Growth Status Among Low-Income Mexican and Mexican-American Elementary School Children

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Objectives: Childhood obesity remains a problem among Latino children in the United States. Acculturation to an American diet and sedentary lifestyle may be causative factors. The research purpose was to assess child growth status, including sitting height, in relation to acculturation among Mexican and Mexican-American children.

Methods: Anthropometric measures of weight, height, and sitting height were taken in a cross-sectional survey of Mexican and Mexican-American elementary school children (N = 484) in Phoenix, Arizona. Height-for-age (HAZ), weight-for-age (WAZ), and body mass index (BMI) Z-scores were calculated based on the Centers for Disease Control 2000 growth reference. Sitting height Z-scores (SHZ) were determined from the NHANES III reference values. Questions about language usage were asked of the children as a proxy for acculturation. Differences in growth measures and acculturation between those born in the United States or Mexico were evaluated by chi-square or t-tests.

Results: The mean HAZ value (−0.23) was close to the reference median. There were no significant differences in HAZ or SHZ by birth country or gender. WAZ values for boys were significantly higher than for girls. More girls (64%) than boys (54%) had normal BMIs. More Mexican-born boys (28%) were obese than Mexican-born girls (17%; P = 0.026) in comparison to the US-born boys (31%) and girls (24%; P = n.s.). Acculturation scale score and male gender predicted a small percentage of the variation in BMI.

Conclusions: Environmental and cultural factors that promote obesity among low-income Mexican and Mexican-American children are similar regardless of birth country but boys may be at greater risk of obesity than girls. Am. J. Hum. Biol. 24:690–695, 2012.

Although the prevalence of childhood overweight and obesity may have plateaued in the United States, rates remain high and are even greater among some ethnic minorities and immigrants such as Mexican Americans (Flegal et al., 2004; Latifyya et al., 2008; Ogden et al., 2010). Immigration and subsequent acculturation may promote obesity through changes in diet and lifestyle (Sussner et al., 2008). Many immigrants often adopt the dietary practices of the host culture over time, but the rate of acculturation varies by ethnic group and individual. Some of the factors involved with the amount and type of change experienced by immigrants are the similarity of host culture to the culture of origin, income level, household demographics, age at immigration, and language use. Little is known about the specific determinants that influence these dietary changes during the acculturation process (Satia-Abouta et al., 2002).

The assumption is often made that acculturation precedes changes in food choices, but this may not always be true. For some Mexican immigrants, changes in dietary habits may already have been made before they arrive in the United States. Dietary surveys among school-aged children in Baja California, a northern state of Mexico, demonstrated high consumption of soft drinks and high-fat snack foods and low consumption of fruits and vegetables (Jiménez-Cruz et al., 2002). Similar circumstances have been documented in the Yucatan peninsula among the Maya. Although tourism has brought an influx of economic opportunities, it has altered the “foodscape” and led to what Leatherman and Goodman (2005) refer to as the “coca-colonization” of diet. Varela-Silva et al. (2007) noted similar circumstances in other Maya villages with transition to a more Western diet and an increase in overweight/obesity in the presence of continued growth stunting.

To complicate matters, there may be cultural differences in perceptions of health, appropriate body size for children, and what constitutes a healthy child. For example, some studies report that desirable body weight is higher among Hispanics than among non-Hispanic whites (Baughcum et al., 1998). The acceptability of higher body weights among children and adults, particularly among boys and men, may obscure recognition of health risks such as childhood obesity. Parental and societal views of acceptable body size and shape influence how children are fed and the ability of parents to comprehend whether obesity poses health risks (Alderson and Ogden, 1999; Kaiser et al., 2002; Sussner et al., 2008).

Based on US national survey data from 2007 to 2008, the prevalence of children with an age- and gender-specific body mass index (BMI) greater than the 85th percentile was estimated as 41.7% for Mexican-American children aged 6–11 years and 44.1% for those aged 12–19 years (Ogden et al., 2010). In comparison, 31.7% of all children aged 2–19 years were classified as overweight with a BMI at or above the 85th percentile, and 16.9% were considered obese with a BMI at or above the 95th percentile (Ogden et al., 2010). Survey data from Mexico indicate that about 25% of children aged 10–17 years are overweight or obese based on BMI percentile categories (del...
Rio-Navarro et al., 2004). Mexican children who resided in the Mexico City metropolitan region and in the northern Mexico border regions were more likely to have a BMI in excess of the 85th percentile than rural Mexican children. The higher rates may be attributable to environmental and lifestyle characteristics in Mexico City and along the US/Mexico Border that are similar to those factors in the United States.

There have been concerns that the BMI may not correlate as closely with body composition in children from different population groups (Norgan, 1994). Children who have been malnourished may have a shorter or disproportionally short trunk vs. trunk length. Thus, they may have a higher BMI value, but not be overweight. The inclusion of sitting height and leg lengths as standard measures in anthropometric assessment allows for more thorough description of limb and trunk segment lengths. These details permit critical evaluation of BMI distortion among children who may have experienced previous or concurrent growth restriction.

In comparison to non-Hispanic whites and non-Hispanic blacks, Mexican-American children tend to be shorter and have higher skinfold measures (Martorell et al., 1987; Ortiz-Hernandez et al., 2008). Children who have experienced growth stunting and have disproportionate trunk and leg length as a result may have a higher BMI percentile because of a shorter total height (Bogin and Rios, 2003). In an examination of short stature and body fat among 7- to 9-year-old Mayan children in Mexico, Wilson et al. (2011) found that sitting height ratio (SHR) did not significantly alter the predictive power of BMI on other adiposity markers such as waist circumference, body fat percentage based on bioelectrical impedance, or the sum of two skinfolds. Measurement of sitting height and calculation of the SHR in disadvantaged populations can serve as an additional indicator of appropriate growth and assessment of proportionality, which can vary across the childhood stunting experience in different populations and circumstances (Bogin et al., 2002; Padez et al., 2009; Varela-Silva et al., 2007).

Furthermore, stunting and restricted nutrient intakes in infancy and early childhood may have long term health effects. These developmental or physiologic adaptations to environmental stresses, i.e. inadequate nutrition, can predispose children to obesity later in life as well as higher risk of diabetes and other chronic diseases (Biro and Wein, 2010; Varela-Silva et al., 2012; Winham, 2000).

The prospect of weight loss for overweight children in their adult years is unlikely. Therefore, prevention of childhood obesity is the most desirable action. Childhood is an ideal time to promote healthy lifestyle interventions to prevent or delay adverse health outcomes in children and parents. However, before attempting intervention it is necessary to evaluate child growth and level of acculturation to meet the needs of the children and their parents in a targeted community. The objectives of this research study were to assess growth status of children in a low-income elementary school to determine prevalence of obesity and undernutrition, compare SHRs with BMI, and evaluate level of acculturation through the use of a standardized series of questions regarding language usage of the child and their parents. These results were used to guide a school-based obesity intervention program.
Unlike the CDC reference, the NHANES III database allows for calculation of sitting height Z-scores (SHZ) in comparison to a US reference population (Frisancho, 2008).

**Acculturation scale questions**

Before the anthropometric measurements were taken, children were asked a series of language usage questions from the Bidimensional Acculturation Scale (Marin and Gamba, 1996). The specific questions were as follows: Do you speak another language besides English? What languages does your mother speak? What languages does your father speak? What is the main language you use to talk to your parents? What is the main language you use to talk to your friends? Bilingual interviewers (Spanish/English) were present for children who did not speak English. The language preference scale had a seven-point range with values between 3 and 9. If the child reported that he or she and both parents spoke only English, the scale value was 3. Conversely, if the child and parents spoke Spanish only, the scale value was 9 (Table 4).

The five language questions and the birth country variable were analyzed to develop an acculturation scale based on the highest Cronbach’s alpha score and the most parsimonious model. Reliability analysis indicated that the best model consisted of a three-item scale with Cronbach’s alpha of 0.78, indicating good reliability (Field, 2005). These three-scale items were the reported language preferences of the child, mother, and father.

**Statistical analysis**

Data entry, cleaning, recoding, and analysis were done using the SPSS Statistics software version 18.0 (IBM Corporation, Somers, NY). Categorical variables were examined for relationships using chi-square test. Relationships between continuous and categorical variables were determined using independent samples t-test for dichotomous items and one-way analysis of variance for variables with more than two options. Significance was assumed if $P \leq 0.05$.

**RESULTS**

During the study period, a total of 672 enrolled students at the school were eligible for the study. Some children ($n = 108$) were not measured because of absence, school field trips, illness, lack of consent form, or parental refusal of consent. Eighty-four percent (564/672) of the eligible children were measured. Of these, the reported ethnic background was 85.8% Hispanic (484), 8% African-American ($n = 45$), 3.5% White ($n = 20$), 1.9% Native American ($n = 11$), and 0.7% ($n = 4$) Asian. Because of the small sample sizes of non-Hispanic children, the analysis focused only on the 484 Mexican children who were born in the United States or Mexico.

Of the 484 children in the final sample, 52.1% were boys and 47.9% were girls. Approximately equal numbers of girls and boys were born in the United States or Mexico with the majority of the children (68.2%) born in the United States. The age of participants ranged from 6 to 14 years, with a mean age of 9.6 (±2.6) years. The average age of children born in Mexico was 10.3 years, in contrast to 9.5 years for those born in the United States ($t$-test $P = 0.002$) although the age range was approximately the same (Table 1).

The HAZ values ranged from −3.58 to 4.34 with a mean of −0.23 (±1.00). Sixteen children, or 3.3% of the sample, met the criteria for stunting. The WAZ values ranged from −3.31 to 3.72 with a mean of 0.55 (±1.18). Eight children, or 1.9% of the sample, were underweight. Five of these children were both stunted and underweight. Three were born in the United States and two in Mexico. Chi-square analysis did not show any significant differences by stuttering and underweight categories and gender or country of birth. An independent sample $t$-test analysis did not support differences for average HAZ and WAZ values by birth country. However, $t$-test analysis did indicate significant differences in mean WAZ values between boys and girls ($P = 0.016$), with boys being heavier than girls. BMIZ values ranged from −2.41 to 3.21 with a mean of 0.81 (±1.10). $t$-Test analysis was significant by gender with boys (0.9) having a higher BMIZ than girls (0.7; $P = 0.006$). The SHZ ranged from −3.01 to 3.97 with a mean of 0.43 (±1.0). The SHZ for Mexican born children was greater (0.45) than for US-born children (0.39), but was not statistically significant.

**TABLE 1. Anthropometric characteristics of Hispanic school children by country of birth ($N = 484$)**

| Characteristics       | All participants | US born ($n = 330$) | Mexico born ($n = 154$) |
|-----------------------|------------------|---------------------|------------------------|
| Gender (%)            |                  |                     |                        |
| Male                  | 52.1             | 51.2                | 53.9                   |
| Female                | 47.9             | 48.8                | 46.1                   |
| Age in years (m ± SD) | 9.6 ± 2.6        | 9.3 ± 2.6           | 10.3 ± 2.7             |
| Anthropometric measures in cm (m ± SD) |                     |                     |                        |
| Weight                | 40.3 ± 17.6      | 39.3 ± 17.4         | 42.5 ± 17.9            |
| Height                | 137.6 ± 16.2     | 136.0 ± 16.1*       | 141.1 ± 16.0*          |
| Sitting height        | 72.6 ± 7.8       | 71.8 ± 7.7          | 74.3 ± 7.6*            |
| Sitting height ratio  | 0.53 ± 0.02      | 0.53 ± 0.02         | 0.53 ± 0.02            |
| Leg length            | 65.0 ± 9.0       | 64.1 ± 8.9          | 66.9 ± 5.8             |
| Child Z-score distributions* |                    |                     |                        |
| HAZ (m ± SD)          | −0.23 ± 1.0      | −0.25 ± 1.0         | −0.19 ± 1.0            |
| WAZ (m ± SD)          | 0.55 ± 1.2       | 0.56 ± 1.2          | 0.53 ± 1.1             |
| WHZ (m ± SD)          | 0.65 ± 1.0       | 0.64 ± 1.0          | 0.69 ± 1.1             |
| BMIZ (m ± SD)         | 0.81 ± 1.0       | 0.84 ± 1.1          | 0.76 ± 1.0             |
| Sitting height Z (m ± SD) | 0.42 ± 1.0       | 0.39 ± 1.0          | 0.45 ± 1.0             |
| Percent clinically stunted | 3.3               | 3.3                 | 3.3                    |
| Percent clinically wasted | 1.7                | 1.8                 | 1.3                    |
| BMI percentile category (%) |                  |                     |                        |
| Underweight           | 1.2              | 1.8                 | 0                      |
| Normal                | 57.6             | 56.4                | 60.4                   |
| Overweight            | 15.3             | 14.5                | 16.9                   |
| Obese                 | 25.8             | 27.3                | 22.7                   |

*Z-scores based on CDC growth reference except for sitting height, which was based on NHANES III.

$P = 0.001$; $P = 0.002$.
country. Of the Mexican-born children classified as obese, 27.7% were boys and 16.9% were girls (P = 0.026). In contrast, more boys (31.2%) than girls (23.6%) of the US-born children were obese but not significantly by gender. A larger percentage of Mexican-born girls (71.8%) were of normal BMI in contrast to Mexican-born boys (50.6%). Table 1 shows the distribution of BMI categories by birth country.

The mean sitting height and leg length for the sample were significantly different by birth country (Table 1). No gender differences were observed in sitting height or SHR, so data were pooled for further analysis. Sitting height and SHR Z-score values were not significantly different from the NHANES III reference data (Frisancho, 2008; Table 2).

The distribution of responses to the language usage questions is shown in Table 3. More fathers than mothers were bilingual regardless of the child’s birth country. More than 80% of the mothers of Mexican-born children spoke only Spanish. Language preference scale values were significantly different by child’s country of birth. Children born in the United States had a mean language preference scale value of 6.50 ± 1.31, which reflects greater use of English or acculturation than the mean score of 7.42 ± 1.06 for those children born in Mexico (P < 0.001). However, the overall mean scale value was 6.52 (SD ± 1.50), and the median value was 7. These descriptors indicate that the majority of the children and their parents were bilingual with a greater emphasis on Spanish. When viewed as a categorical variable, 78% of the children had a language acculturation score of 6, 7, or 8. There were no significant differences in the language preference scale by gender, grade level, or BMI category.

The distribution of the language score summary variable by birth country is shown in Table 4. As expected, Mexican-born children were less English dominant and vice versa. Possible values ranged from 3 (English dominant) to 9 (Spanish dominant). Approximately 36% of the children had a scale score less than or equal to 6 indicat-

### Table 1: Means and standard deviations of anthropometric measures by age for Hispanic school children by country of birth in comparison to NHANES III national sample

| Measure, age in years | US born (n = 330) | Mexico born (n = 154) | NHANES reference |
|-----------------------|------------------|-------------------|------------------|
| Height cm (m ± SD)    |                  |                   |                  |
| 6                     | 116.0 ± 4.8      | 118.5 ± 5.8       | 119.1 ± 6.0      |
| 7                     | 123.4 ± 5.4      | 124.8 ± 4.8       | 125.6 ± 4.5      |
| 8                     | 128.6 ± 6.4      | 127.9 ± 6.6       | 131.5 ± 6.7      |
| 9                     | 134.4 ± 6.7      | 137.4 ± 10.6      | 137.5 ± 7.0      |
| 10                    | 140.7 ± 7.6      | 139.1 ± 7.6       | 142.7 ± 7.4      |
| 11                    | 146.0 ± 8.1      | 147.1 ± 7.4       | 149.1 ± 8.1      |
| 12                    | 150.9 ± 7.0      | 153.3 ± 7.0       | 155.1 ± 8.2      |
| 13                    | 159.4 ± 8.0      | 158.8 ± 5.5       | 160.4 ± 8.2      |
| 14                    | 157.9 ± 8.2      | 150.8 ± 5.1       | 163.9 ± 7.8      |
| Sitting height cm (m ± SD) |                  |                   |                  |
| 6                     | 62.9 ± 3.0       | 64.1 ± 3.3        | 62.5 ± 3.4       |
| 7                     | 65.8 ± 2.6       | 68.9 ± 2.2        | 65.5 ± 3.4       |
| 8                     | 68.3 ± 3.5       | 68.0 ± 3.6        | 68.6 ± 3.5       |
| 9                     | 71.2 ± 3.4       | 72.6 ± 5.2        | 71.6 ± 3.5       |
| 10                    | 73.8 ± 3.3       | 72.7 ± 4.0        | 74.3 ± 4.0       |
| 11                    | 75.6 ± 4.2       | 75.9 ± 3.9        | 76.9 ± 4.4       |
| 12                    | 78.1 ± 3.7       | 79.9 ± 3.1        | 79.4 ± 4.4       |
| 13                    | 83.4 ± 4.2       | 83.0 ± 2.6        | 81.5 ± 4.4       |
| 14                    | 83.4 ± 3.3       | 83.5 ± 3.7        | 83.4 ± 4.2       |
| Leg length cm (m ± SD) |                  |                   |                  |
| 6                     | 53.1 ± 3.1       | 54.4 ± 3.5        | 56.3 ± 3.8       |
| 7                     | 57.8 ± 3.5       | 55.5 ± 6.1        | 60.3 ± 4.1       |
| 8                     | 60.4 ± 3.6       | 60.0 ± 4.2        | 64.1 ± 4.4       |
| 9                     | 63.1 ± 4.8       | 64.8 ± 6.7        | 67.5 ± 4.5       |
| 10                    | 67.0 ± 3.8       | 64.6 ± 4.3        | 70.4 ± 4.7       |
| 11                    | 70.4 ± 4.8       | 71.2 ± 4.6        | 73.0 ± 4.8       |
| 12                    | 72.8 ± 4.5       | 73.4 ± 4.4        | 75.3 ± 4.9       |
| 13                    | 76.0 ± 5.9       | 75.8 ± 4.3        | 77.0 ± 5.0       |
| 14                    | 74.5 ± 5.8       | 75.5 ± 5.5        | 78.5 ± 4.9       |
| Sitting height ratio (m ± SD) |                  |                   |                  |
| 6                     | 54.2 ± 1.6       | 54.1 ± 1.5        | 52.6 ± 1.6       |
| 7                     | 53.2 ± 1.3       | 53.9 ± 1.2        | 52.1 ± 0.7       |
| 8                     | 53.1 ± 1.2       | 53.2 ± 1.6        | 51.8 ± 0.8       |
| 9                     | 53.0 ± 1.8       | 52.9 ± 2.2        | 51.6 ± 0.8       |
| 10                    | 52.4 ± 0.9       | 52.3 ± 1.2        | 51.4 ± 1.5       |
| 11                    | 51.8 ± 1.3       | 51.6 ± 1.5        | 51.3 ± 1.4       |
| 12                    | 51.8 ± 1.4       | 52.1 ± 0.9        | 51.4 ± 1.5       |
| 13                    | 52.3 ± 2.2       | 52.3 ± 1.5        | 51.4 ± 1.5       |
| 14                    | 52.9 ± 1.5       | 52.5 ± 1.5        | 51.6 ± 1.5       |

### Table 2: Percentage of Hispanic elementary school children reporting language use for themselves and parents by child’s country of birth (N = 484)

| Language use question | English only | Spanish only | English and Spanish |
|-----------------------|-------------|--------------|--------------------|
| What language or languages do you speak? | 9.3 | 4.8 | 86.0 |
| US born | 13.0 | 1.2 | 85.8 |
| Mexico born | 1.3 | 12.3 | 86.4 |
| What languages does your mother speak? | 7.5 | 59.4 | 33.1 |
| US born | 9.4 | 48.9 | 41.6 |
| Mexico born | 3.2 | 81.8 | 14.9 |
| What languages does your father speak? | 8.1 | 40.0 | 51.9 |
| US born | 10.3 | 32.0 | 57.7 |
| Mexico born | 3.4 | 57.0 | 39.6 |
| What is the main language you use to talk to your parents? | 19.0 | 62.1 | 18.8 |
| US born | 24.6 | 52.3 | 23.1 |
| Mexico born | 7.1 | 83.1 | 9.7 |
| What is the main language you use to talk to your friends? | 48.6 | 8.7 | 42.6 |
| US born | 52.9 | 6.4 | 40.7 |
| Mexico born | 39.6 | 13.6 | 46.8 |

Chi-square P = 0.000 for all variables by birth country.

### Table 3: Percentage of Hispanic elementary school children reporting language use for themselves and parents by birth country (N = 484)

| Variable | Beta (P value) | P value | Adj. R² | Model P |
|----------|---------------|---------|---------|---------|
| BMI Z-score Male gender | 0.125 (0.006) | 4.17 | 0.019 | 0.006 |
| Mexican born | −0.072 (0.13) | - | 0.064 | - |
| Acculturation Scale Score | 0.006 (0.044) | - | 0.006 | - |

Chi-square P = 0.000 for all variables by birth country.
ing that Spanish or bilingualism was more common overall. Multivariate regression models for predicting BMIZ indicated that male gender, being born in Mexico, and a high acculturation score explained a small portion of the observed variation (~2%) although the model was statistically significant (Table 5).

DISCUSSION

Contrary to expectations, growth measures of height and weight were not different by degree of acculturation or birth country after accounting for difference in age among these low-income Mexican and Mexican-American children. The Mexican and Mexican-American children surveyed showed higher rates of overweight and obesity in comparison to their peers living in Mexico based on other published reports. National survey data of school-aged children in Mexico indicate that 19.5% of children aged 5–11 years were classified as overweight and obese. In Mexico, boys tend to be heavier than girls (del Rio-Navarro et al., 2004; Hernández et al., 2003). In our study sample, 41.3% of the Mexican and Mexican-American children fall into these classifications, with a trend for more boys than girls to be obese. A cross-sectional survey of low-income elementary school children in the Los Angeles Unified School District showed that 42.5% of the Hispanic children were either at overweight or obese. As in the current research, Hispanic boys were heavier than girls (Slusser et al., 2005). This gender difference is even more apparent in the study sample among those children who were born in Mexico. In contrast, the prevalence of overweight and obesity for non-Hispanic white children aged 6–11 years is 34.5% based on recent US national survey estimates (Ogden et al., 2010). The environmental circumstances after immigration may homogenize the growth experience of children in some respects. Alternatively, the circumstances in Mexico prior to immigration are similar to those in the United States.

Overall, the sample children show a trend toward a similar pattern of overweight regardless of birth country with the exception of Mexican-born girls who were less likely to be overweight or obese. The nature of the gender difference and childhood obesity needs to be explored further among Mexican immigrants in the United States. Mexican-origin mothers have been noted to indulge children with food treats (Kaiser et al., 2002). This may be especially true in low-income settings where inexpensive nutrient dense foods are plentiful at convenience stores and fast food establishments (Matheson, 2008). These practices may be even more common with boys who may be culturally favored or indulged than girls and contribute to differential obesity rates (Kaiser et al., 2002).

The length of residence in the United States has been associated with increased obesity among Mexican adults (Kaplan et al., 2004) and indigenous populations such as the Maya after immigration (Bogin et al., 2002). It is possible that the children are experiencing increased adiposity as a consequence of parental dietary and lifestyle acculturation that is not reflected in language use changes (Winham and Florian, 2010). Our results are limited, however, because the length of time in the United States since immigration for the participating children is unknown and may be an important factor.

Childhood growth status reflects dietary and lifestyle patterns, which ultimately influence health across the life cycle (del Rio-Navarro et al., 2004). Continued examination of the growth status changes that occur as part of the immigrant experience for children is vital to preventing and reducing the high prevalence of overweight and obesity among Mexican and Mexican-American children for their future health (Biro and Wien, 2010). In addition to the tracking of individuals over time and immigration, it is essential to incorporate measures of children’s parents as well. Although the current study did not collect data on attained heights of the children’s parents, the intergenerational effects of stunting are well documented (Varela-Silva et al., 2007, 2009; Winham, 2000). Measurements of adult growth are strong predictors of child outcome and indicate the history of environmental conditions for growth. It is vital to frequently monitor growth patterns of populations as the interactions of biology, culture, and environment are dynamic and continuously in flux across time and geography — especially with immigrant groups.

ACKNOWLEDGMENTS

The author thanks the study participants and their families, and the school staff for their participation and assistance in the project. Shawna Horn-Marine McNally and Iwona Steplewska coordinated field staff support and data management.

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