Obesity has reached epidemic proportions in industrialized societies and is becoming increasingly prevalent in the United States. Data from the National Health and Nutrition Examination Survey (NHANES) indicates that the prevalence of obesity (body mass index [BMI] ≥30.0) increased from 14.5% in 1976–1980 to 22.5% in 1988–1994. This increase was observed in both women and men, and in black, Mexican–American, and white ethnic groups. High prevalence of obesity, as well as increasing prevalence, have been documented by other studies conducted in the US and internationally. These trends are important given the association between obesity and adverse health outcomes, including all-cause and cardiovascular disease (CVD) mortality. Furthermore, there is evidence that abdominal obesity is associated with CVD risk factors, as indicated by high serum insulin, non-insulin dependent diabetes (NIDDM), high blood lipids, and hypertension.

Country of birth, acculturation status and abdominal obesity in a national sample of Mexican–American women and men

Jan Sundquista,b and Marilyn Winklebya

Background Few studies have examined the influence of country of birth and acculturation status on indicators of obesity using national samples of Mexican–American women and men.

Methods We analysed data for 1387 Mexican–American women and 1404 Mexican–American men, ages 25–64, from the third National Health and Nutrition Examination Survey (1988–1994). We examined whether waist circumference and abdominal obesity varied by country of birth and acculturation status (primary language spoken), and whether among those with abdominal obesity, number of associated cardiovascular disease (CVD) risk factors varied by country of birth and acculturation status.

Results Both country of birth and, to a lesser degree, acculturation status were significantly associated with waist circumference and abdominal obesity. Mexican-born women and men had the smallest waist circumference (90.4 cm, 94.0 cm respectively), US-born English-speaking women and men had intermediate waist circumference (93.6 cm, 97.3 cm), and US-born Spanish-speaking women and men had the largest waist circumference (96.9 cm, 97.7 cm), after accounting for age, education, per cent of energy from dietary fat, leisure-time physical activity, and smoking. All women had high prevalences of abdominal obesity, particularly US-born Spanish-speaking women (68.7%). In addition, US-born Spanish-speaking women with abdominal obesity were significantly more likely than their counterparts to have one or more of the following CVD risk factors: high serum insulin, non-insulin dependent diabetes, high blood lipids, and/or hypertension.

Conclusions These findings illustrate the heterogeneity of the Mexican–American population and suggest that country of birth and lack of acculturation to the majority culture, as well as secondary lifestyle changes, may explain the significant clinical differences observed in abdominal obesity within Mexican–American population subgroups.

Keywords Mexican–American, migration, acculturation, waist circumference, abdominal obesity

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There are large differences in the prevalence of obesity across ethnic groups, with the problem being particularly important in the Mexican–American population, which it is increasing rapidly. Between 1980 and 1990 the Hispanic population, of whom 63% are Mexican–American, increased by 45% compared with 7% for the overall population, with projected increases in population size from 31.4 million people in 2000 to 96.5 million people in 2050.

There are also differences in the prevalence of obesity within the Mexican–American population, indicating a heterogeneity that is important to examine further. For example, the San Antonio Heart Study showed that Mexican–American women living in more affluent suburbs had a mean BMI of 24.5 while those living in the most socioeconomically disadvantaged neighbourhoods had a mean BMI of 28.3. Corresponding BMI levels for Mexican–American men in these areas were 26.9 and 27.8, respectively.

There are additional variations in obesity among populations that have migrated to new countries, suggesting that factors associated with the migration process (e.g. change in diet, exercise, and stress) may adversely influence body weight. Prospective studies have shown significant BMI increases following immigration to a new country. A prospective study of 654 adult Tokelauans who migrated to New Zealand because of a natural disaster showed that their BMI levels increased from 24.1 to 28.7 between 1968 and 1982 compared with non-migrants whose BMI levels increased from 24.8 to 26.1. Moreover, an 8-year prospective study from Sweden showed a significant net increase in BMI levels among men who immigrated from South Europe to Sweden compared to a reference group of men who had not immigrated (BMI levels for immigrant men increased from 25.5 to 27.0 compared to 24.6 to 25.0 for non-immigrant men, after adjustment for age, leisure-time physical activity, smoking, education, and health status).

In addition to the possible adverse effects of migration on body weight, several studies have suggested that the degree to which people acculturate to the majority culture following migration may influence weight. A cross-sectional analysis of Mexican–American women and men from the Hispanic Health and Nutrition Examination Survey (HHANES) showed that preference for speaking Spanish (indicating a lower level of acculturation) was associated with a significantly higher BMI in women but not in men. Hazuda et al. examined the multidimensional aspects of acculturation and its association with body weight by constructing the following three acculturation scales: functional integration with mainstream American culture, worth placed on conserving Mexican culture, and attitudes toward traditional family structure. The scales showed different associations with body weight, with the first scale (low functional integration) showing the strongest association, but only for women and not for men. In contrast, the well-known study on acculturation and weight, which involved a cohort of 4653 men of Japanese ancestry living in Hawaii, found that men who were most traditional had significantly lower levels of BMI (mean of 23) than those who were more acculturated (mean of 26).

In this analysis we used data from the Third National Health and Nutrition Examination Survey (NHANES III), a large national sample of women and men living in the US. We examined whether abdominal obesity differed among three groups of Mexican–American women and men who reflect different stages of migration and acculturation: those born in Mexico, those born in the US whose primary language was Spanish, and those born in the US whose primary language was English. We also examined whether among those with abdominal obesity, risk of associated CVD risk factors (indicated by high serum insulin, NIDDM, high blood lipids, and hypertension) varied according to the three migration/acculturation groups.

We chose waist circumference as our measure of abdominal obesity for the following reasons. First, waist circumference is more strongly related to the metabolically active visceral adipose tissue and therefore more biologically interpretable than the more widely used measure of abdominal obesity, the waist to hip ratio (WHR). Second, several studies have concluded that waist circumference alone is more closely associated with the amount of abdominal, visceral obesity than the WHR, and recommend that waist circumference should be used to estimate risk of CVD and NIDDM. Third, a 7-year prospective study revealed that waist circumference was the best predictor of NIDDM compared to BMI, WHR, triceps and subscapular skinfolds in Mexican–American women and men.

Methods

The NHANES III study, conducted between 1988 and 1994 by the National Center for Health Statistics, was designed to collect information to assess the health status of the US civilian non-institutionalized population aged ≥2 months. The NHANES III sample design is similar to that of the previous NHANES, which used a stratified multistage probability design. It included an oversampling of both the Mexican–American and black American populations so that the sample could produce statistically reliable health estimates for the two largest ethnic minority groups in the US.

The NHANES III data were collected via standardized questionnaires administered by bilingual interviewers and examiners at participants' homes, and laboratory tests conducted at NHANES mobile examination centres. Of the 40,000 people invited to participate, 86% completed the home questionnaire, and 78% completed both the medical examination and the home questionnaire (n = 33,994).

The sample for our analyses includes 1387 Mexican–American women and 1404 Mexican–American men, 25–64 years of age, who completed both the home questionnaire and medical examination. We used age 25 as our lower age cut-point because educational attainment (a covariate in our multivariate regression models) is often not completed before this age. We used age 64 as our upper age cut-point because of lifestyle changes associated with retirement and ageing after 65. We excluded data for pregnant women (n = 69) and surveys coded as unreliable (n = 3). Missing data were as follows for the outcome variables; waist (4.0%), BMI (0.4%), serum insulin (3.6%), NIDDM (0.2%), high-density lipoprotein cholesterol (4.3%), serum triglycerides (3.7%), and hypertension (4.4%).

Definition of variables

Migration and acculturation status were indicated by country of birth and primary language spoken at home. Race-ethnic groups were based upon combinations of the race and ethnicity...
reported by the participants. Respondents who chose Mexican or Mexican–American ethnicity are included in this analysis.

Waist circumference was measured with the person in the erect position, with an inelastic tape at the level of the natural waist (the most narrow part of the torso). Abdominal obesity was defined as a waist circumference of \( \geq 102 \) cm for men and \( \geq 88 \) cm for women; these cut-points representing a substantially increased risk of future adverse health outcomes and CVD risk factors. As a measure of general obesity, a risk factor associated with CVD, we used BMI.

The CVD risk factors were defined as follows. Non-insulin dependent diabetes mellitus was defined as having an \( \geq 8 \) hour fast and plasma glucose levels \( \geq 126 \) mg/dl and/or a medical history of diabetes (other than during pregnancy) with an age of onset \( > 25 \) years. Non-high-density lipoprotein cholesterol (non-HDL-C) was calculated as the difference between total cholesterol and high-density lipoprotein cholesterol. Non-HDL-C, which may be a better indicator of atherogenic lipoprotein particles than indirectly estimated low-density lipoprotein cholesterol, does not require fasting blood samples and therefore allowed the use of the entire NHANES III sample. High non-HDL-C cholesterol and high triglyceride levels were defined as \( \geq 4.0 \) mmol/l and \( \geq 2.26 \) mmol/l, respectively. Blood pressure was measured on the right arm by health examiners or physicians while the participant was seated during the medical examination; the mean of the second and third of three blood pressure readings was used. Hypertension was defined as systolic blood pressure \( \geq 140 \) mmHg and/or diastolic blood pressure \( \geq 90 \) mmHg and/or current use of antihypertensive medications.

### Data analysis

Primary analyses, using linear models, were carried out in SUDAAN, to adjust for the complex sample design of NHANES III. All analyses incorporated sampling weights that adjusted for unequal probabilities of selection. Sample weights were also adjusted for non-respondents' characteristics. Analyses were run separately for women and men. The primary outcome variable was waist circumference; the predictor variables were country of birth and acculturation status (three groups—born in Mexico and used as the reference group, born in the US and Spanish-speaking, born in the US and English-speaking). The following potential confounding factors were included as covariates in the linear models: age (in years, centred at the sample mean to aid in the interpretation of the regression coefficients), years of education (continuous and centred), per cent of energy from dietary fat (based on a single 24-hour dietary recall and administered by trained dietary interviewers); no leisure-time physical activity (based on whether individuals had engaged in any leisure time physical activity in the past month, including exercises, sports, or physically active hobbies—those who reported no leisure-time activities were considered physically inactive); and current cigarette smoker (determined by self-report and based on whether individuals had smoked \( \geq 100 \) cigarettes during their lifetime and whether they were current smokers). We validated self-reported smoking by examining a biochemical measure, serum cotinine, and found that under-reporting did not differ significantly between the three groups for either women or men. We included all first order interactions between predictor variables in the linear models.

### Results

Individuals born in the US who were Spanish-speaking were older, less likely to live in urban areas, and more likely to live in the South (predominantly Texas), than their counterparts (Table 1). Mexican–Americans born in the US who were English-speaking had substantially higher levels of education, lower levels of poverty, and higher employment rates than the other two groups. Although all groups reported moderately high percentages of energy from total fat, those born in Mexico reported the lowest percentages. Women born in Mexico reported the lowest levels of leisure-time activity and were the least likely to be current cigarette smokers.

Both country of birth and, to a lesser degree, acculturation status (indicated by primary language spoken) were significantly associated with waist circumference in the linear model (Table 2). After adjustment for age, education, per cent of energy from dietary fat, leisure-time physical activity, and smoking, waist circumference was significantly larger in US-born women and men who spoke English or Spanish than Mexican-born women and men, indicating an influence of country of birth. There was also a significant difference in waist circumference between Spanish- and English-speaking US-born women (P-value = 0.04), indicating an influence of acculturation (evident when examining further contrasts in the linear model). There was no significant difference between Spanish- and English-speaking US-born men.

The magnitude of the differences in waist circumference by country of birth was large; for example the beta coefficient of 6.5 for the comparison of US-born Spanish-speaking women to Mexican-born women indicates that the former group had, on average, a waist circumference that was 6.5 cm larger than the Mexican-born women having comparable age, education, smoking, leisure-time physical activity and energy from fat. There were two modestly significant interactions for men, but when examined in more depth, neither were clinically meaningful.

Table 3 presents the unadjusted and adjusted means for waist circumference and BMI by country of birth and acculturation status. After adjustment for age, education, dietary fat, leisure-time physical activity, and smoking, Mexican-born women and men had the smallest waist circumference (90.4 cm, 94.0 cm respectively), US-born English-speaking women and men had intermediate waist circumference (93.6 cm, 97.3 cm), and US-born Spanish-speaking women and men had the largest waist circumference (96.9 cm, 97.7 cm). The corresponding adjusted levels for white women and men (presented for reference only) were 87.9 cm for women and 96.8 cm for men.

Using the recommended cut-points for abdominal obesity (\( \geq 88 \) cm waist circumference for women and \( \geq 102 \) cm for men) we found a gradient effect (Figure 1): US-born Spanish-speaking women and men had the highest levels of abdominal obesity (68.7% and 39.5% obese, respectively), US-born English-speaking women and men had intermediate levels (58.6% and 31.8% obese), and Mexican-born women and men had the lowest levels (55.6% and 21.4% obese). The
Table 1 Sample sizes, weighted sociodemographic and lifestyle characteristics by country of birth and acculturation status, Mexican–American women and men, ages 25–64, NHANES III, 1988–1994

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th></th>
<th>Men</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated US population</td>
<td>1 300 000</td>
<td>1 057 300</td>
<td>416 000</td>
<td>1 600 300</td>
</tr>
<tr>
<td>Sample size</td>
<td>626</td>
<td>502</td>
<td>259</td>
<td>696</td>
</tr>
<tr>
<td>Sociodemographic factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (mean)</td>
<td>38.6</td>
<td>39.6</td>
<td>44.4</td>
<td>36.5</td>
</tr>
<tr>
<td>Family size (mean number of persons)</td>
<td>5.1</td>
<td>3.7</td>
<td>3.8</td>
<td>5.0</td>
</tr>
<tr>
<td>Portion of life lived in the US (%)</td>
<td>34.4</td>
<td>100</td>
<td>100</td>
<td>37.3</td>
</tr>
<tr>
<td>Speaking English at home (%)</td>
<td>7.2</td>
<td>100</td>
<td>0</td>
<td>7.2</td>
</tr>
<tr>
<td>Years of education (mean)</td>
<td>7.0</td>
<td>11.9</td>
<td>8.9</td>
<td>7.3</td>
</tr>
<tr>
<td>Living in an urban area (%)</td>
<td>67.7</td>
<td>57.2</td>
<td>35.9</td>
<td>69.4</td>
</tr>
<tr>
<td>Living below the poverty level (%)</td>
<td>57.8</td>
<td>24.4</td>
<td>45.8</td>
<td>48.0</td>
</tr>
<tr>
<td>Employed (%)</td>
<td>44.4</td>
<td>70.1</td>
<td>48.9</td>
<td>86.1</td>
</tr>
<tr>
<td>Region of residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% West (predominantly California, Arizona, and New Mexico)</td>
<td>64.2</td>
<td>49.2</td>
<td>27.8</td>
<td>61.5</td>
</tr>
<tr>
<td>% South (predominantly Texas)</td>
<td>27.2</td>
<td>40.8</td>
<td>67.2</td>
<td>27.1</td>
</tr>
<tr>
<td>% Northeast/Midwest</td>
<td>8.6</td>
<td>10.0</td>
<td>5.0</td>
<td>11.4</td>
</tr>
<tr>
<td>Lifestyle factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calories from total fat (%)</td>
<td>31.0</td>
<td>35.0</td>
<td>34.3</td>
<td>30.9</td>
</tr>
<tr>
<td>No leisure-time physical activity (%)</td>
<td>56.3</td>
<td>27.1</td>
<td>36.0</td>
<td>37.1</td>
</tr>
<tr>
<td>Current cigarette smoker (%)</td>
<td>11.7</td>
<td>18.2</td>
<td>20.4</td>
<td>33.0</td>
</tr>
</tbody>
</table>

Table 2 Regression model coefficients and P-values for the predictor variables and waist circumference, Mexican–American women and men, ages 25–64, NHANES III, 1988–1994

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th></th>
<th>Men</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>±SE</td>
<td></td>
<td>±SE</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.4</td>
<td>0.08</td>
<td>&lt;0.001</td>
<td>0.4</td>
</tr>
<tr>
<td>Education</td>
<td>-0.5</td>
<td>0.1</td>
<td>&lt;0.001</td>
<td>0.03</td>
</tr>
<tr>
<td>Energy from dietary fat</td>
<td>0.03</td>
<td>0.05</td>
<td>0.62</td>
<td>0.09</td>
</tr>
<tr>
<td>No leisure-time physical activity</td>
<td>0.03</td>
<td>0.05</td>
<td>0.62</td>
<td>0.09</td>
</tr>
<tr>
<td>Current cigarette smoker</td>
<td>-1.1</td>
<td>1.2</td>
<td>0.35</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

Main effects

Country of birth/acculturation status

Born in Mexico

Born in US, English-speaking

Born in US, Spanish-speaking

Age

Education

Energy from dietary fat

No leisure-time physical activity

Current cigarette smoker

Interactions

Age × Spanish-speaking

Education × English-speaking

Further contrasts in the linear model showed a significant difference (P < 0.04) for Spanish- versus English-speaking women, but not for Spanish- versus English-speaking men.
corresponding percentages for white women and men were 45.4% and 31.4%, respectively. It is important to note the substantially higher levels of abdominal obesity in women than men for all subgroups.

High insulin levels, NIDDM, elevated cholesterol and triglycerides, and hypertension are among the main risk factors associated with CVD. In Table 4 we present the percentages with high serum insulin (>mean + 2 SD), NIDDM, high non-HDL cholesterol (>4.0 mmol/l), high triglycerides (>2.26 mmol/l), and hypertension among those with abdominal obesity. Although there were some inconsistencies among the individual risk factors, women born in the US who were Spanish-speaking and who had abdominal obesity were significantly more likely to have one or more CVD risk factors than their counterparts. Among men, there were no significant differences.

Discussion

In this analysis of a large national sample of Mexican–American women and men living in the US, we found important and significant clinical differences in waist circumference and abdominal obesity among three population groups, suggesting that country of birth (for both women and men) and acculturation status (for women only) are associated with the pathogenesis of obesity. We found that Mexican-born women and men had the smallest waist circumference, English-speaking US-born women and men had intermediate waist circumference, and Spanish-speaking US-born women and men had the largest waist circumference, when age, education, per cent of energy from dietary fat, leisure-time physical activity, smoking, and all first order interactions were taken into account. The prevalence of abdominal obesity paralleled these findings, and showed that 68.7% of Spanish-speaking US-born women and 39.5% of Spanish-speaking US-born men had abdominal obesity, indicating substantial risk of CVD.

It is well-known that obesity is strongly associated with behavioural, cultural, and societal factors. This association has been established, in part, by migration studies that have shown increasing levels of obesity among populations that migrate, as well as those that have low levels of acculturation to the majority culture. Mechanisms proposed as possible explanations are lifestyle changes, dietary changes, lack of educational or occupational opportunities, and/or other structural inequalities.

Our findings of an association between country of birth and abdominal obesity (waist circumference) are consistent with findings from the Hispanic HANES that showed BMI was larger for second and third generation Mexican–Americans than for first generation Mexican–Americans. In addition, Hispanic HANES found that Mexican–American women with a preference for the English language had significantly lower levels of BMI than those with a preference for the Spanish language, a finding which agrees with the present study. The San Antonio Heart Study also demonstrated that Mexican–American women with lower acculturation levels (lower functional integration) had higher levels of central obesity (subscapular-to-triceps skinfold-thickness ratio) than women with higher acculturation levels.

| Table 3: Waist circumference and body mass index (BMI) by country of birth and acculturation status, Mexican–American women and men, ages 25–64, NHANES III, 1988–1994 |
|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Born in Mexico & English-speaking | **Women** | **Men** | **Women** | **Men** |
| Unadjusted | Adjusted | SD | Unadjusted | Adjusted | SD | Unadjusted | Adjusted | SD |
| Waist (cm) | 91.1 | 90.4 | 13.1 | 91.9 | 93.6 | 13.0 | 96.9 | 96.9 | 14.9 |
| BMI (kg/m²) | 28.1 | 27.8 | 5.5 | 28.5 | 29.1 | 6.8 | 30.2 | 29.7 | 6.6 |


* Adjusted for age, education, per cent of energy from dietary fat, leisure-time physical activity, smoking, and all first order interactions.

* Data for white, non-Hispanic women and men are presented for reference.
in a different social, political and cultural context, might result in the syndrome of visceral obesity' or the metabolic syndrome, and abdominal obesity may be mediated by a lack of acculturation and secondary lifestyle differences. Underlying mechanisms

It is possible that the biological pathway between migration, acculturation, and abdominal obesity may be mediated by a long-term stress reaction. Stress can result in either an acute fight or flight reaction, the first leading to control and the second leading to a long-term stress reaction, characterized by depression or helplessness. Abdominal obesity has been shown to be associated with the long-term stress reaction, in which the hypothalamic-pituitary-adrenal axis is activated with an increase of cortisol levels, which changes fat metabolism and can result in a central distribution of fat. Migration, whether forced by poverty or persecution, leading to settlement in a different social, political and cultural context, might result in a long-term stress reaction regardless of previous health. In addition to migration stress, not speaking the language of the majority culture and secondary lifestyle changes may induce an increase in weight, consistent with the findings in the present study.

Strengths and limitations

The NHANES III study is one of the most comprehensive national surveys to date. Extensive and complete data are available from both the home survey and medical examination, including standardized measures of waist circumference. As noted previously, response rates were high and there was minimal missing data. Unlike many surveys, NHANES III represents a sample of the US population and therefore results are generalizable to the population of Mexican–Americans living in the US. It also included an oversampling of Mexican–Americans to ensure that large numbers would be available for analyses. In addition, NHANES III assessed BMI as well as waist circumference, which is the preferred clinical and epidemiological method to use because of its association with visceral adiposity, low cost and ease of measurement.

Table 4 Cardiovascular disease risk (CVD) factors among Mexican–American women and men with abdominal obesity, ages 25–64, NHANES III, 1988–1994

<table>
<thead>
<tr>
<th>Women&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Men&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Born in Mexico</td>
<td>English-speaking</td>
</tr>
<tr>
<td>Sample size with abdominal obesity</td>
<td>348</td>
</tr>
<tr>
<td>% with high serum insulin</td>
<td>5.2</td>
</tr>
<tr>
<td>% with non-insulin-dependent diabetes</td>
<td>13.1</td>
</tr>
<tr>
<td>% with high triglycerides</td>
<td>4.0</td>
</tr>
<tr>
<td>% with high non-high-density lipoprotein cholesterol</td>
<td>5.5</td>
</tr>
<tr>
<td>% with hypertension</td>
<td>17.8*</td>
</tr>
<tr>
<td>% with ≥1 of the above CVD risk factors</td>
<td>30.8*</td>
</tr>
</tbody>
</table>

<sup>a</sup> Source: National Center for Health Statistics, NHANES III, 1988–1994. Abdominal obesity defined as ≥88 cm for women, and ≥102 cm for men.

<sup>b</sup> If there was a significant difference among the three Mexican–American groups, then pairwise χ<sup>2</sup> tests were conducted to identify which groups were different. An asterisk indicates a significant (P < 0.01) difference for the indicated group compared to the group with the highest value.

<sup>c</sup> Data for white, non-Hispanic women and men are presented for reference and not included in the pairwise χ<sup>2</sup> tests.
In addition, NHANES III lacks measures of physical activity at work, which may influence the gender differences that we found for leisure-time physical inactivity (significant for women but not for men, Table 2). Finally, our measure of acculturation, indicated by primary language spoken at home, is a static factor that does not measure core beliefs and practices in relation to specific CVD risk factors or medical conditions, and does not consider the social context of behaviour.66,67

In summary, we found substantial variation in waist circumference and abdominal obesity among three subgroups of Mexican–Americans living in the US, distinguished by country of birth and acculturation status. All women, but in particular US-born Spanish-speaking women (68.7%), had high prevalence of abdominal obesity. The variation we found in abdominal obesity illustrates the heterogeneity of the Mexican–American population and suggests that both country of birth and acculturation status influence indicators of obesity. To address these variations, social and economic interventions are needed as well as lifestyle and public health policy interventions, such as those that influence food consumption patterns and stimulate physical activity.66,67 As with all interventions, there is a need for primary prevention efforts that begin early in life that are linguistically and culturally appropriate.

Acknowledgements
This research was supported by an Established Investigatorship Award and National Grant-in-Aid from the American Heart Association and a US Public Health Service Grant from the National Heart, Lung, and Blood Institute to Dr Winkleby, and by grants from the Swedish Medical Research Council (K97–21P-11333–01A), Swedish Heart Lung Foundation, Swedish Institute, Swedish Society of Medicine, and from the Henning and Johan Throne Holst’s Foundation for the Promotion of Scientific Research to Dr Sundquist. The authors thank Drs David Ahn, Lori Beth Dixon, Christopher Gardner, Michaela Kieman, Helena C Kraemer, and Ms Pam Rief for their insightful comments on an earlier draft, and Ms Alana Koehler for her technical assistance.

References


