary characteristics, tests for linear trend across acculturation quartiles were also conducted. The proportional contribution of food sources to intake of total carbohydrate and dietary fiber was estimated with SAS RANK. Food sources of total carbohydrate were classified as low GI (≤ 55), medium GI (56–69), or high GI (≥ 70) (53). In secondary analyses, effect modification by poverty status of associations between language-based acculturation quartiles and health status and dietary intake was assessed. For those variables showing significant interactions ($P < 0.05$), we then conducted analyses stratified by poverty status.

RESULTS

The median language-based acculturation score of the study population was 21%, with 0% representing use of Spanish only and 100%, English only. The upper quartile had a median of 53.6% (Table 1), indicating nearly equal use of English and Spanish; however, the majority (57%) of these individuals spoke only Spanish in the interview. As expected, PAS scores increased across quartiles of language-based acculturation. Similarly, from a scale of 1–50, mean PAS scores ranged from 14.3 for the lowest to 23.2 for the highest quartile, again, showing low psychological acculturation. The majority of participants were born in Puerto Rico, regardless of acculturation quartile. With increasing language acculturation, Puerto Rican adults reported younger age at first arrival in the US and longer length of stay (29.2 to 41.2 y). However, there was no difference in likelihood of circular migration. Individuals with higher language-based acculturation scores were more likely to be male, above the poverty level, currently employed, and to have $>8^{\text{th}}$ grade education ($P < 0.0001$ for each), relative to lower scores. Food insecurity was observed for approximately 25% of individuals in each quartile, but did not differ by quartile. The majority of individuals had

health insurance coverage (93–97%), primarily from the state Medicaid program. More acculturated individuals were less likely to be widowed ($P<0.0001$), more likely to consume alcohol ($P=0.003$), and less likely to be sedentary ($P<0.04$).

Table 2 shows prevalence of health indicators by quartile of language-based acculturation. Obesity and central obesity tended to be lower, and depressive symptoms and perceived stress were significantly lower with greater acculturation after adjusting for age and sex. After further adjustment for poverty status, the association with central obesity strengthened, but associations with depressive symptoms and perceived stress became non-significant. Perceived health status improved across language-based acculturation quartiles, but no significant trends were observed in prevalence of T2D or hypertension.

There was a strong inverse association between language-based acculturation and dietary GI ($P \text{ trend}<0.0001$) (Table 3). Starch intake also decreased across quartiles ($P \text{ trend}=0.005$). Total dietary fiber did not differ; however, fiber from fruit ($P \text{ trend}=0.009$) and cereals ($P \text{ trend}=0.004$) increased, while fiber from starchy vegetables ($P \text{ trend}=0.009$) and legumes ($P \text{ trend}=0.01$) decreased across quartiles. Saturated fat increased ($P \text{ trend}=0.03$), and polyunsaturated fatty acids (PUFA) decreased ($P \text{ trend}<0.0001$), across quartiles.

Repeating analyses between acculturation and lifestyle, health, and dietary characteristics for quartiles of PAS and LOS on the US mainland, as alternative proxy measures of acculturation, revealed fewer significant findings (data not shown), although associations were generally in the same direction as for language-based acculturation. Similar trends were seen for less Spanish language use during the interview, higher likelihood of being male, and higher SES; however, behavioral or health characteristics did not differ significantly across quartiles. Consistent with the language-based measure, greater PAS was significantly associated with lower dietary GI and starch intake, and higher fruit fiber, and greater LOS was associated with lower starchy vegetable and legume fiber, and higher cereal fiber.

In secondary analyses, poverty status modified associations between language-based acculturation and dietary GI ($P \text{ for interaction}=0.03$), starch intake ($P \text{ for interaction}=0.04$), and daily servings of fruit ($P \text{ for interaction}=0.008$) and non-starchy vegetables ($P \text{ for interaction}=0.04$) (Table 4). Stratified analyses showed that results were significant only above the poverty threshold; specifically, increased language-based acculturation was associated with lower dietary GI, lower starch intake, and greater servings of fruit and non-starchy vegetables only among individuals above the poverty line.

Sources of total carbohydrate and dietary fiber varied with acculturation (Table 5), but were similar by poverty status (Table 6, available online at www.adajournal.org). Language acculturation was associated with less carbohydrate and fiber from rice and beans, beans or peas, Hispanic root crops, and plantains, and more from pasta (Table 5), regardless of poverty status. Acculturation was also associated with less carbohydrate from white rice and more from bagels. Further, with increased acculturation, dietary fiber from oatmeal decreased, but fiber from cold breakfast cereal and 100% whole wheat bread increased. Lower dietary GI observed for more acculturated individuals was likely due to lower intake of white rice/rice dishes and Hispanic root crops, which are medium-high GI foods.

DISCUSSION

In this study of Puerto Rican adults residing in the Greater Boston area, language-based acculturation was related to indicators of healthful lifestyle and less central obesity, but effects on dietary intake were both favorable and unfavorable, with improvements in carbohydrate quality primarily among those above the poverty threshold.

Despite relatively early age at first arrival and long length of stay on the US mainland, Puerto Ricans exhibited low psychological and language-based acculturation. Similar acculturation levels have been reported for Puerto Rican adults in the Hispanic Health and Nutrition Examination Survey (54), for older Puerto Rican adults residing in the Boston area (29) and central Chicago (55), and for younger, low-income Puerto Rican women in Connecticut (56). One possible explanation could relate this population's tendency to travel back and forth from Puerto Rico to the US mainland (57). However, in the present sample, there was no significant difference in frequency of circular migration by language-based acculturation, consistent with findings for a sample of older Puerto Ricans residing in linguistically concentrated, ethnic neighborhoods in Chicago (55). As the majority of our study sample resided in high Hispanic-density neighborhoods, language acculturation may not have been essential to manage day-to-day activities. Generally low levels of education and limited economic resources may have further hindered motivation and accessibility to learning English, as previously reported for older US Hispanics (12). US Census Bureau data confirm that Puerto Rican and Mexican immigrants have lower rates of language shift to English than other Hispanic immigrant groups (58).

Thus, of the commonly-used proxy measures of acculturation, language use may be the most sensitive measure (55) because it is associated with many other factors – it affects the way an individual interacts with society (12), one's understanding of different cultures, one's self-management of health conditions by more easily understanding and incorporating health care providers' recommendations (59), and knowledge and understanding of available healthful foods and dietary trends. Indeed, national survey findings indicate that limited English-proficient Hispanics were less likely than those with more proficiency to report receiving advice on physical activity and/or diet (59). English language use at work has been reported to be a more consistent predictor of dietary change among US Hispanics than other proxy measures (60). Not surprisingly, language use was more closely aligned with health and health behaviors than psychological acculturation or LOS in the present study and in other studies (60, 61).

Acculturation has been associated with weight gain among immigrants to the US, as a result of adoption of unhealthful lifestyle and dietary habits (8). Among young Puerto Rican women in Connecticut, increased LOS (62) and English language use adjusted for lifestyle factors and SES (63) were associated with increased obesity. However, in contrast to studies showing greater BMI with longer LOS among US Hispanics (23, 62, 64), acculturation was inversely associated with central obesity in the present study, controlling for poverty status. Interestingly, some studies in Mexican Americans have also suggested higher waist circumference among those less acculturated (65). The San Antonio Heart Study, reported that, in Mexican American women only, cultural assimilation was associated with more favorable body fat distribution, whereas, in men, it was associated with less favorable body fat distribution (66). However, in the Massachusetts Hispanic Elders Study, a rice dietary pattern, consumed by the least acculturated Caribbean-origin Hispanic women and men, was associated with higher waist circumference and BMI (24), lending support to the present findings.

Because low SES has been associated with low social participation and sense of control (67), this may inhibit English language use (12). Recently, acculturation was associated with greater prevalence of psychological and behavioral problems (68) and increased stress (69) in Mexican Americans, without controlling for SES. In the present sample, language acculturation was associated with better perceived health, which confirms previous findings in this ethnic group (7, 70, 71). Further, we found that the low SES environment may trump a potential protective effect of language-based assimilation into mainstream US culture on depressive symptoms and perceived stress among Puerto Rican adults in the Boston area.

In this study, acculturation was associated with some potentially negative dietary changes – including lower intake of legumes and hot cereals like oatmeal. Not surprisingly, there were higher intakes of traditional food sources such as rice, beans, and starchy vegetables in those who were less acculturated, confirming previous findings (24, 29). Studies in Mexican Americans have also reported lower consumption of legumes (i.e., beans and peas), a high-fiber, higher quality carbohydrate food, with acculturation (21, 61, 72). An explanation provided by women in a focus group was that beans take a long time to cook (73). With less frequent cooking of beans in our study sample, there was likely less use of corn oil – their main PUFA source (74); instead, saturated fat increased with acculturation.

Nonetheless, in individuals above poverty in the present sample, improvements in carbohydrate quality were observed with increasing language acculturation. There were trends toward consuming fewer refined grains, more whole grains, and more fruit and non-starchy vegetables. Specifically, fruit and non-starchy vegetable intake each increased by approximately one half serving per day between the lowest and upper quartile of acculturation, which, together, translates into an additional serving per day. Thus, among Puerto Rican adults in the Boston area with more economic resources, greater use of English in daily activities was associated with better carbohydrate quality, and lower dietary GI. Given that fruit, vegetables, and whole grains are classic components of a healthy diet (75), implications of these results may be that language facilitates the message regarding a healthy diet, or the accessibility to a healthy diet; however, higher SES (economic resources) makes improvement in carbohydrate quality possible.

Among those experiencing poverty and/or food insecurity, lack of economic resources may prohibit regular consumption of high-fiber fruits and vegetables (76), as well as whole grains, and encourage consumption of low-fiber, energy-dense foods (77). Consistent with the nutrition transition, as reported in Latin American countries (78), higher SES correlates with greater food variety and availability, while lower SES correlates with more energy-dense foods (79). In low-income Puerto Rican women in Connecticut, SES was positively related to nutrition knowledge and food label use and with intakes of fruit, vegetables, and meats (80). In the Massachusetts Hispanic Elders Study, 60% of Caribbean Hispanics in the rice and starchy vegetables dietary patterns were below the poverty level (24). With increased perceived stress among less acculturated Boston area Puerto Ricans, poorer diet quality has been observed (81), compounding the problem. Contradictory findings have been reported for Mexican Americans, where low acculturation has been associated with lower food insufficiency (82) and greater fruit and vegetable intake (15, 19–21), suggesting unique associations by Hispanic subgroup.

Because it is a novel finding, additional mention of acculturation and poverty status in relation to dietary GI is warranted. While previous research has indicated differences in intake of total carbohydrate or sugars by acculturation (15, 29), this study found differences in dietary GI. Foods contributing most to GI, and to dietary GI differences across acculturation quartiles, were refined grains (particularly white rice) and starchy vegetables (Hispanic root crops), which contributed medium-high GI values, and legumes, non-starchy vegetables, and whole wheat bread, which contributed low GI values. In those above poverty, dietary GI appeared lower with acculturation because starch intake was lower, while whole grain foods, non-starchy vegetables, and fruit intake were higher.

Limitations of this study include its cross-sectional design, precluding causal inference. Secondly, use of the modified BAS (33) may not be directly comparable to studies that used different measures of acculturation. However, analyses with other proxy measures showed similar directions, albeit less significant results. Finally, GI values for some foods were imputed from similar foods, and some GI values were calculated from mixed-meal formulas.

However, we applied a series of decision criteria to carefully select appropriate GI values and believe that foods and mixed meals were ranked correctly, resulting in valid estimates of dietary GI and GL (83).

There are several strengths to the present study. First, while most studies have included Mexican Americans (15), this study examined acculturation, diet, and lifestyle in a large sample of older Puerto Ricans. Detailed information on socio-demographics, cultural preferences (e.g., language use), and migration history allowed examination of acculturation in relation to various SES indicators. Finally, a culturally-specific FFQ designed for this population was used to assess dietary intake, which allowed us to capture detailed information on food intake, enabling development of a GI database for use in future studies.

CONCLUSIONS

Puerto Ricans on the US mainland are a large and growing population with a disparate burden of disease, including higher rates of T2D, than other ethnic groups. In addition to public health strategies aimed at disease prevention (6), targeted educational programs focused on lifestyle modifications are needed to help reduce the impact of disease in this group (84). In this study, Puerto Rican adults with greater language acculturation and SES were more likely to consume higher quality carbohydrate foods, with the exception of legumes, and to be physically active. Based on these findings, it is recommended that Puerto Rican adults maintain traditional, healthful dietary practices including consumption of legumes, while reducing intake of refined carbohydrates including white rice, white bread, and fruit drinks. Puerto Ricans, following a traditional diet, will continue to eat white rice, but recommendations should encourage modification of the proportion of white rice to legumes or addition of non-starchy vegetables to the plate. All groups should be encouraged to incorporate healthful dietary habits such as consumption of fresh fruit, vegetables, and whole grains, while avoiding less healthful habits, such as intake of soft drinks, fried foods, and snacks. National educational tips sheets have been developed to help improve identification of affordable fresh fruits and vegetables (85), and research on availability of culturally-specific fruits and vegetables in Latino neighborhoods has been conducted (86); however, additional research and educational initiatives in this area are needed. In summary, culturally sensitive educational and intervention programs, as well as bilingual health care providers (87), are essential to reach less language-aculturated Puerto Rican adults, particularly those below the poverty level, to improve understanding of and access to healthful lifestyle habits and better carbohydrate quality sources among these individuals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1
Lifestyle characteristics by quartile of language-based acculturation in Puerto Rican adults

Lifestyle Variable ^b	Language-based Acculturation Quartile ^a				Chi-square or P-trend
	Q1	Q2	Q3	Q4	
Median acculturation score	0	8.3	29.2	53.6	N/A
Age (y)	60.5 ± 0.5 ^w	58.3 ± 0.4 ^x	57.2 ± 0.4 ^x	54.3 ± 0.4 ^y	<0.0001
Female (%)	82.9 ^w	73.3 ^{wxx}	67.1 ^x	64.6 ^x	<0.0001
Language of the interview (%)					
English	0.4	0.6	1.3	12.0	<0.0001
Spanish	99.6	97.9	89.4	57.0	
Both	0.0	1.5	9.4	31.1	
Psychological acculturation score ^c	14.3 ± 0.4 ^w	15.5 ± 0.3 ^w	18.7 ± 0.3 ^x	23.2 ± 0.4 ^y	<0.0001
Born in Puerto Rico (%)	98.8	98.8	98.8	88.8	<0.0001
Age at first arrival in the US (y)	30.3 ± 0.7 ^w	26.6 ± 0.6 ^x	22.6 ± 0.6 ^y	16.6 ± 0.7 ^z	<0.0001
Length of time in the US (y)	29.2 ± 0.8 ^w	31.7 ± 0.7 ^w	35.3 ± 0.7 ^x	41.2 ± 0.7 ^y	<0.0001
Circular migration (%)	33.7	41.4	37.0	35.9	0.25
Education ≤ 8 th grade (%)	73.0 ^w	59.3 ^x	39.3 ^y	24.4 ^z	<0.0001
Currently working (%)	14.8 ^w	15.4 ^w	22.8 ^w	37.3 ^x	<0.0001
Household income (\$)	13,054 ^w	13,410 ^w	19,479 ^x	28,062 ^y	<0.0001
Poverty (%)	67.0 ^w	68.0 ^w	51.8 ^x	39.3 ^y	<0.0001
Food insecurity (%)	25.3	28.0	24.1	24.1	0.40
Health insurance (%)	96.9	95.9	93.7	92.9	0.11
Marital status (%)					
Married	26.1	31.1	38.9	32.9	<0.0001
Divorced/separated	40.1	41.6	36.4	42.5	
Widowed	20.6	15.8	11.3	7.2	
Never married	13.2	11.4	13.5	17.5	
Current smoking (%)	25.2	23.1	27.9	28.7	0.40
Current alcohol use (%)	37.5 ^{wxx}	35.7 ^w	47.0 ^x	48.6 ^x	0.003
Physical activity (%)					

Lifestyle Variable ^b	Language-based Acculturation Quartile ^a				Chi-square or P-trend
	Q1	Q2	Q3	Q4	
Sedentary/light	95.0	96.8	92.8	92.3	0.04
Moderate/heavy	5.0	3.2	7.2	7.7	

^aSample sizes per quartile of acculturation were: Q1, n = 258; Q2, n = 341; Q3, n = 320; Q4, n = 294.

^bContinuous variables are means ± SE. Variables were adjusted for age, sex, and poverty status, except for the following: age was adjusted for sex and poverty; % female, for age and poverty; household income and food insecurity, for age and sex; and food insecurity, for age, sex, and education level.

^cPsychological acculturation score was calculated by summing responses to 10 questions, each based on a 5-point Likert scale, with “1” being “Only with Puerto Ricans” and “5”, “Only with Americans”; the possible range was 1–50.

^{wxyz}Means sharing the same superscripts (w,x,y,z) are not significantly different from one another, using ANCOVA with Tukey’s HSD test (P<0.05).

Table 2
Prevalence of health indicators by quartile of language-based acculturation in Puerto Rican adults

Health indicator	Language-based Acculturation Quartile				Chi-square or P for trend
	Q1	Q2	Q3	Q4	
Obesity ^a (%)					
Model 1 ^b	60.4 ^w	52.6 ^{wx}	54.8 ^{wx}	48.7 ^x	0.06
Model 2 ^c	61.2	53.3	54.9	49.8	0.08
Central obesity ^d (%)					
Model 1	67.8	67.0	60.5	60.3	0.05
Model 2	69.5	68.4	61.0	60.3	0.02
Type 2 diabetes ^e (%)					
Model 1	40.9	43.3	39.8	35.5	0.26
Model 2	42.4	44.3	39.4	36.4	0.26
Hypertension ^f (%)					
Model 1	71.9	69.7	70.9	66.5	0.58
Model 2	72.8	71.1	70.9	67.5	0.66
Depressive symptoms ^g (%)					
Model 1	58.0 ^{wx}	61.4 ^w	53.9 ^{wx}	47.6 ^x	0.005
Model 2	56.7	58.9	53.8	49.7	0.15
Perceived stress ^h (mean ± SE)					
Model 1	23.2 ± 0.6	23.7 ± 0.5	23.4 ± 0.5	21.9 ± 0.6	0.04
Model 2	23.0 ± 0.6	23.2 ± 0.5	23.4 ± 0.5	22.3 ± 0.6	0.31
Perceived health status (%)					
Excellent	2.3	3.8	5.3	6.8	<0.0001
Very good	3.1	2.9	6.6	12.2	
Good	14.7	13.5	17.5	29.9	
Fair	67.8	64.7	56.3	39.8	
Poor	12.0	15.0	14.4	11.2	

^aObesity was defined as body mass index ≥ 30 kg/m².

^bModel 1 was adjusted for age and sex.

- ^cModel 2 was adjusted for age, sex, and poverty status.
- ^dCentral obesity was defined as waist circumference > 102 cm for men and > 88 cm for women.
- ^eType 2 diabetes was defined as fasting plasma glucose concentration ≥ 126 mg/dl (7.0 mmol/L) and/or diabetes medication use (38).
- ^fHypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or use of anti-hypertensive medications (37).
- ^g“Depressive symptoms” was defined as a Center for Epidemiological Studies Depression Scale score ≥ 16 (39).
- ^h“Perceived stress” scale scores ranged from 0 to 56, with higher scores indicating higher perceived stress (40).

Table 3
Dietary characteristics by quartile of language-based acculturation in Puerto Rican adults

Dietary Variable ^b	Language-based Acculturation Quartile ^a				P for trend
	Q1	Q2	Q3	Q4	
Total energy (kcal/d)	2200 ± 60.4	2286 ± 51.0	2327 ± 51.0	2177 ± 55.4	0.67
Protein (g/d)	92.5 ± 1.2	92.4 ± 1.0	90.6 ± 1.0	93.2 ± 1.1	0.95
Carbohydrate (g/d)	267 ± 3.0	270 ± 2.6	267 ± 2.6	269 ± 2.8	0.59
Total fat (g/d)	79.3 ± 1.0	78.8 ± 0.8	78.1 ± 0.8	78.1 ± 0.9	0.40
Saturated fat	23.4 ± 0.4 ^{wx}	23.4 ± 0.4 ^w	23.7 ± 0.4 ^{wx}	24.8 ± 0.4 ^x	0.03
PUFA ^c	21.8 ± 0.4 ^w	21.4 ± 0.3 ^w	20.8 ± 0.3 ^w	19.3 ± 0.3 ^x	<0.0001
MUFA ^d	27.3 ± 0.4	27.3 ± 0.3	27.1 ± 0.3	27.3 ± 0.3	0.82
Starch (g/d)	126 ± 2.0 ^{wx}	128 ± 1.7 ^w	125 ± 1.7 ^{wx}	120 ± 1.8 ^x	0.005
Added sugars (g/d)	54.8 ± 2.7	56.2 ± 2.3	53.1 ± 2.3	57.4 ± 2.5	0.60
Glycemic index ^e	57.8 ± 0.3 ^w	57.6 ± 0.2 ^w	57.5 ± 0.2 ^w	56.3 ± 0.2 ^x	<0.0001
Glycemic load ^e	143 ± 1.8	143 ± 1.5	143 ± 1.5	140 ± 1.6	0.33
Total dietary fiber (g/d)	18.9 ± 0.4	19.5 ± 0.3	18.7 ± 0.3	19.5 ± 0.4	0.42
Fruit fiber	1.8 ± 0.1 ^{wx}	1.7 ± 0.1 ^w	1.7 ± 0.1 ^w	2.1 ± 0.1 ^x	0.009
Non-starchy vegetable fiber	2.4 ± 0.1	2.4 ± 0.1	2.4 ± 0.1	2.6 ± 0.1	0.05
Starchy vegetable fiber ^f	2.6 ± 0.1 ^w	2.4 ± 0.1 ^{wx}	2.4 ± 0.1 ^{wx}	2.1 ± 0.1 ^x	0.009
Legume fiber ^g	6.6 ± 0.3 ^{wx}	7.0 ± 0.3 ^w	6.2 ± 0.3 ^{wx}	5.8 ± 0.3 ^x	0.01
Cereal fiber	4.5 ± 0.2 ^w	4.9 ± 0.1 ^{wx}	4.9 ± 0.1 ^{wx}	5.4 ± 0.2 ^x	0.004

^a Sample sizes per quartile of acculturation were: Q1, n = 261; Q2, n = 341; Q3, n = 322; Q4, n = 295.

^b Data are means ± SE, adjusted for age, sex, total energy, poverty status, and type 2 diabetes, with the exception of total energy, which was adjusted for all of these variables except total energy.

^c "PUFA" refers to polyunsaturated fatty acids.

^d "MUFA" refers to monounsaturated fatty acids.

^e Dietary glycemic index and glycemic load were calculated using glycemic index values with glucose as the reference.

^f "Starchy vegetable fiber" includes dietary fiber from corn, green peas, potatoes, sweet potatoes/yams, plantains/green bananas, and Hispanic root crops such as cassava.

^gLegume fiber* includes fiber from nuts.

^{wxyz}Means sharing the same superscripts (^w,^x,^y,^z) are not significantly different from one another, based on ANCOVA with Tukey's HSD test ($P < 0.05$). P values are based on significance tests with logged data, for all variables except dietary glycemic index.

Table 4

Interaction with poverty status across quartiles of language-based acculturation for select dietary variables in Puerto Rican adults

Dietary Variable ^a	Language-based Acculturation Quartile				P for trend	P interaction
	Q1	Q2	Q3	Q4		
Glycemic index						
Below poverty ^b	57.7 ± 0.3	57.4 ± 0.3	57.5 ± 0.3	57.0 ± 0.4	0.23	0.03
Above poverty ^c	58.1 ± 0.5 ^w	58.1 ± 0.4 ^w	57.4 ± 0.3 ^w	55.8 ± 0.3 ^x	<0.0001	
Starch (g/d)						
Below poverty	123 ± 2.3	125 ± 1.9	120 ± 2.3	122 ± 2.9	0.63	0.04
Above poverty	131 ± 3.6 ^{wx}	133 ± 3.0 ^w	131 ± 2.4 ^w	120 ± 2.3 ^x	0.0003	
Fruit (svg/d)						
Below poverty	1.7 ± 0.1	1.7 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	0.53	0.008
Above poverty	1.7 ± 0.2 ^{wx}	1.4 ± 0.1 ^w	1.7 ± 0.1 ^{wx}	2.1 ± 0.1 ^x	0.0006	
Non-starchy vegetables (svg/d)						
Below poverty	1.5 ± 0.1	1.6 ± 0.1	1.4 ± 0.1	1.6 ± 0.1	0.87	0.04
Above poverty	1.4 ± 0.1 ^w	1.6 ± 0.1 ^{wx}	1.8 ± 0.1 ^{wx}	2.0 ± 0.1 ^x	0.0004	

^aData are means ± SE per day, adjusted for age, sex, total energy, and type 2 diabetes. Starch intake is in grams per day, while intake of fruit and non-starchy vegetables is in servings per day.

^bBelow poverty n = 672.

^cAbove poverty n = 486.

Table 5

Top contributors^a to total carbohydrate and dietary fiber in Puerto Rican adults at extreme quartiles of language-based acculturation

	Less Acculturated			More Acculturated			GI ^b	GI Class ^c
	%	Rank		%	Rank			
Total carbohydrate, mean $\pm$ SE (g/d) ^d	267 $\pm$ 3.0			269 $\pm$ 2.8				
White rice	6.3	1		5.3	1	79		High
Rice with beans or pigeon peas	6.0	2		4.7	3	66		Medium
Beans and peas	5.8	3		4.7	2	31		Low
Sugar in coffee and/or tea	3.6	4		3.7	4	65		Medium
Milk (including in cereal or coffee/tea)	3.5	5		3.6	5	31		Low
White bread	3.3	6		2.8	8	71		High
Cold cereal	3.3	7		3.4	7	72		High
Orange juice (100% juice)	3.0	8		3.5	6	50		Low
Hispanic root crops	3.0	9		1.4	16	69		Medium
Soft drinks, regular	2.7	10		2.5	9	57		Medium
Plantains, green bananas	2.6	11		1.9	14	54		Low
Cranberry juice (incl. cocktail)	2.3	12		2.0	12	59		Medium
Pasta	1.6	17		2.3	10	44		Low
Bagels	1.1	22		2.0	11	69		Medium
Dietary fiber, mean $\pm$ SE (g/d) ^d	18.9 $\pm$ 0.4			19.5 $\pm$ 0.4				
Beans and peas	25.8	1		21.3	1	31		Low
Rice with beans or pigeon peas	7.6	2		6.0	2	66		Medium
Hispanic root crops	4.4	3		2.0	11	69		Medium
Oatmeal	4.1	4		2.9	4	66		Medium
Plantains, green bananas	2.7	5		2.0	10	54		Low
Cold cereal	2.6	6		3.4	3	72		High
French fries	2.6	7		2.8	5	69		Medium
100% whole wheat bread	0.9	24		2.7	6	69		Medium
Salad greens	1.8	9		2.2	7	0		-
Pasta	1.6	12		2.2	8	44		Low
Bananas	1.7	10		2.0	9	60		Medium

^a Foods were included if they contributed at least 2% to total daily nutrient intake in either acculturation group.

^b GI values listed are based on glucose as the reference.

^c GI classifications are: low GI: ≤ 55 ; medium GI: 56–69; and high GI: ≥ 70 (53).

^d Total carbohydrate and dietary fiber (mean $\pm$ SE, g/d) were adjusted for age, sex, total energy, poverty status, and type 2 diabetes.