Published in final edited form as:
Int J Public Health. 2013 August ; 58(4): 573–581. doi:10.1007/s00038-012-0414-5.

Secular trends in the association between nativity/length of US residence with body mass index and waist circumference among Mexican-Americans, 1988–2008

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Abstract

Objectives—We investigated whether associations between nativity/length of US residence and body mass index (BMI) and waist circumference (WC) varied over the past two decades.

Methods—Mexican-Americans aged 20–64 years from the National Health and Nutrition Survey (NHANES) III (1988–1994), and NHANES (1999–2008). Sex-stratified multivariable linear regression models further adjusted for age, education, and NHANES period.

Results—We found no evidence of secular variation in the nativity/length of US residence gradient for men or women. Foreign-born Mexican-Americans, irrespective of residence length, had lower mean BMI and WC than their US-born counterparts. However among women, education modified secular trends in nativity differentials: notably, in less-educated women, nativity gradients widened over time due to alarming increases in BMI among the US-born and little increase in the foreign-born.

Conclusions—Associations between nativity/length of US residence and BMI/WC did not vary over this 20-year period, but we noted important modifications by education in women. Understanding these trends is important for identifying vulnerable subpopulations among Mexican-Americans and for the development of effective health promotion strategies in this fast-growing segment of the population.

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Keywords

Obesity; Trends; Mexican; Immigrants; Socioeconomic status

Introduction

The US has experienced alarming growth in obesity in recent decades (Flegal 2005). Although most socio-demographic groups have been affected, race/ethnic disparities are pronounced (Wang and Beydoun 2007). Obesity prevalence among Hispanics, particularly of Mexican origin, is considerably higher than among whites (Flegal et al. 2010).

There is evidence that the disparity in prevalence between Mexican-Americans and whites masks important heterogeneity. Foreign-born Mexican-Americans are characterized by a lower body mass index (BMI) compared to the US-born despite having lower socioeconomic status (SES) (Barcenas et al. 2007; Khan et al. 1997; Sundquist and Winkleby 2000). There is also important heterogeneity within foreign-born groups; individuals residing in the US for a longer period of time tend to be more obese, possibly reflecting the impact of behavioral change and increased exposure to obesogenic environments (Goel et al. 2004; Oza-Frank and Cunningham 2009) However, previous studies examining weight differentials in nativity and length of residence have relied on single cross-sections. Moreover, none has examined whether these relationships have changed over time. A more complete understanding of this within-group heterogeneity and of changes in within-group differences over time is critical to identify vulnerable sub-populations among Mexican-Americans, the largest immigrant group and Hispanic subgroup in the US (Dockterman and Velasco 2010; Martin and Midgley 2006).

There are several reasons why the relationship between nativity/length of US residence and weight may be changing over the past two decades. First, obesity rates in Mexico are rapidly increasing; among more recent immigrants, the obesity epidemic in their home communities has become comparable in scale to that of the US communities to which they are migrating (Popkin and Gordon-Larsen 2004) According to a highly publicized report published by the Organization for Economic Co-operation and Development in 2010, Mexico’s obesity prevalence is now only marginally lower and second in the world to that of the US. By another measure, Mexico’s overweight prevalence ranks as the highest in the world (70 vs. 68 % in the US) (Sassi 2010). The rapid rise in obesity in Mexico is also evident when compared against patterns among Mexican-Americans. In 1988, obesity prevalence among women in Mexico was 9 %—considerably lower than the 35 % prevalence among Mexican-American women (Flegal et al. 2004; Rivera et al. 2006); but by 2006, national estimates among Mexican women reached 37 % which was only slightly lower than the 42 % prevalence among Mexican-American women (Barquera et al. 2009; Flegal et al. 2010). These patterns suggest that more contemporary immigrants may be entering the US with higher BMI levels than immigrants from earlier cohorts. If new immigrant BMI estimates are also rising at a faster pace than those among US residents, this could result smaller weight differentials by nativity and length of residence in more recent times. If foreign-birth no longer exerts the health ‘protection’ implied by past patterns, this will have implications for the targeting of public health interventions.

Another factor that may underlie secular variation of weight differentials by nativity/length of US residence is the changing nature of Mexican migration to the US. Research shows that since the late 1990s, migration has shifted away from traditional origin regions in the Western and Central parts of Mexico to poorer areas in the south (Riosmena and Massey 2012). Although the southern states of Mexico are characterized by lower obesity than other parts of the country, it is these poorer areas that have seen the greatest increases in obesity over the past decade (Barquera et al. 2009). Over this timeframe, Mexican migration has also shifted to new destination areas in the US like the South and away from traditional receiving states like California (Riosmena and Massey 2012). Migration to new areas previously unaccustomed to immigrants may result in increased marginalization with implications for the acculturation process and its association with weight over time.

Using nationally representative data on Mexican-American adults, we examined whether associations between nativity/length of US residence and BMI and waist circumference (WC) varied over a period of 20 years. We also investigated whether secular trends in these associations varied by education. Recognition of these patterns and the processes that underlie them is fundamental to understanding the causes of the obesity epidemic in Mexican-Americans and to the development of more effective strategies for prevention.

Methods

Data came from successive waves of the third National Health and Nutrition Examination Survey (NHANES) III (1988–1994), and the continuous NHANES (1999–2008). NHANES is a series of cross-sectional nationally representative health examination surveys beginning in 1960. In each survey, a nationally representative sample of the US civilian non-institutionalized population was selected using a complex, stratified multi-stage probability cluster sampling design (National Health and Nutrition Examination Survey 2010). Oversampling of Mexican-Americans did not begin until NHANES III precluding use of earlier surveys. NHANES III was conducted between 1988 and 1994, and was designed so that the entire 6 year was a national probability sample. In 1999, NHANES became a continuous survey, in which ~5,000 individuals of all ages completed the health examination component of the survey each year. The continuous surveys, a series of repeated cross-sections, are available in 2-year blocks (e.g., 1999–2000–2001–2002–2003–2004, etc.). There were two phases of data collection: in the first phase, researchers collected information from household interviews on demographics, socioeconomic indicators, past medical history, and health behaviors. In the second phase, participants were administered a physical examination in a mobile examination center.

To achieve sufficient sample sizes, we pooled NHANES data to represent three time points: 1988–1994 (NHANES III), 1999–2004 (continuous NHANES), and 2005–2008 (continuous NHANES). We restricted the sample to adult, non-pregnant women and men aged 20–64 who self-identified as Mexican/Mexican-American. The sample was limited to adults < 64 years to avoid selection problems that may arise from morbidity/mortality associated with older age, and to allow for a more interpretable examination of BMI differences that are less likely to be influenced by age-related loss of body mass (House et al. 1990; Seidell and Visscher 2000). Of the 4,614 men (1988–1994: $n = 1,898$; 1999–2004: $n = 1,674$; 2005–2008: $n = 1,042$) and 4,199 women (1988–1994: $n = 1,795$; 1999–2004: $n = 1,458$; 2005–2008: $n = 946$) meeting our inclusion criteria, we further excluded individuals with missing information on BMI and other key covariates of interest (men: 8.2 % missing; women: 6.8 % missing), yielding a final sample of 4,235 men and 3,914 women for analyses examining BMI. Waist circumference models included a sub-sample of 4,129 men and 3,808 women among whom this information was available.

Height (m), weight (kg), and waist circumference (cm) were measured via physical examination. Body mass index (BMI) (kg/m^2) and waist circumference were examined as separate outcomes and as continuous variables. For descriptive purposes, participants were also classified based on the World Health Organization's criteria for abdominal obesity (men: ≥102 cm; women: ≥88 cm) (Alberti and Zimmet 1998). Obesity prevalence (BMI ≥

30 kg/m^2) was also modeled. Nativity (US vs. foreign birth), years lived in the US among the foreign-born, age, sex, and education (less than high school education, completed high school, and more than high school) were self-reported during the household interview. We created a single three-level variable to examine nativity and length of US residence together: US-born (referent), <10 years in the US, ≥10 years in the US.

Statistical analysis

Results were stratified by sex. Appropriate sampling weights were incorporated to produce national population estimates for Mexican-Americans for each calendar period. Sampling weights accounted for unequal probabilities of selection, non-response, and non-coverage. All analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA) and SUDAAN version 10.01 (Research Triangle International, Research Triangle Park, NC, USA) with Taylor series linearization methods to adjust for the complex survey design. Age-adjusted means (BMI and WC) and prevalence (obesity) were first calculated and plotted for each level of the nativity/length of US residence variable both within and across survey periods. For reference, estimates for whites were also plotted. To facilitate comparisons, estimates were age-adjusted by the direct method to the 2000 US standard population (Klein and Schoenborn 2001). Differences across nativity categories, length of US residence and survey years were evaluated using the t statistic, and a p value of <0.05 was considered statistically significant. Multivariable linear regression was used to separately model associations between nativity/length of US residence and continuous measures of BMI and WC among Mexican-Americans, controlling for age and NHANES survey period [1988–1994 (ref), 1999–2004, 2005–2008]. An age-squared term was retained in models in which age had a non-linear relationship with BMI and WC (all except female WC models). An age-by-period interaction was also included since the association between age and all anthropometric measures was not constant over time. Subsequent models controlled for education. To investigate whether the relationship between nativity/length of US residence and BMI/WC varied with time, models included an interaction between the nativity/length of residence variable and NHANES period. We also considered whether secular trends in the association between nativity/length of residence and BMI/WC differed by education. Multivariable logistic regression was similarly used to estimate odds ratios for obesity; however, since results were similar to those obtained with BMI, results are not shown.

Results

Across all time periods, foreign-born Mexican men and women were more likely than US-born Mexicans to have less than a high school education (Table 1). However, the educational distribution among all Mexican-Americans shifted toward higher educational attainment over time. Among men, the foreign-born consistently had a lower mean BMI and WC, and a lower prevalence of obesity and high-risk WC than the US-born. In contrast, among women, except for mean WC in 2005–2008 which was lower in foreign than in the US-born, there were no statistically significant differences by nativity for other years or other anthropometric measures.

Among men, BMI, WC, obesity, and high-risk WC were higher in 2005–2008 than in 1988–1994, regardless of nativity, though the increase in high-risk WC among the foreign-born was not statistically significant. Among foreign-born women, estimates for all anthropometric measures were higher in 2005–2008 than in 1988–1994, but only the difference in WC was statistically significant. Among US-born women, all anthropometric measures, except BMI, were significantly higher over time.

Figure 1a–f shows age-adjusted mean BMI, mean WC, and obesity prevalence across NHANES survey periods by nativity and length of US residence among Mexican-Americans and whites for men and women. Among men, US-born Mexican-Americans had the highest BMI, whereas Mexican immigrants in the US <10 years had the lowest BMI (Fig. 1a). Immigrants in the US ≥10 years and whites had intermediate and similar BMI levels. These patterns generally held across time and were also present for WC (Fig. 1b) and obesity prevalence (Fig. 1c).

In contrast to the patterns among men, all Mexican-American women, regardless of nativity and length of residence, had higher BMI than white women (Fig. 1d). In general, there was little difference in BMI among the three Mexican-American groups. Patterns were similar for WC (Fig. 1e) and obesity prevalence (Fig. 1f).

Table 2 presents adjusted mean differences in BMI and WC by nativity/length of US residence by period (top panel), and mean differences in BMI and WC across time periods by nativity/length of US residence (bottom panel) among Mexican-Americans. Estimates were derived from a model including nativity/length of US residence, age, age^2, NHANES survey period, and interactions between age and period, and between nativity/length of US residence and period (Model 1). Age was mean-centered to the gender-specific sample mean (men: age 35; women: age 37). Among men, Model 1 confirmed findings illustrated in Fig. 1a, b. All men experienced increases in BMI and WC over time, although changes were of a smaller magnitude and not statistically significant among immigrants in the US < 10 years (Model 1, bottom panel). However, there was no evidence of secular variation in the association between nativity/length of US residence and BMI or WC [p-interaction = 0.3 (BMI model); $p = 0.5$ (WC model)]. Adjusting for education did not appreciably alter estimates (Model 2).

Among women, age-adjusted models confirmed patterns from Fig. 1d, e. BMI and WC increased over time in all groups though BMI increases were small and less likely to be statistically significant than WC increases (Model 1, bottom panel). Mean BMI and WC did not differ by nativity or length of residence and this pattern did not vary over time [Model 1; p-interaction = 0.9 (BMI model); $p = 0.9$ (WC model)]. However, after adjusting for education, foreign-born women, regardless of length of residence, had a lower mean BMI and WC than US-born women, but there was still no evidence of any time variation in this pattern (Model 2).

In women, there was modification of these secular trends by education. Since trajectories were similar among individuals who completed high school and those with more than high school, we collapsed this category into ‘high school or more’ to ease interpretation and improve stability of estimates. Among Mexican-American women with less than high school education, BMI differences by nativity and length of residence became magnified over time: in 1988–1994 there was little difference in BMI across the three groups, but by 2005–2008, the US-born had a considerably higher BMI than either of the foreign-born groups (Fig. 2). This gap was attributable to large increases in BMI among US-born women with less than high school education, and little increase in BMI over time among similarly educated foreign-born women. Among women with high school or more education, the US-born had a higher BMI than both foreign-born groups in 1988–1994, but by 2005–2008, nativity differences were minimized due to little change in BMI among the US-born paired with marked increases in BMI over time among both foreign-born groups (Fig. 2). Similar findings were observed for WC [3-way interaction between nativity/length of US residence × education × survey period: p (BMI model) = 0.0114; p (WC model) = 0.05].

Discussion

Using data from nationally representative samples of Mexican-Americans, we found that among men, foreign birth, regardless of length of residence, was associated with lower BMI and WC. In addition, immigrants living in the US longer had higher BMI/WC than more recent arrivals. Foreign birth was also associated with lower BMI and WC in women but this finding was only evident after adjusting for education. Anthropometry gradients by length of residence were also less apparent in women than men. There was no evidence that the associations between nativity/length of US residence with BMI/WC varied over the 20 years spanning 1988–2008 regardless of sex.

The nativity and length of residence gradients we report, particularly in men, are consistent with patterns described in the literature (Abraido-Lanza et al. 2005; Akresh 2008; Antecol and Bedard 2006; Barcenas et al. 2007; Kaushal 2009; Sanchez-Vaznaugh et al. 2008; Sundquist and Winkleby 2000). BMI and WC were highest among the US-born and lowest among the most recent immigrants. Explanations for these patterns have focused on selective migration and protective cultural characteristics among newer immigrants. Migrants are thought to be healthier relative to their native populations, and are thus selected for their ability to cope with the rigors of migration (Akresh and Frank 2008). To explain the later decline associated with longer US residence, hypotheses have focused on acculturation, a process whereby immigrants progressively adopt the detrimental behaviors and norms of their new culture, such as poorer diet and sedentary lifestyles (Abraido-Lanza et al. 2005; Lara et al. 2005). Some studies have also reported a stronger association between longer length of residence and weight among immigrant women relative to patterns among men (Antecol and Bedard 2006; Barcenas et al. 2007; Kaplan et al. 2004; Oza-Frank and Cunningham 2009; Sanchez-Vaznaugh et al. 2008). In contrast, we found these associations to be smaller in magnitude in women than in men. Reasons for this discrepancy are unclear however results from previous studies applied more to the broader Hispanic population in the US without distinction by country of origin (Antecol and Bedard 2006; Kaplan et al. 2004; Sanchez-Vaznaugh et al. 2008), or were specific to a more localized community of Mexican-Americans (Barcenas et al. 2007).

We found no evidence of secular variation in the association between nativity/length of US residence and BMI or WC, regardless of sex. In the context of Mexico's emerging obesity epidemic, we anticipated some narrowing of the nativity/length of US residence gradient over time. However, we observed no such pattern. Disparities in BMI or WC between foreign-born and US-born persons may be related to differential exposure to obesogenic environments and associated behavioral consequences. Alternatively they could reflect selection factors by which immigrants are a healthier subset of the population from which they migrate. The extent to which Mexican immigrants are positively selected on health is unclear, but one study that compared the weight of Mexican migrants to non-migrants demonstrated a lower prevalence of overweight among migrants (Rubalcava et al. 2008). If selection factors are responsible for the stable nativity differences we observed, they must be operating similarly over time despite a background of rising obesity in Mexico.

Our results suggested complicated interactions over time among nativity, sex, and education. Education was more strongly associated with BMI and WC in women than in men, and functioned as a negative confounder of the association of foreign birth with anthropometrics. In addition, there was evidence that education modified the association between nativity and anthropometrics over time. Among women, we observed a widening of the nativity gradient in BMI among the less educated, driven by alarming BMI increases among the US-born. In contrast, among women with high school or more education, the nativity gradient narrowed over time as a function of BMI increases among the foreign-born and little BMI change in the US-born. These results highlight differences in the socioeconomic patterning of obesity that appear to differ by nativity: among less-educated women, BMI increased more rapidly among in the US-born than the foreign-born, while the opposite was true in the more educated. Although SES gradients in health among US Hispanics are reportedly weak (Boykin et al. 2011; Goldman et al. 2006; Khan et al. 1997), these findings point to the emergence of an SES gradient, especially among US-born Mexican-American women. They also underscore the importance of simultaneously accounting for the joint influence of nativity, SES, and time to better understand health patterns among Mexican-Americans.

Our study had several strengths. First, we used large, nationally representative datasets that over-sampled Mexican-Americans over a large time span. Second, use of clinically measured anthropometric indicators mitigates problems with validity and reliability inherent in self-reported measures. Third, unlike previous studies that explored anthropometric trends among Mexican-Americans as a single group (Flegal et al. 2004; Ogden et al. 2006), or that restricted examination of nativity differentials to a single time point (Barcenas et al. 2007; Khan et al. 1997; Sundquist and Winkleby 2000), we were able to investigate how weight-related patterns by nativity and length of residence may have changed over time within the largest US Hispanic subgroup.

This work also had some limitations. Although NHANES data on Mexican-Americans is intended to be nationally representative, the extent to which undocumented individuals were captured is unclear. The undocumented are estimated to constitute more than half of the Mexican immigrant population in the US (Pew Hispanic Center 2011). In general, data among newer immigrants may not be adequately representative of all new Mexican immigrants to the US Other data sources may be necessary to better quantify health patterns for newer arrivals.

Reliance on repeated, cross-sectional data is also a limitation, although the NHANES are arguably one of the most important data sources for reporting US obesity trends. Moreover, national, longitudinal samples of Hispanics are limited. We documented trends in anthropometry, but these repeated cross-sectional samples may be composed of individuals different on several unmeasured characteristics. Circular migration is not uncommon, particularly among Mexican men (Durand et al. 2001), which complicates findings based on length of residence. Without the ability to follow the same individuals over time, we cannot ascertain, for example, the extent to which the higher weight among long-term immigrants is a reflection of greater return migration of healthier individuals. Studies documenting migration patterns of Mexicans to the US also reveal a greater likelihood of return migration in the wake of enactment of immigration policies aimed at legalization of long-term immigrants. After the passage of the Immigration and Control of 1986, for example, return migration rates increased dramatically (Durand et al. 2001), possibly biasing findings among long-term immigrants that remained in the US. If immigrants more physically capable of return travel are not represented in estimates of long-term immigrants, we may falsely attribute a decline in health among immigrants that remain in the US to their greater exposure to US society. Analogously, rather than operating as a risk factor for weight gain, longer length of residence may instead be a reflection of who remains in the US over the long-term. Additional research on migratory patterns and future studies that integrate other measures of exposure to US society may help shed light on the dynamics underlying the patterns we report.

Conclusions

We contribute to previous research on weight patterning in Mexican-Americans by examining whether the association between nativity/length of US residence and BMI/WC has changed over time. Our findings illustrate the ways in which the impact of migration on

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health cannot be understood in isolation from the roles of gender, SES, and time. Although overall nativity/length of residence gradients in weight appeared stable over time, we noted an alarming rise in BMI among less-educated, US-born Mexican-American women—a finding that is all the more notable in light of the weak SES gradients in health that are often reported in studies of US Hispanics.

Changes to US immigration policy and other economic and social factors that motivate migration will likely continue to play an important role in shaping the health profile of immigrants in the future. Continued monitoring of these trends in Mexican-Americans will be essential to the development of more effective strategies for prevention for this fast-growing segment of the US population.

Acknowledgments

This work was supported by the National Heart, Lung, and Blood Institute (grants R01HL07175905A1S1 and R01HL071759), and by the Michigan Center for Integrative Approaches to Health Disparities (P60 MD002249) funded by the National Institute on Minority Health and Health Disparities.

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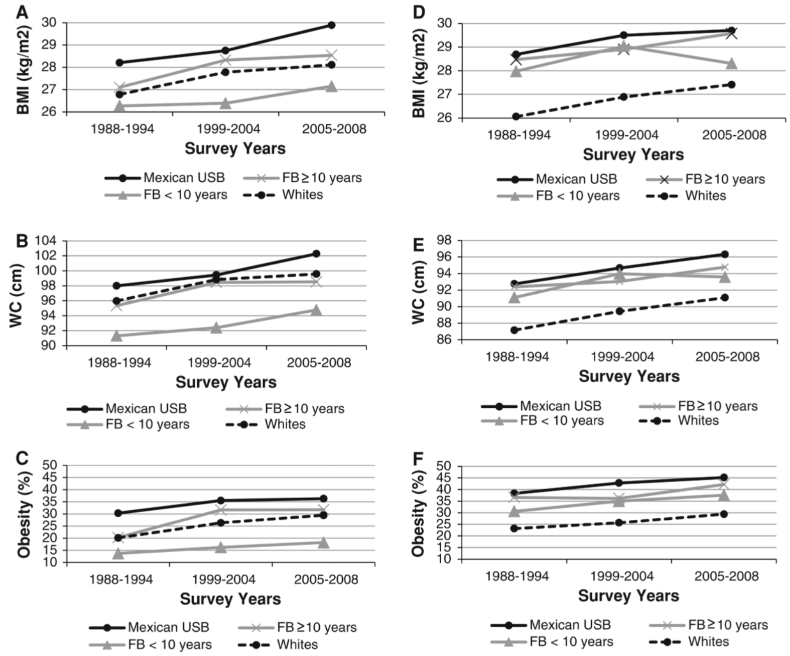

Fig. 1.

Age-adjusted body mass index (BMI), waist circumference (WC), and obesity prevalence for Mexican-American foreign-born (FB) by length of US residence (<10 years, ≥10 years) and US-born (USB) men (**a**–**c**) and women (**d**–**f**) by National Health and Nutrition Examination Survey (NHANES) years. Estimates for whites presented for reference. Age-adjusted by the direct method to the year 2000 US Census population using age groups 20–34, 35–44, and 45–64. United States National Health and Nutrition Examination Surveys (NHANES), 1988–2008

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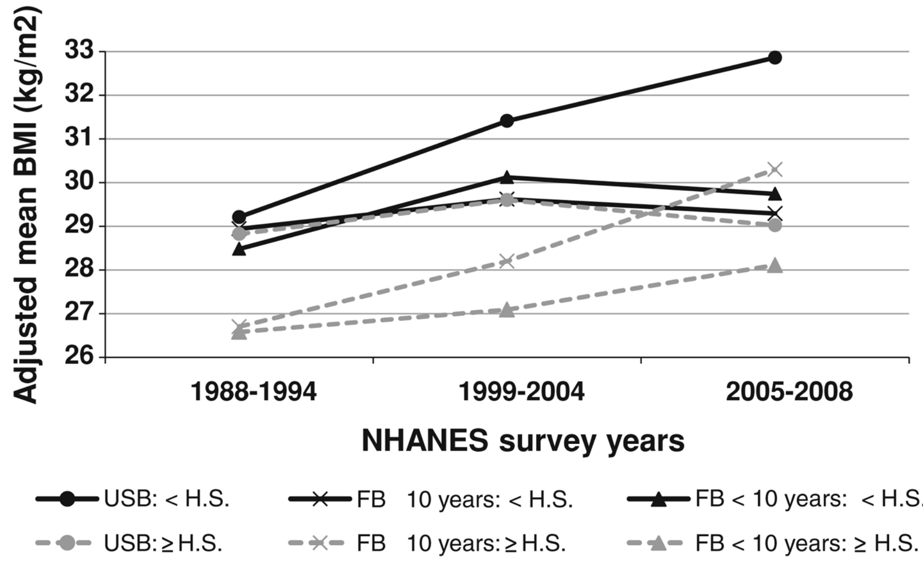

Fig. 2.

Adjusted mean body mass index (BMI) by nativity/length of US residence among Mexican-American women by level of educational attainment across National Health and Nutrition Examination Survey (NHANES) years. *USB* US-born, *FB* foreign-born, *HS* high school. Model adjusted for nativity/length of US residence, age, age^2, survey period, education, nativity/length of US residence × survey period, age × period, nativity/length of US residence × education, education × period, and nativity/length of US residence × education × period. Estimates shown were calculated to correspond to the mean age of the female sample (age 36). United States National Health and Nutrition Examination Surveys (NHANES), 1988–2008

Table 1

Sample Characteristics by Nativity and by National Health and Nutrition Examination Survey (NHANES) period, Mexican-American women and men, aged 20–64 years

	NHANES III: 1988–1994 (*n* = 3,175)				Continuous NHANES							
					1999–2004 (*n* = 3,037)				2005–2008 (*n* = 1,937)			
	Women (*n* = 1,571)		Men (*n* = 1,604)		Women (*n* = 1,420)		Men (*n* = 1,617)		Women (*n* = 923)		Men (*n* = 1,014)	
	US born	Foreign born	US born	Foreign born	US born	Foreign born	US born	Foreign born	US born	Foreign born	US born	Foreign born
N[a]	908	663	821	783	693	727	707	910	443	480	385	629
Mean age (years)	37.6	35.2[b]	37.2	32.5[b]	35.3	36	35.8	34.5	37.1	37.7	35.3	35
Education (%)												
Less than high school	34.2	77.1[b]	33.6	76.3[b]	22.2	62.3[b]	25.2	63.4[b]	20.4	60[b]	20.2	67.4[b]
Completed high school	39.9	13.1	34.4	13.3	25.9	15.7	26.4	19.4	23.1	16.8	25.3	18.2
More than high school	25.9	9.8	32	10.4	51.9	22	48.4	17.2	56.6	23.2	54.5	14.3
Years in US (among foreign born) (%)												
<10 years	–	45.2	–	48.3	–	41.3	–	43.7	–	40	–	46.7
≥10 years	–	54.8	–	51.7	–	58.7	–	56.3	–	60	–	53.3
Mean body mass index (kg/m^2)[e]	28.7	28.3	28.2	26.7[b]	29.5	29	28.8	27.7[c]	29.7	29.2	29.9[d]	27.9[b,d]
Obese (%)[e]	38.3	34.6	30.3	18[b]	42.8	35.6	35.5	25.3[c]	45.2[d]	41.4	36.3[d]	25[c,d]
N[f]	874	637	798	755	683	714	699	893	435	465	378	606
Mean waist circumference (cm)[e]	92.8	91.7	98	93.6[b]	94.7	93.3	99.4	96.3[c]	96.3[d]	94.5[c,d]	102.3[d]	96.8[b,d]
High-risk waist circumference (%) (men: ≥102 cm; women: ≥88 cm)[e]	62.4	59.8	34.3	22[b]	64.9	62.7	42.5	28.4[c]	64[d]	67.3	40.1[d]	27[b]

[a] Number of individuals with complete information on body mass index, nativity, length of US residence, and education

[b] $p \leq 0.0001$,

[c] $p < 0.05$: comparing foreign-born to US-born within survey period and by gender

[d] $p < 0.05$; comparing respective nativity estimates in 2005–2008 to estimates in 1988–1994

[e]Estimates age-adjusted by the direct method to the year 2000 Census population using the age groups 20–34, 35–44, and 45–64

[f]Number of individuals with complete information on waist circumference, nativity, length of US residence, and education

Table 2

Adjusted mean differences in body mass index (BMI) and waist circumference (WC) by nativity/length of US residence and National Health and Nutrition Examination Survey (NHANES) period, Mexican-Americans

	Men				Women			
	BMI		WC		BMI		WC[a]	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Mean difference by nativity/length of US residence								
1988–1994								
US born	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Foreign born: ≥10 years	−1.30 (0.31)[b]	−1.33 (0.33)[b]	−3.01 (0.79)[b]	−3.39 (0.83)[b]	−0.57 (0.57)	−1.18 (0.61)	−0.88 (1.09)	−2.02 (1.16)
Foreign born: <10 years	−1.97 (0.28)[b]	−2.00 (0.29)[b]	−6.18 (0.74)[b]	−6.59 (0.76)[b]	−0.75 (0.39)	−1.45 (0.44)[b]	−1.59 (0.83)	−2.89 (0.90)[b]
1999–2004								
US born	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Foreign born: ≥10 years	−0.54 (0.64)	−0.61 (0.63)	−1.31 (1.60)	−1.84 (1.63)	−0.94 (0.59)	−1.60 (0.54)[b]	−2.39 (1.52)	−3.69 (1.33)[b]
Foreign born: <10 years	−1.92 (0.63)[b]	−2.08 (0.65)[b]	−5.89 (1.77)[b]	−6.63 (1.84)[b]	−0.90 (0.90)	−1.75 (0.91)	−1.94 (1.47)	−3.62 (1.49)[c]
2005–2008								
US born	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Foreign born: ≥10 years	−1.48 (0.49)[b]	−1.65 (0.53)[b]	−4.32 (1.29)[b]	−5.13 (1.34)[b]	−0.20 (0.57)	−1.03 (0.50)[c]	−1.84 (1.24)	−3.49 (1.12)[b]
Foreign born: <10 years	−3.19 (0.63)[b]	−3.36 (0.64)[b]	−8.92 (1.80)[b]	−9.81 (1.80)[b]	−0.80 (0.46)	−1.48 (0.51)[b]	−1.79 (1.09)	−3.12 (1.30)[c]
Mean difference across time period								
US born								
1988–1994	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1999–2004	0.55 (0.62)	0.64 (0.61)	1.87 (1.56)	2.18 (1.53)	0.92 (0.57)	1.29 (0.57)[b]	2.45 (1.40)	3.25 (1.34)[c]
2005–2008	2.06 (0.59)[b]	2.22 (0.59)[b]	5.93 (1.59)[b]	6.51 (1.60)[b]	0.78 (0.64)	1.20 (0.63)	3.71 (1.24)[b]	4.59 (1.24)[b]
Foreign born: ≥10 years								
1988–1994	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1999–2004	1.34 (0.34)[b]	1.36 (0.34)[b]	3.57 (0.88)[b]	3.73 (0.89)[b]	0.55 (0.61)	0.87 (0.63)	0.94 (1.38)	1.57 (1.42)
2005–2008	1.88 (0.48)[b]	1.90 (0.48)[b]	4.62 (1.35)[b]	4.76 (1.38)[b]	1.15 (0.63)	1.35 (0.63)[b]	2.74 (1.37)[c]	3.12 (1.39)[c]
Foreign born: <10 years								
1988–1994	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

	Men				Women			
	BMI		WC		BMI		WC[a]	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
1999–2004	0.59 (0.52)	0.56 (0.52)	2.17 (1.45)	2.14 (1.42)	0.77 (1.06)	0.99 (1.03)	2.11 (1.70)	2.52 (1.67)
2005–2008	0.84 (0.51)	0.86 (0.53)	3.19 (1.62)	3.28 (1.67)	0.73 (0.82)	1.17 (0.79)	3.52 (1.67)[c]	4.36 (1.63)[b]
Education								
Less than high school		Ref		Ref		Ref		Ref
Completed high school		0.31 (0.35)		0.30 (0.89)		−0.98 (0.50)		−1.66 (1.00)
More than high school		−0.46 (0.38)		−2.06 (0.96)[c]		−2.15 (0.58)[b]		−4.25 (1.23)[b]
p-interaction (nativity/length of residence × period)	0.2671	0.2338	0.539	0.4164	0.9372	0.9615	0.9084	0.8205

Model 1 adds age, age^2, nativity/length of US residence, NHANES period, and interactions between age and period, and nativity/length of US residence and period. Model 2 further adjusts for education. In all models, referent group was recoded to obtain relevant estimates within and across time periods

BMI body mass index, *WC* waist circumference

[a]WC models for women did not require age^2 term

[b]$p < 0.01$

[c]$p < 0.05$