Public Health Nutrition: 20(7), 1267–1278 doi:10.1017/S1368980016003311

Healthy eating patterns associated with acculturation, sex and BMI among Mexican Americans

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Submitted 2 December 2015: Final revision received 27 September 2016: Accepted 8 September 2016: First published online 22 December 2016

Abstract

Objective: Examine relationships of healthy and unhealthy dietary patterns with BMI, sex, age and acculturation among Mexican Americans.

Design: Cross-sectional. Participants completed culturally tailored Healthy and Unhealthy Eating Indices. Multivariable mixed-effect Poisson regression models compared food pattern index scores and dietary intake of specific foods by BMI, sex, age and acculturation defined by language preference and generational status.

Setting: Participants recruited from the Cameron County Hispanic Cohort study, Texas–Mexico border region, between 2008 and 2011.

Subjects: Mexican-American males and females aged 18–97 years (*n* 1250).

Results: Participants were primarily female (55·3 %), overweight or obese (85·7 %), preferred Spanish language (68·0 %) and first-generation status (60·3 %). Among first-generation participants, bilingual participants were less likely to have a healthy eating pattern than preferred Spanish-speaking participants (rate ratio (RR) = 0·79, $P = 0·0218$). This association was also found in males (RR = 0·81, $P = 0·0098$). Preferred English-speaking females were less likely to consume healthy foods than preferred Spanish-speaking females (RR = 0·84, $P = 0·0293$). Among second-generation participants, preferred English-speaking participants were more likely to report a higher unhealthy eating pattern than preferred Spanish-speaking participants (RR = 1·23, $P = 0·0114$). Higher unhealthy eating patterns were also found in females who preferred English *v.* females who preferred Spanish (RR = 1·23, $P = 0·0107$) or were bilingual (RR = 1·26, $P = 0·0159$). Younger, male participants were more likely to have a higher unhealthy eating pattern. BMI and diabetes status were not significantly associated with healthy or unhealthy eating patterns.

Conclusions: Acculturation, age, sex and education are associated with healthy and unhealthy dietary patterns. Nutrition interventions for Mexican Americans should tailor approaches by these characteristics.

Keywords
Healthy eating patterns
Mexican Americans
US–Mexico border
Acculturation
Community nutrition

The study of dietary patterns and their effects on health outcomes is novel[1–4] and is beginning to show that specific unhealthy and healthy dietary patterns identified from FFQ are associated with[5–7] and predict[8,9] modulation of biomarkers for chronic disease[5–10]. The US Healthy People 2020 guidelines for disease prevention recommend following a heart-healthy dietary pattern that includes fruits, vegetables, whole grains, low-fat dairy and lean proteins, and engaging in physical activity to maintain a healthy weight[11]. These same guidelines also recommend avoiding a pattern of unhealthy food consumption that includes foods high in saturated fats and *trans*-fats, cholesterol, added sugars and sodium[11]. However, dietary behaviours vary greatly by racial/ethnic population[12–18], BMI[14–19] and sex[20–22], and the examination of healthy and unhealthy dietary patterns deserves further attention, particularly among fast-growing populations facing health disparities associated with obesity.

As the demographic distribution of race and ethnicity changes in the American population, inequalities in health-related outcomes among certain population groups,

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including Mexican-American populations, are becoming pronounced. For example, obesity-related health disparities are prevalent among Hispanics nationwide, especially Mexican Americans[23], and overweight and obesity prevalence rates for Mexican-American women have already surpassed the US 2020 projections[24]. Among US adults aged 20 years or older, 69 % of all racial and ethnic groups were found to be overweight or obese (BMI ≥ 25·0 kg/m^2), while 80 % of Mexican Americans were found to be overweight or obese (BMI ≥ 25·0 kg/m^2)[25]. Along the US–Mexico border, exacerbated rates of obesity and obesity-related co-morbidities such as type 2 diabetes and heart disease have been identified[26].

In addition to the high overweight and obesity rates in Mexican-American populations, researchers have also found shifting patterns of healthy and unhealthy eating among Mexican Americans born in the USA or Mexico and Mexicans born in Mexico. Mexican Americans born in the USA report greater intakes of foods high in saturated fat and sugar and less consumption of the traditional Mexican diet compared with Mexicans born in Mexico[27]. This information indicates that compared with the US diet, the traditional Mexican diet may be lower in saturated fat and sugar. US-born Mexican Americans also show increased consumption of carbohydrates and total energy intake compared with Mexican Americans studied in the mid-20th century[28]. Mexican-American populations born in Mexico report consuming more fruits and vegetables compared with Mexican Americans born in the USA. Additionally, Mexican Americans who speak only or mostly English report consuming more fast foods, pizza, non-homemade meals and meals at sit-down restaurants relative to Spanish speakers[29]. And generally, while healthier dietary intake is found among Mexicans living in Mexico, obesity rates in Mexico and the USA lead all other nations worldwide[30].

While some information may suggest that the traditional Mexican diet is lower in saturated fat and sugar compared with the typical US diet, other sources suggest different alternatives, leading to inconsistencies in research findings. For example, some research indicates that Mexicans' dietary choices include high intakes of refined foods, sweets and animal products, particularly among the overweight and obese[31]. Additionally, most Mexicans do not meet recommendations for basic food groups such as fruits, vegetables and legumes[32]. A recent study also found that if a Mexican woman was of lower economic status and had lived in the USA, she reported more unhealthy food choices such as hamburgers[33]. In general, it appears that across populations of Mexican descent, there is a shift towards greater consumption of unhealthy foods.

To better understand the unique burden of disease among Mexican-American populations, researchers have reviewed the associations between acculturation and dietary eating patterns; however, the association seems to be complex. Acculturation is generally understood as the transitioning process of merging and adapting social patterns and traits including food choices when individuals, groups and populations have prolonged contact – even across generations – with another culture[34]. Despite the absence of a gold standard to measure acculturation, commonly used proxy measures include language preference and generational status. Research findings have been consistent in showing that acculturation, including when it is measured as generational status defined by birthplace only[34–37], and language preference[38,39] or language preference only[40], is significantly associated with dietary patterns and BMI levels. With regard to generational status, research indicates that second- and third-generation Mexicans compared with recent immigrants consume fewer fruits, which account for a healthy diet. Also, less healthy dietary behaviours such as the consumption of sweetened beverages and fast foods have been found to be more common among native-born Mexicans compared with first-generation immigrants[41]. While immigrants with the lowest levels of acculturation are often the healthiest, the association between high acculturation and poor diet has been observed to be stronger for males[42]. Another study that examined generational differences in dietary quality among Mexican-born mothers and children based on the US Department of Agriculture's Healthy Eating Index found that the mean Healthy Eating Index score for Mexican-born women who migrated to the USA was approximately 6 points higher than that of Mexican-American mothers born in the USA[43]. Other studies have also observed that Mexican Americans who were less acculturated, defined by language use and country of birth, reported higher frequency of fruit and vegetable consumption than individuals who were more acculturated[44]. At the same time Liu *et al.* found that greater acculturation, as measured by generation status and language preference, was significantly associated with unhealthy dietary patterns and a higher BMI after controlling for sociodemographic factors, health, dietary intake, physical activity and sedentary behaviours[45].

Few researchers have examined how gender roles may influence dietary consumption in Mexican-American households. Within marriage relationships, many Mexican Americans adhere to gender roles of '*marianismo*' where women are self-sacrificing and nurturing and '*machismo*' where men are self-reliant and dominant over women[46]. With adherence to such roles, women's job duties are associated with household tasks like meal preparation and raising children and men's job duties are outside the home[47]. One qualitative study focused on Mexican-American mothers and their role as the primary food preparers (cooking, shopping and meal planning) in the home. These women learned to cook from female family members through observation and kept traditional Mexican food items in their homes as staples; several reported low cooking self-efficacy because they considered meals prepared by other maternal family members better tasting than their own, but not healthier. The women reported making some changes to recipes (like replacing lard) to make them healthier but also

incorporating more American-style dishes such as macaroni and casseroles as well as fast foods to please their families[48].

Differences by sex in dietary patterns have been found in other cultural groups including Chinese[20], Tanzanian[49], other international populations[22] and Mexican-American men with gallbladder disease[50], but results from these studies have limited applicability to Mexican-American men and women when cultural differences and specific diseases are taken into consideration. For example, although dietary patterns were found within a sex for one study (i.e. Mexican-American men with gallbladder disease and those who did not have it), no differences were seen between sexes[50]. Furthermore, there are studies that explicitly examined dietary patterns by sex within Mexican populations[35,44]; however, some do not represent current dietary food patterns and have sex comparison limitations because the dietary patterns of both sexes were not included in the sample[51]. Although many studies have assessed the impact of food acculturation on dietary patterns by generation, they are limited in assessing a clear understanding of how food acculturation affects the diets in multiple Mexican-American populations[27]. Further characterization of eating patterns among Mexican-American men and women from regions where obesity is prevalent are warranted. In addition to acculturation and sex, age is another factor associated with dietary differences as there is an indication that older generations report healthier eating patterns compared with younger generations; however, this indication has been found only in women[51].

Despite consistent findings in studies linking dietary patterns to health outcomes, little is known about the dietary patterns of adult Mexican Americans where acculturation is measured by both language preference and generational status. The purpose of the present study was to address this gap and examine the relationship of dietary patterns with BMI categories and acculturation levels as defined by language preference and generational status, age, education and sex among Mexican Americans living along the US–Mexico border. The hypothesis is that participants who have a higher BMI, report English language preference and third-generation status, are younger, less educated and male will have more unhealthy dietary patterns.

Methods

Participants

A cross-sectional sample of 1250 Mexican-American adults were selected from the ongoing, randomly recruited Cameron County Hispanic Cohort located in a four-county area along the Texas–Mexico border. This sample population was chosen as an appropriate population to study due to its similar cultural reflection of the Mexican-American communities in the USA. Cohort participants were recruited from randomly selected households to eliminate selection bias towards existing disease or concurrent infectious diseases. Overall, 71 % of households approached elected to participate, but more did so in the lower socio-economic status stratum compared with the higher socio-economic status stratum (78 *v.* 63 %, $P=0{\cdot}03$)[26]. The cross-sectional sample of cohort members for the current study was enrolled between 2008 and 2011, and reported both measures of acculturation.

Data collection and management

Following door-to-door recruitment, participants were asked to visit the cohort study's clinical research unit where behavioural surveys were conducted via interviews, medical data were collected and clinical examinations took place. Bilingual nurses and community health workers highly trained in Good Clinical Practice based on federal regulations for clinical research trials conducted all visits in the participant's preferred language (Spanish or English). A gift card incentive was provided to participants. Each participant was assigned a unique ID and his/her data was recorded in a secured database. This study was approved by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston, which is based in this region, and written informed consent was obtained from each participant.

Measures

Dietary patterns

Participants completed a dietary intake survey that assessed 'yesterday's' consumption of twenty commonly eaten foods. In accordance with the low education levels of this population, the survey was constructed from items from the 4th-grade School Physical Activity & Nutrition (SPAN) survey, a valid and reliable instrument for 4th-grade students in Texas[52,53]. The survey was tailored to include common traditional Mexican foods such as tortillas, refried beans and chorizo (a Mexican pork sausage) eaten by adults based on qualitative input from Mexican-American adult participants. An evaluation of the psychometric properties of the adult version of SPAN for Mexican-American adults (SPAN MAA) found the instrument had fair to moderate agreement with a multiple-pass 24 h dietary recall interview for males and females, indicating acceptable level of validity of the instrument.

The dietary patterns were determined through the Healthy/Unhealthy Eating Indices and were based on previous work examining factor structures using the SPAN survey[54]. Participants self-reported the number of times they ate foods listed on the index the day before. Healthy Eating Index (baked/grilled fish or poultry, beans, eggs, fruit, fruit juice, orange vegetables, other vegetables, salad, wholegrain breads and wholegrain cereals) and the Unhealthy Eating Index (baked goods, French fries/chips, fried meat, frozen desserts, red and processed meats, non-chocolate candy, regular sodas, sweetened drinks/sports

https://doi.org/10.1017/S1368980016003311 Published online by Cambridge University Press

drinks and white bread). In the later version of the survey, baked fish and baked poultry were collected separately; whereas in the early versions of the survey they were aggregated. The Healthy Eating Index score for each participant was comprised of responses to the ten items measuring healthy foods with a possible response range of 0 to 50. The Unhealthy Eating Index score for each participant was comprised of the responses to the nine items measuring unhealthy foods with a possible range of 0 to 45. These non-negative numeric scores for the Healthy and Unhealthy Eating Indices were analysed as continuous variables.

Acculturation

Studies have commonly used measures of language preference[55,56] and generational status[45] to assess acculturation. We also used these measures in the present study. The Bidimensional Acculturation Scale for Hispanics (BAS)[55] was used to measure language preference in different settings and with different people. This scale has previously been validated for Mexican Americans and used in recent studies[55,56]. The four items assessed measure preferred language with regard to: (i) reading and speaking in general; (ii) speaking at home; (iii) thinking; and (iv) speaking with friends. The response options of the scale were: (i) 'only Spanish'; (ii) 'both equally' English and Spanish; and (iii) 'only English'. The mean across the four survey items was taken. Participants with scores ≤2·50 were considered to prefer Spanish. Participants with scores between 2·50 and 3·49 were considered to be bilingual and those with scores ≥3·50 were considered to prefer English.

The second measure used to assess acculturation was generational status, which was based on nativity self-reported by participants for themselves and their parents. Nativity was categorized by first, second and third generation. Participants were categorized as first generation if the participant was not born in the USA and at least one parent was also not born in the USA. Participants who were born in the USA but had at least one parent not born in the USA were classified as second generation. Participants born in the USA with both parents born in the USA were classified as third generation. Definition of these generational categories aligns with previous studies for Mexican-American populations[45].

BMI and age

Height and weight measurements were obtained following the standard protocol for the Cameron County Hispanic Cohort described elsewhere[57]. Two measurements for weight and height were taken for each participant. Using the average of the two measurements, BMI was calculated using the formula: [weight (kg)]/[height (m)]^2. A BMI within the range of 25·0–29·9 kg/m^2 was defined as overweight and a BMI ≥30·0 kg/m^2 was defined as obese[58]. Age at visit within the range of 18 and 97 years was categorized into quartiles.

Education

Educational attainment was dichotomized as either greater than 8 years of education, or equal to or less than 8 years of education.

Diabetes status

Diabetes was directly measured using glycated Hb (Hb_{A1c}) tests and interpreted according to Cameron County Hispanic Cohort protocols[57] that are based on the 2010 American Diabetes Association definition of diabetes, which added the diagnostic tool of the Hb_{A1c} test with a reading of greater than or equal to 6·5 %[59].

Statistical analysis

Survey-weighted means and standard deviations of the number of times healthy and unhealthy items were eaten on the previous day were calculated and compared for participants across sex, age, education level, BMI, diabetes status, language preference and generation status. Data were weighted to census data and corrected for sampling bias by socio-economic status, age, sex, census tract or block, and household clustering[26]. To evaluate differences in healthy and unhealthy food patterns by language preference and generational status, multivariable mixed-effect Poisson regression models that accounted for the correlations among observations within/between multiple cluster levels were conducted while controlling for potential confounders such as BMI, age, sex, education and diabetes. The multivariable mixed-effect Poisson regression models were conducted to show an association by generation and language preference and each of the Healthy Eating Index and Unhealthy Eating Index separately after controlling for sex, age, education, BMI and diabetes status. Interaction effects with language preference were also examined that allowed for estimation of the association between language preference and food choices at each of the generation levels and sex. All analyses were performed using the statistical software package SAS version 9.3 at a statistical significance level of 0·05.

Results

Participant characteristics

Of the 1250 Mexican Americans in the sample, the majority was female (55·3 %), 48·4 % were aged 49 years or older, 72·0 % reported having completed 8 years or more of education, and almost a quarter (24·7 %) had diabetes. The majority of the sample was either overweight (35·3 %) or obese (50·4 %), reported Spanish language preference (68·0 %) and first-generation status (60·3 %; Table 1).

Effects of BMI and sex on dietary patterns

BMI was not significantly associated with the Healthy or Unhealthy Eating Index, but was related to certain healthy and unhealthy food items (Table 2). There were slight but

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Table 1 Demographics of the sample of Mexican-American adults aged 18–97 years from the Cameron County Hispanic Cohort study (*n* 1250), Texas–Mexico border region, 2008–2011

Demographic variable	*n*	Survey-weighted %
Sex		
Male	403	44·69
Female	847	55·31
Age		
≤35 years	308	31·64
36–48 years	315	19·93
49–59 years	331	21·28
≥60 years	296	27·15
Years of education		
≤8 years	435	34·80
>8 years	815	72·04
BMI		
Underweight/normal weight	169	14·32
Overweight	423	35·27
Obese	655	50·40
Diabetes		
Diabetes	295	24·68
No diabetes	933	75·32
Language preference		
Spanish	946	68·03
Bilingual	166	16·83
English	134	15·13
Generation level		
First	818	60·28
Second*	320	27·92
Third†	109	11·39
Unknown‡	3	0·42

*Eleven US-born participants who had no information on either of two parents' nativity were coded in the second generation.
†Seven non-US-born participants who had both US-born parents were coded in the third generation.
‡No information on participants' birthplace or non-US-born participants who had no information on two parents' nativity.

significant differences in the reported times that other vegetables were consumed by overweight participants compared with underweight or normal-weight and obese participants (overall $P=0·0340$). Underweight or normal-weight and overweight participants reported eating wholegrain cereals significantly more often than obese participants (overall $P=0·0281$). Also, obese participants consumed red and processed meats significantly more often (overall $P=0·0140$), while underweight or normal-weight participants consumed sweetened drinks/sports drinks significantly more often (overall $P=0·0035$).

The sex of a participant was not significantly associated with the Healthy Eating Index but was significantly associated with certain healthy foods (Table 2). Males consumed eggs ($P=0·0007$) and wholegrain breads ($P=0·0045$) more often, while females consumed salad ($P=0·0364$) and wholegrain cereal ($P=0·0013$) more often. Sex was significantly associated with the Unhealthy Eating Index ($P<0·0001$). Specifically, males consumed French fries/chips ($P=0·0047$), fried meat ($P<0·0001$), red and processed meats ($P<0·0001$), regular sodas ($P<0·0001$), sweetened drinks/sports drinks ($P=0·0004$) and white breads ($P<0·0001$) significantly more often compared with females.

Effects of acculturation on dietary patterns

Acculturation as measured by language preference and generational status was significantly associated with both Healthy and Unhealthy Eating Indices (overall $P<0·0001$ and 0·0007, respectively, for Healthy; both overall $P<0·0001$ for Unhealthy; Table 3). Participants preferring Spanish language consumed healthy foods significantly more often and unhealthy foods significantly less often than bilingual or English-preference participants. In comparison to English-preference and bilingual participants, participants preferring Spanish consumed the following foods significantly more often: beans, fruit, and whole grain breads. English-preference participants consumed other vegetables significantly more often in comparison to bilingual and Spanish-preference participants. Similarly, when looking at food items on the Unhealthy Eating Index, Spanish-preference participants consumed French fries/chips, red and processed meats, and white breads less often but regular sodas more often than English-preference and bilingual participants (all $P<0·05$).

First-generation participants consumed beans and fruit significantly more often in comparison to second- and third-generation participants. Second-generation participants consumed French fries/chips significantly more often than first- or third-generation, red and processed meats more often than first-generation, and white breads more often than first- or third-generation participants (all $P<0·05$).

Multivariable analyses

The multivariable models showed an association between acculturation (measured by language preference) and the Healthy and Unhealthy Eating Indices by different levels of generation and sex after controlling for age, education, BMI and diabetes status (Table 4). For first-generation individuals, those who were bilingual were significantly less likely to have a higher Healthy Eating Index (rate ratio (RR) = 0·79; 95 % CI 0·65, 0·97) compared with participants with a Spanish language preference. Bilingual males were significantly less likely to have a higher Healthy Eating Index (RR = 0·81; 95 % CI 0·69, 0·95) compared with male participants who preferred Spanish. Females who preferred English were significantly less likely to have a higher Healthy Eating Index (RR = 0·84; 95 % CI 0·73, 0·98) compared with female participants with a Spanish language preference. Also, participants aged over 35 years were significantly more likely to report a higher Healthy Eating Index, with participants aged 60 years or older reporting the highest likelihood (RR = 1·21; 95 % CI 1·11, 1·33) compared with participants aged less than 35 years. Individuals with more than 8 years of education were more likely to report a higher Healthy Eating Index (RR = 1·09; 95 % CI 1·02, 1·16) compared with those with fewer than 8 years of education.

In regard to the Unhealthy Eating Index, among second-generation participants, those who preferred English were

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Table 2 Dietary intake of specific foods by sex and BMI among the sample of Mexican-American adults aged 18–97 years from the Cameron County Hispanic Cohort study (*n* 1250), Texas–Mexico border region, 2008–2011

	Sex					BMI						
	Male (*n* 403)		Female (*n* 847)			Underweight or normal weight (*n* 169)		Overweight (*n* 423)		Obese (*n* 655)		
	Survey-weighted					Survey-weighted						
	Mean	SD	Mean	SD	Overall *P*	Mean	SD	Mean	SD	Mean	SD	Overall *P*
Healthy Eating Index	5·67	31·68	5·49	19·80	0·9575	6·03	26·82	5·50	24·35	5·50	23·49	0·1744
Baked/grilled/broiled/steamed chicken or fish*	0·69	8·55	0·63	5·40	0·1197	0·74	6·59	0·66	7·25	0·63	6·11	0·4681
Beans	0·56	6·82	0·48	4·33	0·3122	0·59	5·63	0·53	5·18	0·49	5·22	0·4616
Eggs†	0·88	9·98	0·59	5·89	0·0007	0·45	6·06	0·69	8·46	0·82	7·27	0·3780
Fruit	0·81	8·95	0·86	6·23	0·3049	0·77	6·56	0·82	7·13	0·86	7·45	0·0587
Fruit juice	0·44	8·11	0·33	4·07	0·1371	0·28	4·19	0·36	5·23	0·42	6·30	0·9076
Orange vegetables	0·21	4·39	0·27	3·77	0·1661	0·19	3·55	0·23	3·72	0·26	4·26	0·0920
Other vegetables	0·47	6·64	0·49	4·49	0·0929	0·50	5·74	0·46	5·50	0·50	5·01	0·0340
Salad	0·40	5·85	0·52	4·94	0·0364	0·56	6·09	0·43	4·42	0·48	5·53	0·4193
Wholegrain breads	1·90	17·65	1·56	10·70	0·0045	1·90	14·50	1·76	13·80	1·62	12·79	0·9246
Wholegrain cereals	0·22	4·93	0·37	4·35	0·0013	0·48	5·48	0·31	4·91	0·25	4·00	0·0281
Unhealthy Eating Index	5·97	33·39	3·88	18·45	<0·0001	4·39	23·96	4·73	25·60	4·99	25·90	0·9806
Baked goods	0·61	9·38	0·55	6·24	0·8434	0·51	6·35	0·59	7·31	0·59	7·71	0·2303
French fries/chips	0·55	7·47	0·41	4·79	0·0047	0·54	6·26	0·43	5·61	0·49	5·82	0·6739
Fried meat	0·49	8·70	0·23	3·80	<0·0001	0·27	4·81	0·34	6·51	0·37	5·79	0·6139
Frozen desserts	0·26	5·46	0·26	3·73	0·9167	0·19	3·41	0·27	4·63	0·27	4·40	0·0578
Red and processed meats‡	1·16	11·93	0·74	6·79	<0·0001	0·90	9·46	0·82	8·41	1·02	9·05	0·0140
Non-chocolate candy	0·26	6·93	0·14	3·16	0·6989	0·19	3·68	0·22	6·27	0·18	3·71	0·6600
Regular sodas	0·78	11·02	0·52	6·53	<0·0001	0·62	8·59	0·62	8·48	0·65	8·13	0·5958
Sweetened drinks/sports drinks	0·47	9·39	0·21	3·79	0·0004	0·36	6·31	0·45	8·11	0·23	4·53	0·0035
White breads	1·39	14·67	0·82	7·50	<0·0001	0·82	9·76	1·01	11·09	1·19	10·42	0·1327

*Baked foods were collected differently in different versions of survey: BAKEGRILL (Versions 1 and 2); BAKEFISH and BAKEPOUL (Version 3 only).
†Egg consumption data were captured only in Version 3.
‡Hamburger meat/hot dogs/chorizo/meat/bacon/ribs.

Table 3 Dietary intake of specific foods by acculturation, as measured by language preference and generational status, among the sample of Mexican-American adults aged 18–97 years from the Cameron County Hispanic Cohort study (*n* 1250), Texas–Mexico border region, 2008–2011

	Language preference							Generational status						
	Spanish (*n* 946)		Bilingual (*n* 166)		English (*n* 134)			First (*n* 818)		Second (*n* 320)		Third (*n* 109)		
	Survey-weighted							Survey-weighted						
	Mean	SD	Mean	SD	Mean	SD	Overall *P*	Mean	SD	Mean	SD	Mean	SD	Overall *P*
Healthy Eating Index	5·79	22·73	5·21	28·67	5·00	27·88	<0·0001[a,b]	5·67	23·21	5·34	26·19	5·59	26·16	0·0007[a,b]
Baked/grilled/broiled/steamed chicken or fish*	0·66	6·19	0·78	7·98	0·53	7·31	0·8445	0·66	6·16	0·66	6·88	0·64	8·55	0·9224
Beans	0·58	5·07	0·56	6·55	0·17	3·41	<0·0001[a,c]	0·55	4·90	0·48	6·06	0·47	5·36	0·0163[a,b]
Eggs†	0·73	6·92	0·61	9·57	0·81	9·12	0·7049	0·73	7·16	0·80	8·51	0·53	7·97	0·1264
Fruit	0·89	7·14	0·86	7·29	0·54	7·24	0·0428[b]	0·89	7·25	0·78	6·90	0·63	7·53	0·0029[a]
Fruit juice	0·35	4·45	0·38	6·70	0·53	10·38	0·1943	0·33	4·34	0·48	8·15	0·43	5·92	0·8781
Orange vegetables	0·22	3·74	0·26	4·11	0·33	5·27	0·3211	0·22	3·82	0·27	4·29	0·28	4·22	0·5698
Other vegetables	0·50	5·22	0·32	4·30	0·58	6·46	0·0337[b,c]	0·50	5·39	0·41	4·75	0·60	5·75	0·6080
Salad	0·49	5·02	0·33	4·56	0·53	7·30	0·3785	0·50	5·09	0·39	4·88	0·48	7·21	0·2797
Wholegrain breads	1·80	12·76	1·44	15·14	1·63	15·26	0·0003[a,b]	1·72	13·01	1·69	14·27	1·69	13·80	0·0646
Wholegrain cereals	0·33	4·35	0·30	6·01	0·20	4·08	0·9006	0·33	4·34	0·21	4·30	0·42	6·51	0·1184[c]
Unhealthy Eating Index	4·56	23·45	5·53	29·86	5·14	32·23	<0·0001[a,b,c]	4·63	24·24	5·24	28·29	4·72	26·23	<0·0001[a,b]
Baked goods	0·57	6·86	0·77	10·54	0·44	6·00	0·8203	0·54	6·27	0·75	9·74	0·39	6·78	0·1143[a]
French fries/chips	0·42	5·25	0·50	7·02	0·69	7·44	<0·0001[a]	0·42	4·99	0·62	7·41	0·46	5·87	0·0003[a]
Fried meat	0·33	5·60	0·37	6·16	0·39	7·70	0·0992	0·35	5·93	0·34	5·87	0·36	6·02	0·2657
Frozen desserts	0·27	3·99	0·26	5·12	0·20	5·74	0·2775	0·27	4·00	0·24	4·62	0·26	5·99	0·2296
Red and processed meats‡	0·84	8·08	0·97	9·84	1·28	12·18	<0·0001[a,c]	0·87	8·44	1·03	9·92	1·02	9·08	0·0002[a,b]
Non-chocolate candy	0·18	3·83	0·31	8·66	0·11	3·33	0·6765	0·20	3·93	0·12	3·22	0·38	10·33	0·4697
Regular sodas	0·64	7·64	0·69	10·98	0·55	8·91	0·0366[a]	0·66	7·66	0·64	9·78	0·50	8·26	0·3469
Sweetened drinks/sports drinks	0·32	5·95	0·37	7·65	0·32	6·48	0·3414	0·29	5·63	0·34	6·39	0·50	9·41	0·9498
White breads	0·99	9·77	1·33	12·43	1·17	13·18	<0·0001[a,b]	1·06	10·08	1·18	11·96	0·87	9·25	0·0022[a]

Pairwise comparisons with $P < 0·05$: [a]English *v.* Spanish, second *v.* first generation; [b]bilingual *v.* Spanish, third *v.* first generation; [c]English *v.* bilingual, third *v.* second generation.
*Baked foods were collected differently in different versions of survey: BAKEGRILL (Versions 1 and 2); BAKEFISH and BAKEPOUL (Version 3 only).
‡Egg consumption data were captured only in Version 3.
‡Hamburger meat/hot dogs/chorizo/meat/bacon/ribs.

Table 4 Factors associated with healthy and unhealthy food choices based on multivariable analysis among the sample of Mexican-American adults aged 18–97 years from the Cameron County Hispanic Cohort study (*n* 1250), Texas–Mexico border region, 2008–2011

	RR	95 % CI	*P*
Healthy Eating Index			
Acculturation			
Bilingual *v.* Spanish preference by generation level			
First generation	0·79	0·65, 0·97	0·0218
Second generation	0·90	0·79, 1·03	0·1259
Third generation	0·83	0·64, 1·08	0·1590
English preference *v.* Spanish preference by generation level			
First generation	0·87	0·66, 1·15	0·3189
Second generation	0·94	0·81, 1·10	0·4574
Third generation	0·83	0·65, 1·05	0·1178
English preference *v.* bilingual by generation level			
First generation	1·09	0·79, 1·52	0·5924
Second generation	1·04	0·89, 1·23	0·6067
Third generation	1·00	0·79, 1·26	0·9933
Acculturation			
Bilingual *v.* Spanish preference by sex			
Male	0·81	0·69, 0·95	0·0095
Female	0·87	0·76, 1·00	0·0519
English preference *v.* Spanish preference by sex			
Male	0·91	0·76, 1·09	0·3183
Female	0·84	0·73, 0·98	0·0293
English preference *v.* bilingual by sex			
Male	1·13	0·92, 1·39	0·2468
Female	0·97	0·81, 1·15	0·7068
Age (ref.: ≤35 years)			
36–48 years	1·14	1·05, 1·24	0·0014
49–59 years	1·13	1·04, 1·23	0·0058
≥60 years	1·21	1·11, 1·33	<0·0001
Years of education (ref.: ≤8 years)			
>8 years	1·09	1·02, 1·16	0·0163
BMI (ref.: normal)			
Obese	1·03	0·95, 1·13	0·4476
Overweight	0·98	0·90, 1·07	0·6787
Diabetes (ref.: no diabetes)			
Diabetes	0·99	0·92, 1·06	0·6965
Unhealthy Eating Index			
Acculturation			
Bilingual *v.* Spanish preference by generation level			
First generation	1·01	0·82, 1·25	0·9083
Second generation	1·07	0·93, 1·23	0·3259
Third generation	0·91	0·68, 1·23	0·5579
English preference *v.* Spanish preference by generation level			
First generation	1·31	0·99, 1·72	0·0587
Second generation	1·23	1·05, 1·45	0·0114
Third generation	1·07	0·82, 1·40	0·6244
English preference *v.* bilingual by generation level			
First generation	1·29	0·92, 1·80	0·1339
Second generation	1·15	0·98, 1·36	0·0914
Third generation	1·17	0·91, 1·49	0·2119
Acculturation			
Bilingual *v.* Spanish preference by sex			
Male	1·01	0·86, 1·19	0·8685
Female	0·98	0·84, 1·15	0·8076
English preference *v.* Spanish preference by sex			
Male	1·17	0·97, 1·41	0·1025
Female	1·23	1·05, 1·44	0·0107
English preference *v.* bilingual by sex			
Male	1·15	0·94, 1·41	0·1741
Female	1·26	1·04, 1·51	0·0159
Age (ref.: ≤35 years)			
36–48 years	0·98	0·89, 1·07	0·6161
49–59 years	0·87	0·79, 0·96	0·0040
≥60 years	0·73	0·66, 0·81	<0·0001
Years of education (ref.: ≤8 years)			
>8 years	1·01	0·93, 1·09	0·8972
BMI (ref.: normal)			
Obese	1·01	0·92, 1·11	0·8456
Overweight	1·00	0·91, 1·11	0·9451
Diabetes (ref.: no diabetes)			
Diabetes	1·02	0·95, 1·11	0·5576

RR, rate ratio; ref., reference category.

https://doi.org/10.1017/S1368980016003311 Published online by Cambridge University Press

significantly more likely (RR = 1·23; 95 % CI 1·05, 1·45) to report a higher Unhealthy Eating Index compared with participants who preferred Spanish language. Among females, those who preferred English were significantly more likely to report a higher Unhealthy Eating Index compared with females who preferred Spanish (RR = 1·23; 95 % CI 1·05, 1·44) or who were bilingual (RR = 1·26; 95 % CI 1·04, 1·51). Participants who reported a higher Unhealthy Eating Index were less likely to be aged 49–59 years (RR = 0·87; 95 % CI 0·79, 0·96) or 60 years or older (RR = 0·73; 95 % CI 0·66, 0·81) compared with those who were 35 years old or younger.

Discussion

The present study shows that acculturation, sex and age are significantly related to both healthy and unhealthy food choices. Our findings indicate that Mexican Americans who are less acculturated with the US culture (as measured via language preference and generation status) were more likely to report consuming food items on the Healthy Eating Index and not on the Unhealthy Eating Index. Other studies have found similar results where individuals who are less acculturated to the USA are more likely to prepare and eat healthier foods[46–51]. Our study also extended previous research by examining how generational status and language preference, and sex and language preference interact with regard to healthy and unhealthy dietary patterns. For healthy food patterns, we found across multiple generational statuses and language preferences that Spanish-speaking individuals were more likely to report consuming foods on the Healthy Eating Index compared with bilingual or English-preference speakers and higher consumption in the Spanish preference group compared with bilingual was statistically significant in first-generation individuals. We also found that men who preferred Spanish language *v.* those with bilingual language preference and women who preferred Spanish language *v.* those with English language preference reported consuming foods on the Healthy Eating Index. For the unhealthy food pattern, we found across multiple generational statuses and language preferences that there was a tendency of higher consumption of unhealthy foods in the English preference group compared with bilingual or Spanish language preferences, but only second-generation participants who preferred English were significantly more likely to consume foods on the Unhealthy Eating Index than those with Spanish language preference. When we examined the interaction of language preference and sex, we found that females who preferred English compared with those who were bilingual or preferred Spanish were statistically more likely to report consuming foods on the Unhealthy Eating Index. While additional studies have examined sex differences regarding food consumption[60,61], our study is one of the first to report these differences among Mexican Americans. The specificity we provide regarding language preference, generational status and sex by reported food pattern among Mexican Americans sheds further light on the acculturation process for those of Mexican descent to the US culture and its negative influence on healthy and unhealthy food choices.

As such, there is a need for future research to more fully understand the influence of gender roles in the acculturation process and dietary choices as our study focused on quantitative associations only. Healthy, Spanish-speaking, first-generation individuals demonstrated higher Healthy Eating Index scores. Males who preferred Spanish had a higher Healthy Eating Index compared with bilingual males. Females who preferred Spanish had a higher Healthy Eating Index than females who preferred English. Our findings indicate that women and men who prefer Spanish or who report being first generation report eating healthier food items. Qualitatively it may be worth exploring if meals such as breakfast and dinner are being prepared by women and are healthier than those prepared by their more acculturated counterparts. Also, it could be that lunch and snacks consumed by men are purchased outside the home since only females who are bilingual or prefer Spanish reported avoiding unhealthy foods in our study. Exploring to what extent traditional Mexican gender roles of '*marianismo*' and '*machismo*' may influence the dietary patterns found in the current study seems warranted. Future intervention programmes may need to account for gender roles by acculturation level when creating and improving nutrition programmes for Mexican-American populations.

Age was significantly associated with dietary patterns, where older individuals demonstrated a greater likelihood of consuming foods on the Healthy Eating Index and of not consuming foods on the Unhealthy Eating Index. Despite our hypothesis regarding an association of high BMI and dietary patterns, BMI and diabetes status were not significantly associated with consuming foods on the Healthy Eating Index or Unhealthy Eating Index.

Overall, our findings suggest the need for intervention programmes that take into account language preferences, generational status, age and sex when working with similar Mexican-American sub-populations regardless of BMI levels or diabetes status. Language preference, for example, could be fittingly addressed by practitioners targeting nutrition education with programmes conducted by Spanish-speaking and English-speaking community health workers. Other studies have achieved measurable success in improving dietary behaviours of Mexican Americans through these types of intervention[62–67]. The differences in eating patterns by generational status found in the present study also suggest a need for more research on interventions tailored to meet the needs of populations in different stages of the acculturation process. Some interventions, for example, have successfully promoted traditional Mexican foods, including beans, fruit and wholegrain breads, as a way to increase healthy

food choices[66,67] – a method that could benefit this study population and other similar Mexican-American populations experiencing acculturation. At the same time, any interventions promoting the traditional Mexican diet must recognize that today's Mexican diet is also undergoing negative changes[68] and not all traditional Mexican foods contain healthy ingredients[48]. Thus, any suggestions to return to the traditional Mexican diet should ensure that health promotion messages clearly define foods included in the diet.

Strengths and limitations

There are limitations to consider regarding the findings of the current study. These data were collected through self-report and therefore are subject to recall bias. The cross-sectional design limits the breadth of the study findings to one point in time and causality cannot be implied. On the other hand, the study includes a large and representative sample size, which increases the confidence of the study results. Brief FFQ have been shown to be good measures of food intake in research among Mexican Americans[69–71]; however, healthy and unhealthy eating indices vary and often include more food items than the indices used herein.

The BAS was used to measure language preference. Although the reliability for the scale was not assessed and the acculturation measure used in the current study was originally tested years ago, the concepts assessed by the tool remain relevant and aligned to more recently developed acculturation tools[42] as they all measure use of language in various domains (media, health status and cultural awareness) and with different types of people[72]. It is likely that some foods commonly consumed along the US–Mexico border were not included in the survey. The results therefore are limited to the dietary patterns consisting of the culturally tailored and commonly eaten food categories in the Texas–Mexico border region and aligned with the most recent dietary guidelines measured in the SPAN MAA. The latter survey is also limited in examining quantity of consumption of food items listed on each index. This may be a reason why BMI and diabetes status were not significantly associated with healthy and unhealthy food indices.

New contributions to the literature

Study results magnify the complexity of modifying nutritional behaviours for the Mexican-American population's transition to the US culture. The study suggests a need for interventions to effectively impact dietary patterns of Mexican Americans through customized nutrition education in light of language preference, generational status, age and sex.

Acknowledgements

Acknowledgements: The authors thank the cohort team, particularly Rocío Uribe and her team, who recruited and documented the participants; and the intervention team who contributed to the data collection and refining of the SPAN MAA. They also thank Israel Hernández and his team for data management; Marcela Morris and other laboratory staff for their contributions; Christina Villarreal and Norma Pérez-Olazarán for administrative support; and the Valley Baptist Medical Center in Brownsville for housing our Clinical Research Unit. The authors also would like to thank the participants for their willingness to graciously give of their time for this research endeavour. *Financial support:* This work was supported by funding from the National Center on Minority Health and Health Disparities (NCMHD); the Michael and Susan Dell Center for Healthy Living at the University of Texas School of Public Health; and the Center for Clinical and Translational Sciences (CCTS) (grant number MD000170 P20), which is funded mainly by the National Institutes of Health (NIH) Centers for Translational Science Award (NIH CTSA) (grant number UL1 RR024148) from the National Center for Research Resources (NCRR). NCMHD, CCTS and NCRR had no role in the design, analysis or writing of this article. *Conflict of interest:* None. *Authorship:* B.R., M.L., R.J. and A.E. conceptualized the study and formulated the research questions. B.R., R.J. and A.E. directed data collection. M.L. conducted statistical analyses and drafted the analysis section. B.R. drafted the manuscript. M.L., S.F., R.J., A.E. and M.V. assisted in drafting the manuscript. All authors read and approved the final manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston. Written informed consent was obtained from all subjects/participants.

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