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Childhood Obesity Among Children of Mexican Descent: A Binational Approach

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The prevalence of childhood obesity has increased dramatically in the United States over the past 30 years, especially among children of Mexican origin. Children of Mexican origin are an especially high-risk group because of their increased risk for morbidities associated with obesity in adulthood, such as diabetes, cardiovascular disease and uncontrolled hypertension compared to other racial and ethnic groups. This study takes a binational approach to understanding the health disparity in obesity among children of Mexican descent by examining the acculturation hypothesis as well as the factors associated with children's weight status in Mexico. Two cross-sectional samples of 5-year-old children from California and Mexico were designed to compare predictors of obesity. The California sample included 287 children from a longitudinal birth cohort. Mexican children were 316 participants in a study designed to capture a sample similar to the California sample. Equivalent recruitment and data collection methodologies were used in both sites. I found significant differences between samples; California mothers reported that their children played outside fewer hours per day, drank more sweetened beverages per day, consumed fast food more frequently but ate more fresh fruits and vegetables than mothers in Mexico reported (p-value<0.05 for each). Using Center for Disease Control growth charts, I found that 53% of California children and 15% of Mexican children were classified as at-risk for overweight or overweight with an age- and sex-specific body mass index greater than the 85th percentile. I found no significant differences in children's weight status according to acculturation level of the mother. I used logistic regression models to determine predictors of being at-risk for overweight or overweight in each sample. Maternal obesity was the only significant predictor in California (OR 2.5 95% CI 1.2, 5.3). The odds of being classified as at risk of overweight or overweight in Mexico were significantly positively associated with having an obese mother versus a normal-weight or overweight mother (OR 2.4, 95% CI: 1.3, 4.6), living in households in the upper socioeconomic status level compared to the lowest SES level (OR 2.9, 95% CI: 1.2, 6.8) and experiencing food insecurity with hunger in the last 12 months compared to food-secure children (OR 3.7, 95% CI: 1.4, 9.9). In the absence of support for the acculturation hypothesis, alternative hypotheses to explain the high prevalence of overweight among children of Mexican descent in the US may come from understanding the predictors of children's weight status in sending communities in Mexico.

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Introduction[a]

The prevalence of childhood obesity has increased dramatically in the United States (US) over the past 30 years[1-4], especially among children of Mexican origin[5]. The most recent National Health and Nutrition Survey (NHANES) in 2003-2004 indicated that 37% of Mexican-American children in the US were classified as at risk of overweight or overweight[6]; this percentage is higher than white children in all age groups among both boys and girls[6-9]. Among younger children ages two to five, Mexican-American children are more likely to be classified as at risk of overweight or overweight than African American children with a more pronounced difference among males[6-9]. In addition, overweight children of Mexican origin are an especially high-risk group because of their increased risk for morbidities associated with obesity in adulthood, such as diabetes, cardiovascular disease and uncontrolled hypertension compared to other racial and ethnic groups[10-14].

Researchers of health disparities among Latino immigrants have found that health status appears to decrease with increasing exposure to US society[15, 16]. Foreign-born immigrants in the US tend to be healthier than the native population, but this advantage vanishes and in some cases reverses with increasing time spent and with each successive generation born in the US[17, 18]. The health advantage of recent immigrants has been called the *"Latino health paradox"* because it counters the widely observed association of poor health outcomes and low socioeconomic status[19, 20].

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The most commonly posited hypothesis to explain this paradoxical finding points to acculturation. Acculturation is modification of the culture of a group or individual as a result of continuous, first-hand contact with a different culture[21]. The acculturation hypothesis states that health behaviors related to an immigrant's home culture have a protective effect on health, and as immigrants spend more time in the US they adopt less healthy behaviors that are common in mainstream US culture. While the acculturation hypothesis has been supported in the literature on obesity and diet among adults of Mexican origin[22-27], patterns of obesity among children of Mexican origin remain unclear[28]. A study using data from the from the National Longitudinal Study of Adolescent Health found a significant positive association of increasing acculturation, measured by generational status, and prevalence of overweight and obesity among all Hispanics including those from Puerto Rico, Cuba, Central and South America, however, this was not true for the Mexican-American sub-population[29]. Ariza et al.'s (2004) study of 250 five- and six-year-old Mexican-American children also failed to document an association between acculturation and children's weight status[30].

One possible explanation for an unclear association between acculturation and obesity in children of Mexican origin is the increasing prevalence of obesity in Mexico, as it transitions to an epidemiologic and nutritional profile similar to industrialized countries[31-33]. This transition is characterized by lifestyle changes including sedentary behavior, diets rich in saturated fats and carbohydrates and low fruits and vegetable consumption[34]. Recent nationally representative surveys of the Mexican population have revealed that 67% of adult women and 60% of adult men are classified as overweight or obese[35, 36], which is only slightly lower than the prevalence of overweight and obesity in the general US adult population at 61% for women and 71% for men[37]. A nationally representative survey of Mexican children aged five to 11 years showed that

19.5% of Mexican children were classified as overweight or obese (equivalent to at risk of overweight and overweight by US standards), with the highest prevalence in Mexico City and in Northern Mexico[38]. A second study of 8,241 children aged 24 to 72 months from low-income, rural families in seven Mexican states (Guerrero, Hidalgo, Michoacán, Puebla, Queretaro, San Luis Potosi and Veracruz) found that 17% to 25% were overweight or obese[39]. This research suggests that new immigrants and their children may not arrive in the US with healthier behaviors related to obesity than the mainstream US population, as implied by the acculturation hypothesis. Studies of childhood obesity among children of Mexican descent in the US have not considered this shift in nutritional status in the immigrants' home country. This limitation has led to recommendations in recent publications for the implementation of binational studies comparing Mexican immigrants in the US to Mexicans in their home country[40, 41]. A binational research design enables consideration of current levels of childhood obesity and related factors in Mexico as well as varying levels of acculturation in the US.

In this study, I compare the prevalence of childhood overweight and obesity and related determinants in a sample of five-year-old children born to Mexican immigrant women in California and five-year-old children residing in Mexico in the same areas where the Mexican immigrant women originated. I also consider in the California cohort, the relation of children's weight and acculturation, defined by the number of years the mothers lived in the US. This binational study will contribute to current understanding of health patterns among children of Mexican descent by examining the effects of immigration in addition to acculturation on childhood obesity.

Methods

Study Design and Population

I conducted a binational study using two cross-sectional samples of five-year-old children and their mothers in California and Mexico. The children from California were participants of the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) study, a longitudinal birth cohort of pregnant women and their children living in the agricultural region of Salinas Valley. Pregnant women were recruited from October, 1999 to October, 2000 in six prenatal clinics that serve a predominantly low-income, Spanish-speaking population. Eligible women were 18 years or older, less than 20-weeks gestation at enrollment, English- or Spanish-speaking, Medi-Cal eligible and planned to deliver at the county hospital. Of 601 women initially enrolled, 526 were followed through delivery of a live birth that survived the neonatal period, and 350 children completed the five-year follow-up visit. The visits with five-year-old children were conducted between February, 2005 and August, 2006. Trained bilingual and bicultural interviewers conducted face-to-face interviews with the mothers and measured the height and weight of mothers and children.

Mexican five-year-old children and their mothers were participants in the Proyecto Mariposa study. I designed the Proyecto Mariposa study to capture a sample of women and their children living in Mexico who closely resembled the CHAMACOS sample, yet who never migrated to the US. As seen in Table 1, the majority of the Mexican-born women in the CHAMACOS cohort were from the states of

Table 1. State of birth for CHAMACOS participants, Salinas Valley, California, 2000-2001 (n=384).*

State of birth	No.	(%)
Distrito Federal	13	(3.4)
Guanajuato	78	(20.3)
Hidalgo	12	(3.1)
Jalisco	45	(11.7)
Michoacán	91	(23.7)
Oaxaca	20	(5.2)
Sinaloa	12	(3.1)
Sonora	6	(1.6)

*Only states where more than 5 women were born are included

Guanajuato, Jalisco and Michoacán. To mirror the CHAMACOS sample, Proyecto Mariposa included women and their five-year-old children from high-migration communities in these three states. The communities of Irapuato and Celaya in Guanajuato; Uruapan and Apatzingan in Michoacán; and Tlaquepaque and Zapopan in Jalisco were selected based on the following criteria:

1. The federal social welfare program, *Oportunidades,* operated in the community.
2. For sample size purposes, the communities were large enough to have 120 eligible five-year-old children and mother pairs in Guanajuato and Michoacán and 60 eligible five-year-old children and mother pairs in Jalisco.
3. The most recent Mexican census indicated that the community had a high level of migration.

Women and their five-year-old children were recruited through health clinics participating in the *Oportunidades* program and were eligible to participate if: (1) the child was approximately five years old (59 months to 66 months); (2) the mother and child received the *Oportunidades* health care services; (3) the mother and child lived exclusively in Mexico and had never migrated to the US; and (4) the mother spoke fluent Spanish. Recruiting children through *Oportunidades* reached a similar population as the CHAMACOS population which was also receiving government benefits (Women Infant and Children coupons) and accessing health care. Women who had previously migrated to the US were excluded in order to obtain a sample that had not been directly influenced by migration. Interviewers in Mexico, trained in the same study protocols as the CHAMACOS interviewers, conducted a total of 328 face-to-face interviews and anthropometric measurements with mothers and their five-year-old children from June to August 2006. Informed consent was obtained from all participants.

All protocols, study instruments and consent forms were reviewed and approved by the appropriate Institutional Review Boards in each site.

Children's Weight Status

Children were weighed and measured without jackets and shoes using a calibrated electronic Tanita scale and stadiometers according to identical protocols in each site. I calculated body mass index (BMI) as mass in kilograms divided by height in meters squared and compared to sex-specific BMI-for-age percentile data issued by the Centers for Disease Control and Prevention (CDC) for both samples[42]. The CDC classifies children who are at or above the 85th percentile but less than the 95th percentile as "at risk for overweight" and those at or above the 95th percentile as "overweight".

Independent Variables

A face-to-face interview using a similar questionnaire was administered to mothers in both CHAMACOS and Proyecto Mariposa to measure demographics, proximate determinants of childhood obesity and other related factors. Although the target population in each study was Spanish-speaking and Mexican, the questionnaires were slightly different to reflect the different environments in which each population lived.

Information collected about the children included their age, number of months breastfed, physical activity and inactivity levels, and dietary intake. For physical activity and inactivity, mothers reported on the number of hours their children play outside on an average day and the number of hours spent watching television during a typical weekday and weekend in both samples. Due to non-Gaussian distributions, median daily hours playing outside and watching

television were calculated. Dietary intake was measured using different food frequency questionnaires (FFQ) in each location. In the CHAMACOS sample, an adaptation of the Harvard Service Food Frequency Questionnaire (HSFFQ) for Hispanic children was used. In Proyecto Mariposa, a FFQ developed by the Nutritional Epidemiology Department at the National Institute of Public Health was used. The instruments were similar to each other in that they had the same number of food items in the main food groups, although specific food items varied, and used the same response categories. With both instruments, interviewers asked the mother how many times the child had eaten a certain item in the last month, and women could answer in times per day, times per week or times per month. Using the most appropriate FFQ for each environment allowed for differences in customs and the availability of foods while obtaining equivalent dietary intake measurements. Servings per day or per week were calculated for specific food items such as soda, other sweetened beverages such as juice, fast food and food groups such as fruits and vegetables.

Household level information included food insecurity and socioeconomic status (SES). Household food insecurity was measured using the US Household Food Security Instrument, Spanish Version (Short Form) in both locations [43, 44]. Households were classified into food secure, food insecure without hunger, and food insecure with hunger according to US Department of Agriculture guidelines[43]. Two measurements of SES were created for each sample. First, one indicator for each sample was selected to give a sense of the household's socioeconomic status relative to their respective countries. In the US, I compared the household's per capita income to the national poverty level and classified households as below the poverty level, above the poverty level to less than 200% of the poverty level and greater than 200% of the poverty level. In Mexico, I reported whether the family had dirt, cement or

additional finishing (wood, tile, or other) in their house. Second, a variable for each sample that differentiated between the low, medium and high socioeconomic levels within each sample was created. In the CHAMACOS study, SES was measured using a continuous measure of per capita household income divided into tertiles. In Mexico, housing characteristics and household assets served as proxy measures for SES. I used a principal component analysis to summarize these variables for the Mexican sample and the first principal component was retained[45] and divided into tertiles. Continuous and categorical housing characteristic and asset variables used in the principal component analysis included type of house (owned, rented, borrowed, shared, mortgaged, given as benefit of employment), floor (dirt, cement, wood/tile/other finish), sanitary service (none, latrine, toilet with no plumbing, toilet with plumbing), and kitchen (no separate room, a separate room where people also sleep, a separate room where no one sleeps), as well as televisions (none, black and white, color, more than one color), cars (none, one, new, more than one), number of household appliances (VCR, DVD player, CD player, tape player, microwave, washer, computer, printer, air conditioner and home phone) and number of light bulbs.

Information collected on the mother included her weight status, marital status, educational attainment, work status and maternal perception of her child's weight status, number of years spent in the US for the CHAMACOS mothers and family member migration for the Proyecto Mariposa mothers. The mother's height and weight were measured with shoes and coats removed using an electronic Tanita scale and a stadiometer. Mother's weight status was defined as overweight if her BMI was greater than or equal to 25 and less than 30 and obese if her BMI was 30 or greater. Using the seven drawings of children's body types in Figure 1, interviewers asked mothers two questions about their perception of their child's weight status: (1) What figure looks most like your child's body type? and (2) What figure represents the ideal

body type?[b] I assigned each figure a number from one to seven, with one being the skinniest figure, and calculated an average actual and ideal body type for each sample as well as the average difference between actual and ideal body type. Time spent in the US was used as a proxy for acculturation in the CHAMACOS sample because all women were foreign-born, the majority was monolingual Spanish-speaking and information on other acculturation domains was not available. To determine the extent to which the mother and child may be affected by migration to the US, women were asked if the child's father or the current head of household or any other close family member, including her grandparents, parents, siblings or other children had migrated to the US for work and if any of them were currently residing in the US.

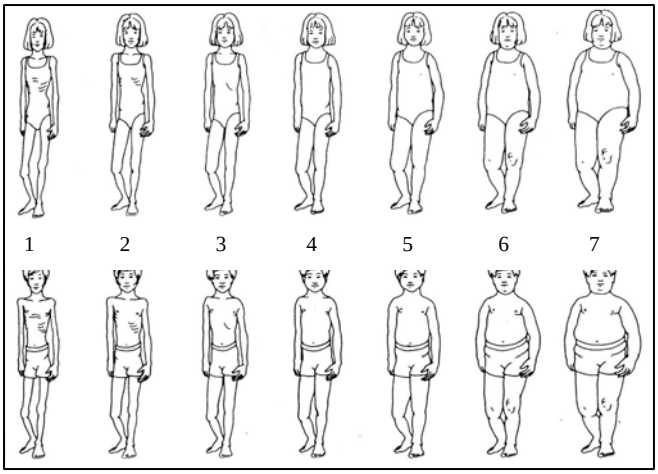

Figure 1. Body type figures 1-7

Statistical Analysis

Statistical analyses were conducted using STATA 10.0 for Windows (STATA Corporation, College Station, TX). For the CHAMACOS sample, the data were limited to Mexican-born mothers and their children with complete anthropometric information. Of the 350 mother-child pairs in the CHAMACOS sample, 45 women who were born in the US and 18 children with incomplete anthropometric information were excluded. The final CHAMACOS sample size was 287 mother-child pairs. In Proyecto Mariposa, 316 children of the initial 328 had complete anthropometric information and were included in this analysis. In the

[b] These questions were asked to only 60 women in the CHAMACOS sample, while they were asked to all mothers in the Proyecto Mariposa study. A slightly higher percentage of children whose mothers answered the body type questions in CHAMACOS were overweight or obese compared to the whole sample (56.7% vs. 53.3%).

CHAMACOS sample, children with missing anthropometric information were more likely to have obese mothers and mothers who had lived in the US less time than children without missing data ($p < 0.05$). Maternal weight status was not associated with missing data in the Proyecto Mariposa sample. There were no significant differences between children with complete or missing anthropometric information in either sample by age, sex, breastfeeding history, maternal education, maternal marital status, household food insecurity status or any dietary intake or physical activity indicator in either sample.

I generated descriptive statistics comparing the two samples using chi-square tests and Fisher's exact test in the case of small cell sizes for categorical variables and t-tests and rank-sum tests for non-Gaussian continuous variables. Within the CHAMACOS sample, I also compared children whose mothers had been in the US 5 to ten years, eleven to fifteen years and sixteen years or more at the time of the interview using chi-square tests and Fisher's exact tests for categorical variables and one-way analysis of variance (ANOVA) and Kruskal-Wallis tests for non-Gaussian continuous variables.

To establish the most important determinants of being classified as at risk of overweight or overweight ($\geq 85^{th}$ percentile) among children in CHAMACOS and Proyecto Mariposa, I used logistic regression models and report crude and adjusted odds ratios (OR) and 95% confidence intervals (CI). For the crude analysis, I chose demographic and behavioral variables that have been shown in the literature to be associated with children's weight status or that I hypothesized to be associated with children's weight status in this population a priori. For the multivariate logistic regression analysis, I considered variables for inclusion if they were moderately related to the outcome ($p < 0.2$) in the crude analysis for either sample or if they were of *a priori* interest. I considered mother's weight status, mother's marital status, SES, household food

security, soda or other sweetened beverage consumption, fast food consumption, hours spent watching TV, and hours spent playing outside as potential determinants of childhood weight status in each country. In addition, I examined mother's time spent in the US in the model for CHAMACOS and migration experience in the model for Proyecto Mariposa. I used a manual backwards stepwise elimination procedure and removed variables from the model one at a time using the likelihood ratio test to determine if the model's fit improved. The final model was the best fit model which included the significant determinants of childhood weight status. Lastly, I investigated interaction by sex in the final models for each sample.

Results & Discussion

Sample Characteristics

General characteristics of each sample are presented in Table 2. Although the average mother's age was the same in both studies (33 years), children in CHAMACOS were significantly younger than those in Proyecto Mariposa. This is likely due to the fact that in the longitudinal CHAMACOS study, children were interviewed as close to their five-year birthday as possible while Proyecto Mariposa interviews were not. The children's average age was 60.3 months ($\pm$ 0.1 months) in CHAMACOS, compared to 64.7 months ($\pm$ 0.2 months) in Proyecto Mariposa (p-value < 0.001). As expected, both samples reported high levels of poverty relative to the respective countries. In CHAMACOS, the majority reported per capita incomes less than the national poverty level, and the majority of mothers in the Proyecto Mariposa study reported living in houses with dirt or concrete floors as opposed to a finished floor (i.e. tile, wood, carpet).

Over 40% of Proyecto Mariposa mothers reported that their partner or other close family member (grandparents, parents, siblings, or other children) was currently living in the US,

revealing that the study design was successful in capturing a group of mothers and their children residing in high-migration communities in Mexico. However, despite the fact that the mothers in both samples shared a common Mexican background, the CHAMACOS and Proyecto Mariposa samples differed in several ways. CHAMACOS mothers reported slightly higher levels of education than Proyecto Mariposa mothers, suggesting that higher education levels may be associated with an increased likelihood of migration. Work status significantly differed between the two groups of mothers as well. CHAMACOS mothers were more likely to be working and to work a greater number of hours than Proyecto Mariposa mothers. Mothers also differed in the extent to which they breastfed. Proyecto Mariposa mothers were more likely to breastfeed for six months exclusively than CHAMACOS mothers. Because cultural beliefs regarding breastfeeding are likely similar, this difference may reflect different maternal work patterns or adoption of US breastfeeding norms by CHAMACOS mothers. While the majority of mothers in both studies were classified as overweight or obese, the prevalence of obesity was higher at 49% among mothers in the CHAMACOS study compared to 33% in Proyecto Mariposa. This is possibly due to weight gain since migrating to the US for the CHAMACOS mothers. Finally, CHAMACOS mothers reported less food insecurity than mothers from Proyecto Mariposa, who reported significantly more household food insecurity, both with and without hunger, indicating that migration may increase food security for Mexican families. These differences suggest that immigration impacts mothers and their families in several ways that may influence the childhood obesity prevalence in both groups.

Overall, approximately half of the women in CHAMACOS had been in the US fewer than five years when the index child was born (five to 10 years at the time of the interview). The length of time the mother had lived in the US at the time of the interview was not significantly

associated with any of the demographic characteristics, as seen in Table 2. CHAMACOS mothers may be relatively homogenous in their level of acculturation or it is possible that the number of years the mother lived in the US may not have captured true acculturation levels.

Diet and Physical Activity, and Maternal Perception of Weight Status

In terms of sedentary and physical activity indicators, children in CHAMACOS and Proyecto Mariposa appeared to watch similar amounts of television, while Proyecto Mariposa children spent more time playing outside according to maternal report (Table 3). This is an important difference with respect to childhood obesity; however, CHAMACOS mothers may not have been able to accurately report their children's time spent playing outside because they were more likely to be working away from home. In regard to diet, compared to CHAMACOS mothers, Proyecto Mariposa mothers reported that their children consumed more soda, but fewer other sweetened beverages. Overall, according to maternal report CHAMACOS children consumed more total sweetened beverages, including juice and soda, per day than Proyecto Mariposa children with median drinks per day of 1.5 and 1.2, respectively, ($p < 0.001$, data not shown). Median intake levels of junk food and vegetables were similar for both groups while fruit intake was significantly higher for CHAMACOS compared to Proyecto Mariposa (3.0 times/day vs. 1.4 times/day, $p < 0.001$). Thus, dietary indicators do not suggest that either group of children has a healthier diet, except that CHAMACOS children consumed more total sweetened beverages.

Children's physical activity and dietary intake varied little by mother's years in the US except that mothers in the middle group living 11 to 15 years in the US reported more sweetened beverage consumption and less vegetable consumption compared to mothers who had been in the

US fewer than 11 years or more than 15 years ($p < 0.05$). The acculturation hypothesis would suggest that physical activity and dietary indicators would worsen with mother's increased time spent in the US, however, these data do not conclusively support that hypothesis.

Mother's perception of their child's actual weight did not differ significantly between the two groups, despite a much higher prevalence of overweight and obesity in the CHAMACOS sample. Although I did not observe any significant difference of maternal perception by mother's years in the US, mothers' perception of an ideal body type was larger in Proyecto Mariposa than CHAMACOS. This sentiment was reflected in the average difference between actual and ideal body types with Proyecto Mariposa mothers wanting their children to be larger and CHAMACOS children wanting their children to be smaller.

Weight Status

This study's findings do not support the immigration hypothesis but, rather, reveal that children of Mexican descent who live in the US are at significant increased risk of becoming overweight compared to their peers who remain in Mexico, see Figure 2. No significant differences in weight status were detected by mother's years in the US, although a greater percentage of children born to women in the 11 to 15 years group were classified as at risk for overweight or overweight (60%) compared to children born to mothers in the lower and upper categories (50% and 51% respectively). Significantly more children were classified above the 85^{th} percentile in CHAMACOS compared to Proyecto Mariposa (53.3% versus 14.9%, $p < 0.001$). More children in CHAMACOS were classified as overweight than at risk of overweight.

The crude odds ratios and 95% confidence intervals for weight status according to demographic and behavioral characteristics are presented in Table 4. Having an obese mother

was significantly associated with being at risk of overweight or overweight (> 85th percentile of BMI) in both samples ($p \leq 0.01$). No other characteristics or behaviors were significantly associated with the child's weight status in the CHAMACOS sample. Among the Mexican children from Proyecto Mariposa, the odds of males being classified above the 85th percentile was 1.8 times that for girls with borderline significance (95% CI: 0.96, 3.38). Children who drank one to six sodas a week compared to fewer sodas had an increased odds of being classified as at risk of overweight or overweight (OR 3.20 95% CI: 1.20, 8.51), but surprisingly, the odds ratio associated with drinking one or more sodas a day was not significant. There also appeared to be differences in children's weight status by socioeconomic status and household food insecurity in this sample. The odds of being at risk of overweight or overweight for Proyecto Mariposa children in the highest socioeconomic level were 2.24 times higher than those in the lowest level (95% CI: 0.99, 5.04) while the odds for children living in households with food insecurity and hunger were 2.57 times higher than those living in food secure households (95% CI: 1.01, 6.54).

The results of the adjusted logistic regression are presented in Table 4. The only significant determinant of children's weight status in the CHAMACOS sample was mother's weight status. Although this may suggest a genetic component to weight status, the parent's weight status may also reflect characteristics of the environment shared with the child, which may be more important. The odds of being at risk of overweight or overweight were 1.4 times higher for children whose mothers had lived in the US 11 to 15 years compared to less time, but this was not statistically significant. Thus these data do not lend support to the acculturation hypothesis in regard to childhood obesity. There was no evidence of interaction by sex in the CHAMACOS sample.

Aside from maternal weight status, important determinants of childhood weight status in Proyecto Mariposa included SES and household food security. The odds of being classified as at risk of overweight or overweight were significantly positively associated with having an obese mother versus a normal-weight or overweight mother (OR 2.4, 95% CI: 1.3, 4.6), living in households in the upper socioeconomic status level compared to the lowest SES level (OR 2.9, 95% CI: 1.2, 6.8) and experiencing food insecurity with hunger in the last 12 months compared to food-secure children (OR 3.7, 95% CI: 1.4, 9.9). The odds ratio associated with household food insecurity with hunger increased from 2.6 (95% CI: 1.0, 6.5) in the crude analysis to 3.7 (CI: 1.4, 9.8) in the multivariate model. In addition, I detected evidence for interaction by sex in the association between household food insecurity and child weight status. The magnitude of the association for household food insecurity with hunger and child weight status was greater among boys (OR 8.4 95% CI: 1.9, 37.0) than girls (OR 1.3 95% CI: 0.3, 5.7). Behavioral characteristics such as physical activity and inactivity levels and dietary intake were not significantly associated with weight status in either sample.

Conclusion

In a comparison of children of Mexican descent living in migrant communities in California and Mexico, I found the prevalence of at risk of overweight and overweight to be significantly higher among children living in California compared to children living in Mexico (53% vs. 15%), while I found no significant differences according to acculturation level of the mother. In the absence of support for the acculturation hypothesis, alternative hypotheses to explain the high prevalence of overweight among children of Mexican descent in the US may

come from understanding the predictors of children's weight status in sending communities in Mexico.

In the Mexican sample, in addition to mother's weight status, SES and household food insecurity were important risk factors associated with childhood overweight, especially among boys. The children in Proyecto Mariposa were recruited from the *Oportunidades* social welfare program (previously *Progresa*) in Mexico, which serves the lowest quintile of income in Mexico. Within this low-income sample, higher SES was associated with increased odds of overweight. This may help us to understand why in the US, where migrant families benefit from higher SES compared to Mexico, as evidenced by higher maternal educational attainment and less food insecurity, the prevalence of childhood obesity is much higher.

I also found that household food insecurity with hunger was associated with an increased odds of being classified above the 85th percentile among Mexican boys. Household food insecurity is thought to lead to obesity when people who must limit their food costs select low-cost, energy-dense food to maintain an adequate energy intake or when intermittent periods of food insecurity lead to overeating when food is available[46]. It is possible that in food insecure households in Mexico, limited resources for food are devoted more to boys than girls. It is unclear how this may help to explain high prevalence of overweight among children of Mexican descent in the US, as I observed lower levels of food insecurity in the California sample. However, it does provide insight into possible behaviors among the Mexican immigrant mothers. Mexican immigrant mothers in the US, who likely experienced similar or worse levels of food insecurity during their childhood in Mexico as the levels I observed in this study, may compensate now that they are in the US and can afford more by giving their own children what

they did not have. If this results in consumption of large portion sizes of food or junk foods and fast food, their children may be at increased risk for becoming overweight.

The fact that both household food insecurity and high SES were independently associated with an increased odds of at risk for overweight or overweight in Mexico is of interest. It is possible that both of these factors contribute to increased consumption of energy-dense foods, in different ways. Overeating during times when food is available may lead to higher weight status in children from food insecure households while children in higher SES households may have increased access to energy-dense foods compared to children in lower SES households.

Indicators of physical activity and dietary intake were not associated with children's weight status in this study. However, I found that neither group appeared to have a healthier diet according to the indicators we investigated. While children in Mexico ate less fast food, they consumed more soda and fewer vegetables. Public health campaigns in the US targeting Mexican-Americans often promote the "traditional" Mexican diet to promote healthy weight status. Although further research is needed to characterize current Mexican food consumption patterns, these results suggest that the traditional diet may not be healthier. Elucidating the mechanisms whereby SES and household food insecurity influence children's dietary intake in Mexico may help us to better understand the high prevalence of overweight among children of Mexican descent in the US.

This is the first study to collect data on similar populations of Mexican children living in migrant communities the US and Mexico. Although the study has several limitations[c], these data

[c] First, the proxy measure of acculturation of length of residence in the US may not have been sufficient for measuring the domain(s) of acculturation important for childhood obesity. Recent research on acculturation has offered a more multidimensional conceptualization of the process whereby individuals may retain their original culture in some domains while also adapting the new culture in other domains[47-51]. It may be important to measure the specific areas of acculturation related to obesity, such as dietary acculturation in order to better understand the association between acculturation and childhood obesity. Second, although I made every attempt to recruit comparable samples and collect equivalent data in each site, our samples may have been too different and data

clearly show that children of Mexican descent living in the receiving communities in the US are at increased risk for becoming overweight compared to children that remain in the sending communities in Mexico. SES and household food security were identified as correlates of child weight status in Mexico, which offer some insight into possible reasons for the high prevalence of overweight among Mexican children in the US. Future research examining the impacts of SES and household food insecurity on dietary consumption patters in Mexico is needed to understand the underlying mechanism of how these factors influence children's weight status.

collection instruments incapable of collecting the same information in both sites thus making any comparisons difficult. Finally, this was a cross-sectional study, which limits our ability to infer any causality.

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Table 2. Selected socio-demographic characteristics of participants, CHAMACOS (Salinas, CA) and Proyecto Mariposa (Guanajuato, Jalisco, and Michoacan, Mexico) 2006.

Characterisitc	Proyecto Mariposa	CHAMACOS		CHAMACOS: Mother's Years in the US			
				5-10 years	11-15 years	16 years or more	
	n = 316	n = 287		n = 160	n = 92	n = 53	
	n (%)	n (%)	p-value	n (%)	n (%)	n (%)	p-value
Child sex			0.98				0.80
Male	149 (47.2)	135 (47.0)		71 (49.0)	40 (44.9)	24 (45.3)	
Female	167 (52.9)	152 (53.0)		74 (51.0)	49 (55.1)	29 (54.7)	
Exclusively breastfed ≥ 6 months			<0.001				0.47
No	100 (31.7)	35 (12.3)		16 (11.1)	14 (15.7)	5 (9.6)	
Yes	216 (68.4)	250 (87.7)		128 (88.9)	75 (84.3)	47 (90.4)	
Mother's weight status			<0.001				0.10*
Normal	78 (24.7)	37 (12.9)		24 (16.6)	9 (10.1)	4 (7.6)	
Overweight	132 (41.8)	110 (38.3)		61 (42.1)	32 (36.0)	17 (32.1)	
Obese	106 (33.5)	140 (48.8)		60 (41.4)	48 (53.9)	32 (60.4)	
Mother's education							0.30
Elementary or less	217 (68.7)	142 (49.5)	<0.001	66 (45.5)	51 (57.3)	25 (47.2)	
Middle or high school	93 (29.4)	101 (35.2)		52 (35.9)	27 (30.3)	22 (41.5)	
High school graduate or more	6 (1.9)	44 (15.3)		27 (18.6)	11 (12.4)	6 (11.3)	
Married or living as married			0.05				0.66
No	21 (6.7)	32 (11.2)		14 (9.7)	12 (13.5)	6 (11.3)	
Yes	295 (93.4)	255 (88.9)		131 (90.3)	77 (86.5)	47 (88.7)	
Mother's work status			<0.001				0.27*
Not working	203 (64.0)	86 (28.2)		48 (30.0)	27 (29.4)	11 (20.8)	
Work less than 20 hours/week	54 (17.0)	15 (4.9)		6 (3.8)	4 (4.4)	5 (9.4)	
Work 20 to 40 hours/week	22 (6.9)	68 (22.3)		31 (19.4)	20 (21.7)	17 (32.1)	
Work more than 40 hours/week	38 (12.0)	136 (44.6)		75 (46.9)	41 (44.6)	20 (37.7)	
Household food insecurity			<0.001				0.50*
Secure	78 (24.7)	172 (59.9)		93 (64.1)	50 (56.2)	29 (54.7)	
Insecure without hunger	149 (47.2)	87 (30.3)		39 (26.9)	28 (31.5)	20 (37.7)	
Insecure with hunger	89 (28.2)	28 (9.8)		13 (9.0)	11 (12.4)	4 (7.6)	
Percent poverty categories							.43*
At or below poverty level		187 (65.4)		111 (69.8)	58 (63.0)	32 (60.4)	
Poverty level - 200% poverty		92 (32.2)		44 (27.7)	33 (35.9)	19 (35.9)	
> 200% poverty level		7 (2.5)		4 (2.5)	1 (1.1)	2 (3.8)	
Type of floor in house							
Dirt	60 (19.0)						
Cement	221 (69.9)						
Wood, tile or other finish	35 (11.1)						
Family member currently in US[a]							
No	176 (55.7)						
Yes	140 (44.3)						

[a] Family member includes child's father or the current head of household and the mother's grandparents, parents, siblings, or other children

* Fisher's exact test used due to small cell sizes

Figure 2. Children's weight status in Proyecto Mariposa, CHAMACOS, and CHAMACOS by mother's years in the US

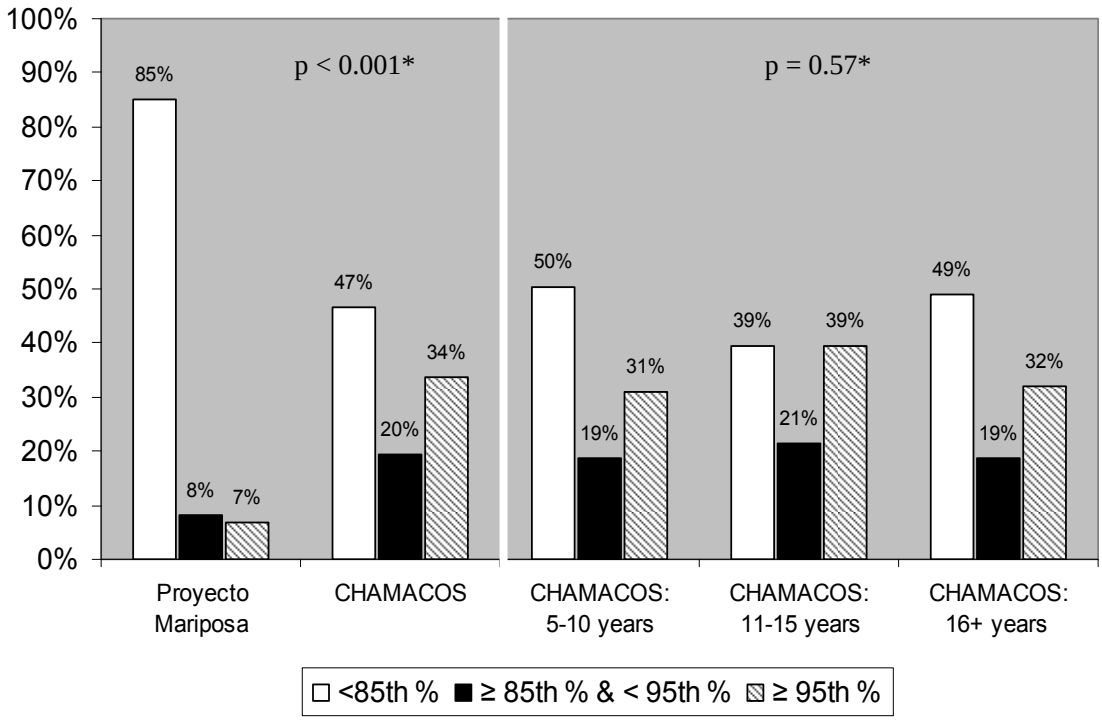

Table 3. Median and interquartile range (IQR) for physical activity, dietary intake and perception of body type by sample, CHAMACOS (Salinas, CA) and Proyecto Mariposa (Guanajuato, Jalisco, and Michoacan, Mexico) 2006.

Behavior	Proyecto Mariposa		CHAMACOS			CHAMACOS: Mother's Years in the US						
						5-10 years		11-15 years		16 years or more		
	n = 316		n = 287			n = 160		n = 92		n = 53		
	median	(IQR)	median	(IQR)	p-value†	median	(IQR)	median	(IQR)	median	(IQR)	p-value‡
Physical Activity/Inactivity												
TV hours per day[a]	1.3	(0.9 , 2.4)	1.7	(1.0 , 2.4)	0.15	1.6	(0.9 , 2.4)	1.7	(1.0 , 2.6)	1.7	(1.5 , 2.6)	0.17
Playing outside hours per day[a]	3.0	(2.0 , 5.0)	2.0	(1.0 , 3.0)	<0.001	2.0	(1.0 , 3.0)	2.0	(1.0 , 3.0)	2.0	(1.0 , 3.0)	0.41
Dietary intake indicators[b]												
Sodas per week	3.0	(1.0 , 3.0)	1.0	(0.0 , 3.0)	≤0.001	1.0	(0.0 , 3.0)	1.0	(0.5 , 3.0)	1.0	(0.0 , 3.0)	0.19
Other sweetened beverages per day	0.8	(0.4 , 1.1)	1.1	(0.8 , 2.5)	≤0.001	1.0	(0.5 , 2.5)	1.8	(0.9 , 2.9)	1.2	(0.9 , 2.9)	0.02
Fast food per week	0.0	(0.0 , 0.0)	1.0	(0.5 , 1.0)	≤0.001	1.0	(0.5 , 1.0)	1.0	(0.5 , 1.0)	1.0	(1.0 , 1.0)	0.06
Junk food per day[c]	2.0	(1.1 , 3.2)	2.1	(1.4 , 3.3)	0.17	2.1	(1.4 , 2.9)	2.3	(1.4 , 3.3)	2.1	(1.2 , 3.5)	0.80
Fruits per day[d]	1.4	(0.9 , 2.2)	3.0	(2.1 , 4.4)	≤0.001	3.1	(2.2 , 4.3)	2.9	(2.1 , 4.2)	3.1	(2.0 , 4.8)	0.79
Vegetables per day[ae]	2.6	(1.6 , 3.9)	2.6	(1.6 , 3.7)	0.30	2.6	(1.8 , 3.9)	2.4	(1.6 , 3.4)	2.6	(1.6 , 3.7)	0.03
Perception of body type												
Actual body type[a]	3.6	(3.0 , 4.0)	3.7	(3.0 , 5.0)	0.345	3.6	(3.0 , 5.0)	3.9	(3.0 , 5.0)	3.8	(3.0 , 4.0)	0.84
Ideal body type[a]	4.1	(4.0 , 5.0)	3.7	(3.0 , 4.0)	≤0.001	3.9	(3.0 , 4.0)	3.7	(3.0 , 4.0)	3.5	(3.0 , 3.0)	0.25
Difference between actual and ideal body type[a]	0.5	(0.0 , 1.0)	-0.1	(-1.0 , 1.0)	≤0.001	0.3	(0.0 , 1.0)	-0.3	(-1.0 , 0.5)	-0.3	(-2.0 , 1.0)	0.46

† Rank-sum test or t-test if indicated

‡ Kruskal -Wallis test or one way ANOVA if indicated

[a] T-test and ANOVA used for normally distributed data

[b] Mother's report of how many times the child consumed the item, serving sizes were not specified

[c] In CHAMACOS, the following 12 junk food categories were included: chips (potato, corn or others), nuts, cookies or brownies, cake or cupcake, pie, jello, chocolate or candy bar, other candy (not chocolate), ice cream, pudding, doughnut, pastry. In Proyecto Mariposa, the following 10 junk food categories were included: chocolate candy, other candy, deep fried snacks (potato chips, pork skin and others), jello or flan, cake or pie, nuts, packaged pastries, cookies, cereal bars, ice cream, sweet breads, doughnuts or churros

[d] In CHAMACOS, the following 11 fruit categories were included: banana, peaches, fuit cocktail or mixed fruit, orange or grapefruit, apple or pear, applesauce, grapes, strawberries, melon, pineapple, raisins or prunes. In Proyecto Mariposa, the following 11 fruit categories were included: fruits included banana, fried banana, orange or mandarine, apple or pear, melon or watermelon, guava, mango, papayay, pineapple, grapefruit, and strawberry

[e] In CHAMACOS, the following 14 vegetable categories were included: corn, peas, tomatoes or tomato sauce or salsa, peppers (green, red or hot), carrots, broccoli, green beans, spinach, greens (mustard, turnip, kale), mixed vegetables, squash (orange or winter), zucchini (yellow or squash), cabbage or cauliflower, lettuce. In Proyecto Mariposa, the following 14 vegetable categories were included: tomato, greens (swiss chard, spinach, or quelites-a local green), chayote, carrot, zucchini, broccoli or cauliflower, cabbage, green beans, corn, lettuce, nopal, cucumber, avocado

Table 4. Selected characteristics and behaviors and crude odds ratios with 95% confidence intervals for weight status, CHAMACOS (Salinas, CA) and Proyecto Mariposa (Guanajuato, Jalisco, and Michoacan, Mexico) 2006.

Characterisitc/Behavior	CHAMACOS n = 287				Proyecto Mariposa n=316			
	<85th % n (%)	≥ 85th % n (%)	Crude OR	95% Confidence Interval	<85th % n (%)	≥ 85th % n (%)	Crude OR	95% Confidence Interval
Total*	134 (46.7)	153 (53.3)			269 (85.1)	47 (14.9)		
Sex								
Female	69 (45.4)	83 (54.6)	1.00		148 (88.6)	19 (11.4)	1.00	
Male	65 (48.2)	70 (51.9)	0.90	(0.56 , 1.42)	121 (81.2)	28 (18.8)	1.80	(0.96 , 3.38)‡
Mother's weight status								
Normal	22 (59.5)	15 (40.5)	1.00		74 (94.9)	4 (5.1)	1.00	
Overweight	60 (54.6)	50 (45.5)	1.22	(0.57 , 2.60)	113 (85.6)	19 (14.4)	3.11	(1.02 , 9.51)†
Obese	52 (37.1)	88 (62.9)	2.48	(1.18 , 5.20)†	82 (77.4)	24 (22.6)	5.41	(1.79 , 16.33)†
Exclusively breastfed ≥ 6 months								
No	17 (48.6)	18 (51.4)	0.92	(0.45 , 1.86)	83 (83.0)	17 (17.0)	1.27	(0.66 , 2.43)
Yes	116 (46.4)	134 (53.6)	1.00		186 (86.1)	30 (13.9)	1.00	
Socioeconomic Status[a]								
Tertile 1	62 (47.0)	70 (53.0)	1.00		95 (90.5)	10 (9.5)	1.00	
Tertile 2	27 (45.0)	33 (55.0)	1.08	(0.59 , 2.00)	87 (83.7)	17 (16.4)	1.86	(0.81 , 4.27)
Tertile 3	44 (46.8)	50 (53.2)	1.01	(0.59 , 1.71)	85 (81.0)	20 (19.1)	2.24	(0.99 , 5.04)†
Mother's education								
Elementary or less	61 (43.0)	81 (57.0)	1.00		187 (86.2)	30 (13.8)	1.00	
Middle or high school	53 (52.5)	48 (47.5)	0.68	(0.41 , 1.14)	76 (81.7)	17 (18.3)	1.39	(0.73 , 2.68)
High school graduate or more	20 (45.5)	24 (54.6)	0.90	(0.46 , 1.78)	6 (100.0)	0 (0.0)		
Married or living as married								
No	18 (56.3)	14 (43.8)	0.65	(0.31 , 1.36)	20 (95.2)	1 (4.8)	0.27	(0.04 , 2.07)
Yes	116 (45.5)	139 (54.5)	1.00		249 (84.4)	46 (15.6)	1.00	
Household food insecurity								
Secure	81 (47.1)	91 (52.9)	1.00		71 (91.0)	7 (9.0)	1.00	
Insecure without hunger	42 (48.3)	45 (51.7)	0.95	(0.57 , 1.60)	127 (85.2)	22 (14.8)	1.76	(0.72 , 4.32)
Insecure with hunger	11 (39.3)	17 (60.7)	1.38	(0.61 , 3.11)	71 (79.8)	18 (20.2)	2.57	(1.01 , 6.54)†
Daily TV time								
1 hour or less	27 (45.9)	36 (54.1)	1.00		120 (87.0)	18 (13.0)	1.00	
1 to 2 hours	42 (49.5)	45 (50.5)	0.86	(0.49 , 1.54)	68 (80.0)	17 (20.0)	1.67	(0.81 , 3.45)
Greater than 2 hours	65 (44.6)	72 (55.5)	1.06	(0.59 , 1.88)	81 (87.1)	12 (12.9)	0.99	(0.45 , 2.16)
Time spent playing outside								
1 hour or less	50 (44.3)	63 (55.8)	1.00		31 (75.6)	10 (24.4)	1.00	
2 to 3 hours	63 (50.8)	61 (49.2)	0.77	(0.46 , 1.28)	124 (87.9)	17 (12.1)	0.43	(0.18 , 1.02)
4 hours or more	21 (42.0)	29 (58.0)	1.10	(0.56 , 2.15)	114 (85.1)	20 (14.9)	0.54	(0.23 , 1.28)
Soda consumption[b]								
Less than 1 per week	55 (50.0)	55 (50.0)	1.00		68 (93.2)	5 (6.9)	1.00	
1 to 6 per week	70 (45.8)	83 (54.3)	1.19	(0.73 , 1.94)	153 (81.0)	36 (19.1)	3.20	(1.20 , 8.51)†
1 a day or more	9 (37.5)	15 (62.5)	1.67	(0.67 , 4.13)	48 (88.9)	6 (11.1)	1.70	(0.49 , 5.89)
Other sweetened beverage consumption								
Less than 1 per day	50 (44.6)	62 (55.4)	1.00		166 (84.7)	30 (15.3)	1.00	
1 to less than 2 per day	23 (42.6)	31 (57.4)	1.09	(0.56 , 2.09)	61 (85.9)	10 (14.1)	0.91	(0.42 , 1.97)
2 or more perday	61 (50.4)	60 (49.6)	0.79	(0.47 , 1.33)	42 (85.7)	7 (14.3)	0.92	(0.38 , 2.24)
Fast food consumption[b]								
Less than once per week	47 (45.2)	57 (54.8)	1.00		260 (86.4)	46 (13.7)	1.00	
Once a week or more	86 (47.5)	95 (52.5)	0.91	(0.56 , 1.48)	8 (77.3)	1 (22.7)	1.86	(0.85 , 4.08)
Junk food consumption								
Less than 1 per day	18 (43.9)	23 (56.1)	1.00		47 (81.0)	11 (19.0)	1.00	
1 to less than 2 per day	36 (44.4)	45 (55.6)	0.98	(0.46 1.20)	83 (89.3)	10 (10.8)	0.51	(0.20 , 1.30)
2 or more perday	80 (48.5)	85 (51.5)	0.83	(0.42 , 1.65)	139 (84.2)	26 (15.8)	0.80	(0.37 , 1.74)
Fruit consumption[b]								
Less than 1 per day	9 (56.3)	7 (43.8)	1.00		96 (85.0)	17 (15.0)	1.00	
1 to 2 per day	21 (48.8)	22 (51.2)	1.35	(0.42 , 4.27)	96 (86.5)	19 (16.5)	1.12	(0.55 , 2.28)
2 per day or more	104 (45.6)	124 (54.4)	1.53	(0.55 , 4.26)	77 (87.5)	11 (12.5)	0.81	(0.36 , 1.82)
Vegetable consumption[b]								
Less than 1 per day	18 (52.9)	16 (47.1)	1.00		21 (84.0)	4 (16.0)	1.00	
1 to 2 per day	27 (39.7)	41 (60.3)	1.71	(0.74 , 3.92)	68 (82.9)	14 (17.1)	1.08	(0.32 , 3.64)
2 per day or more	89 (48.1)	96 (51.9)	1.21	(0.58 , 2.52)	180 (86.1)	29 (13.9)	0.85	(0.27 , 2.64)
Mother's years in the US								
5-10 years	73 (50.3)	72 (49.7)	1.00					
11-15 years	35 (39.3)	54 (60.7)	1.56	(0.92 , 2.67)‡				
16 + years	26 (49.1)	27 (50.9)	1.05	(0.56 , 1.98)				
Family member currently in US[c]								
No					116 (82.9)	24 (17.1)	1.00	
Yes					153 (86.9)	23 (13.1)	0.73	(0.39 , 1.35)

* Row percentages

[a] Socioeconomic status was determined by a principal component analysis of housing

[b] Mother's report of how many times the child consumed the item, serving sizes were not specified

† p<0.05

‡ p<0.01

Table 5. Predictors of at risk for overweight and overweight (≥ 85th percentile), CHAMACOS (Salinas, CA) and Proyecto Mariposa (Guanajuato, Jalisco, and Michoacan, Mexico) 2006.

	Overall		Boys		Girls	
	Adjusted Odds Ratio*	(95% CI)	Adjusted Odds Ratio*	(95% CI)	Adjusted Odds Ratio*	(95% CI)
CHAMACOS, n = 285						
Mother's weight status						
Normal or overweight	ref		ref		ref	
Obese	2.1	(1.3 , 3.4)†	2.4	(1.2 , 4.9)‡	1.9	(1.0 , 3.6)
Mother's years in the US						
5-10 years	ref		ref		ref	
11-15 years	1.4	(0.8 , 2.5)	1.3	(0.6 , 2.9)	1.6	(0.7 , 3.3)
16 + years	0.9	(0.5 , 1.7)	0.9	(0.4 , 2.4)	0.9	(0.4 , 2.2)
Proyecto Mariposa, n = 316						
Mother's weight status						
Normal or overweight	ref		ref		ref	
Obese	2.4	(1.3 , 4.6)‡	2.2	(0.9 , 5.4)	3.0	(1.1 , 8.0)‡
Socioeconomic Status[a]						
Tertile 1	ref		ref		ref	
Tertile 2	2.1	(0.9 , 4.9)	3.1	(1.0 , 9.2)†	1.4	(0.3 , 6.5)
Tertile 3	2.9	(1.2 , 6.8)†	3.8	(1.1 , 12.9)†	2.8	(0.7 , 11.3)
Household food insecurity						
Secure	ref		ref		ref	
Insecure without hunger	2.0	(0.8 , 5.1)	2.5	(0.6 , 10.2)	1.7	(0.5 , 6.0)
Insecure with hunger	3.7	(1.4 , 9.9)‡	8.4	(1.9 , 37.0)†	1.3	(0.3 , 5.7)

* Adjusted for all other variables listed.

[a] Socioeconomic status was determined by a principal component analysis of housing characteristics and assets in Proyecto Mariposa.

† p≤0.05

‡ p≤0.01

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