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Bimodal Distribution of Risk for Childhood Obesity in Urban Baja California, Mexico

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ABSTRACT *In Mexico, higher socioeconomic status (SES) has been found to be associated with increased risk for obesity in children. Within developed urban areas, however, there may be increased risk among lower SES children. Students in grades 4–6 from five public schools in Tijuana and Tecate, Mexico, were interviewed and weight, height and waist circumference (WC) measurements were taken. Interviews consisted of questions on food frequency, food insecurity, acculturation, physical activity and lifestyle practices. Multivariate logistic models were used to assess risk factors for obesity (having a body mass index [BMI] ≥95th percentile) and abdominal obesity (a WC >90th percentile) using Stata 11.0. Five hundred and ninety students were enrolled; 43.7% were overweight or obese, and 24.3% were obese and 20.2% had abdominal obesity. Independent risk factors for obesity included watching TV in English (odds ratio [OR] 1.60, 95% confidence interval [CI] 1.06–2.41) and perceived child food insecurity (OR 1.57, 95% CI 1.05–2.36). Decreased risk for obesity was associated with female sex (OR 0.64, 95% CI 0.43–0.96), as was regular multivitamin use (OR 0.63, 95% CI 0.42–0.94). Risk obesity was also decreased with increased taco consumption (≥1×/week; OR 0.64, 95% CI 0.43–0.96). Independent risk factors for abdominal obesity included playing video games ≥1×/week (OR 1.18, 95% CI 1.11–2.96) and older age group (10–11 years, OR 2.47, 95% CI 1.29–4.73 and ≥12 years, OR 2.21, 95% CI 1.09–4.49). Increased consumption of tacos was also associated with decreased risk for abdominal obesity (≥1×/week; OR 0.56, 95% CI 0.40–1.00). We found a bimodal distribution for risk of obesity and abdominal obesity in school aged children on the Mexican border with the United States. Increased risk for obesity and abdominal obesity were associated with factors indicative of lower and higher SES including watching TV in English, increased video game playing and perceived food insecurity. Increased consumption of tacos (≥1×/week) was associated with decreased risk, possibly suggesting an association with children from middle income families. Regular multivitamin use was protective and future studies may focus on micronutrient supplementation as a means to prevent obesity in children or further investigate factors associated with vitamin use. Additionally, future studies need to examine the processes of acculturation on both sides of the US–Mexican border that contribute to increased risk for obesity in children in relation to SES.*

KEYWORDS *Obesity, Mexico, Acculturation, SES*

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BACKGROUND

Obesity in Mexican Children

Mexican children have a high prevalence of overweight (≥85th percentile body mass index [BMI]) and obesity (≥95th percentile BMI) with national prevalence of overweight estimated at 26.3% for children age 2–18 years from the Mexican National Health and Nutrition Survey 2006 (ENSANUT).[1] Mexican adolescents have a higher prevalence estimated at 30.9%.[1] The prevalence of overweight and obesity are highest in the children from families in the higher socioeconomic (SES) brackets with the prevalence in school children from the highest SES tertile almost two times higher than those in the lowest tertile.[1] Additionally, areas of Mexico with a greater concentration of economic development, such as Northern Mexico and urban areas, have a higher percentage of overweight and obese children compared with less developed regions. Correspondingly, national data have shown that children from the highest SES groups have excessive fat dietary intakes.[2] Within highly developed urban areas, however, data suggest that lower socioeconomic status (SES) and food insecurity/hunger are both associated with increased risk for obesity in school children.[3]

Obesity and Acculturation

A growing body of literature examines the relationship between acculturation to the United States and risk for obesity in Latinos. In studies with adults and adolescents, second-generation Latinos and Latinos with greater residence time in the United States are more likely to be obese compared with the first generation primarily due to poor dietary practices and lower physical activity levels.[4–6] Similar trends of a high prevalence of childhood obesity are seen in Northern Mexican populations bordering on the United States, particularly in the urban areas of Ensenada, Tijuana and Tecate,[7–9] with some studies suggesting that the high socioeconomic Mexicans who have adopted more of an American lifestyle, including increased soda and fast food consumption, are at greater risk for obesity.[7] However, the specific dietary and lifestyle factors associated with increased risk of obesity in border Mexican communities have not been examined in scientific studies.

We report our investigations of specific dietary and lifestyle variables associated with increased risk for obesity among school-aged child living in the Baja California area of Mexico with a particular focus on middle-income public school children.

METHODOLOGY

Subjects and Recruitment Procedures

Tijuana/Tecate Two middle-income public elementary schools from Tijuana and three from Tecate, where interviewers had previous collaborations, were chosen to participate in the study by convenience sampling at schools as described previously.[10] School principals, teachers and parents were contacted and told about the purpose of the study. Parents were asked to participate before or after school hours. Every child in the fourth, fifth, and sixth grades at these two schools was recruited ($n=590$). The Human Subjects Committees of the University Autonomous of Baja California and the University of California, San Francisco approved the

study. Written informed consent was obtained from all parents. The study and interviews were conducted in 2005–2006.

Data Collection

Two graduate research assistants in Tijuana and Tecate conducted all interviews. The research assistants were trained at one central location in Tijuana by two of the authors of this study (AG, MBG) in taking anthropometric measurements for children and in conducting interviews. Children's weights and heights and waist circumferences (WC) were measured as part of the interview process.

Anthropometric Measurements

Height was measured to the nearest millimeter with a portable stadiometer (model 214 Rodad Rod, Seca Corp, Hanover, MD, USA). Weight was measured with electronic scales (model 2001; Tanita Corp, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI; kg/m^2) was subsequently calculated. WC was measured at the minimum circumference between the iliac crest and the rib cage. BMI values were compared with age/gender BMI percentiles from the Centers for Disease Control and Prevention Growth Charts.[11] Cutoff points were the 85th and 95th percentiles for overweight and ≥95th percentile for obesity. WC measurements were compared to CDC growth charts defining >90th percentile for abdominal obesity for children.[12-13]

Questionnaires

We developed a questionnaire to measure child intake, food insecurity, migration and health history, physical and leisure time activities for use both in Tijuana/Tecate, Mexico and the San Francisco Bay Area.[10] For some sections of the questionnaire, we used previously validated instruments as referenced below. The children's questionnaire contained questions pertaining to food consumption, food security using the food insecurity questionnaire,[14] physical activity, food and nutrition knowledge, family environment, migration and psychosocial issues. For food habits, children were asked questions about frequency of breakfast, lunch, and eating at restaurants.

Children were also asked if they restricted any food items or beverage including sweets/candy, cookies, sugar-added breakfast cereals, soda/sweetened beverages, chocolate, ice cream or cakes. A child was defined as being restricted certain foods if parents restricted any of the above-mentioned foods or drinks or any other food/beverage item. A child was defined as having perceived food insecurity if he/she answered yes to any of the following five questions: (1) Did your household ever run out of money to buy food to make a meal during the last year? (2) Did you ever eat less than you felt you should because there was not enough money to buy food during the last year? (3) Did you ever tell your parent(s) that you were hungry because there was not enough food in the house during the last year? (4) Did you ever go to bed hungry because there was not enough money to buy food in the past year? (5) Did you ever cut the size of your meals or did you skip meals because there was not enough money to buy food?

Food frequency questionnaire (FFQ) was administered for all single foods items.[15] The FFQ included the following food items: American fast food (burgers, pizzas, etc.), Mexican fast food (tacos, tortas), white bread, tortillas, beans, pastries, soft drinks, juices, sandwiches, and high-fat containing snacks (corn and potato chips). Children were asked how often they eat each food item or group. Possible answers

were never, once a month, or one to seven days a week. Physical activity questions asked about frequency of walking and sports activities in and out school hours. Sedentary activities concerned questions on frequency of TV and video game watching. To validate our questionnaire, 25 fifth grade children and their parents from a different elementary school in Tijuana were recruited, and questionnaires were administered twice by direct interview within 2 weeks. Test–retest was conducted using Spearman correlation, ($r=0.75$, $p<0.05$).

Statistical Analysis

The main dependent variable of interest was childhood obesity and abdominal obesity. The main independent variables were facts associated with SES including acculturation such as use of English versus Spanish language and watching TV in English versus Spanish and perceived food insecurity measured by a positive answer to one of five questions as described by Jimenez-Cruz et al. (2011).[10] Stata 11.0 was used to conduct all analyses. Univariate analyses were conducted to compute means and standard deviations and percentages and bivariate logistic regression analyses were conducted to assess odds ratios (OR) and 95% confidence intervals (CI). Multivariate logistic regression models included all variables that were significant at a $p<0.10$ in bivariate analysis.

RESULTS

Demographics and Weight Specifics

The study population had a mean age of 10.6±1.3 years; 50% were female. Mean BMI% was 73.1±25.6%, with 24.3% having a BMI ≥95th percentile and 43.7% with BMI ≥85th percentile. WC was >90th percentile in 20.2%. The children came from two cities in Baja California, Mexico: with 43.1% residing in Tecate and 57.0% in Tijuana (Table 1)

Risk Factors for Obesity

In bivariate analysis, reduced risk for obesity was associated with female sex (OR 0.65, 95% CI 0.45–0.95), consumption of daily breakfast (OR 0.67, 95% 0.46–0.98), and regularly taking multivitamins (OR 0.67, 95% CI 0.50–0.98) (Table 2). Increased consumption of tacos (≥1×/week) (OR 0.63, 95% CI 0.43–0.92) were

TABLE 1 Mean, standard deviation (SD) and frequencies for selected characteristics among Mexican children in Tijuana and Tecate, Mexico

	Mean	SD	% (*n*/total)
Mexico ($n=590$)			
Age (years)	10.6	1.3	
Sex, female			50.0 (295/590)
BMI percentile	73.1	25.6	
BMI ≥95th percentile			24.3 (143/588)
BMI ≥85th percentile			43.7 (257/588)
Waist circumference >90th percentile			20.2 (119/588)
City of residence			
Tecate			43.1 (254/590)
Tijuana			57.0 (336/590)

similarly associated with decreased risk. Viewing TV shows in English was associated with increased risk (OR 1.52, 95% CI 1.03–2.24) as was perceived food insecurity (OR 1.63, 95% CI 1.11–2.38) (Table 2). In multivariate analysis adjusting for bivariate risk factors that were significant at $p<0.10$, children were at increased risk for obesity if the child watched TV in English (OR 1.60, 95% CI 1.06–2.41) or if the household had perceived food insecurity in the last year (OR 1.57, 95% CI 1.05–2.36). Dietary factors that were associated with decreased risk included increased taco consumption (≥1×/week) (OR 0.64, 95% CI 0.43–0.96). Female sex was associated with reduced risk (OR 0.64, 95% CI 0.43–0.96) as was regular multivitamin use (OR 0.63, 95% CI 0.42–0.94) (Table 3).

Risk Factors for Abdominal Obesity

We also evaluated the relationship between abdominal obesity and sociodemographic, dietary and lifestyle variables, particularly those variables associated with risk for obesity in children. Independent predictors for increased risk including having parents who restricted certain foods (OR 2.00, 95% CI 1.15–3.48), engaging in increased video game playing (≥1×/week) (OR 1.81, 95% CI 1.11–2.97) and being of older age (OR 2.47, 95% CI 1.29–4.73 for 10–11 years and OR 2.21, 95% CI 1.09–4.49 for >=12 years in comparison to ages 8–9 years). Increased taco consumption (≥1×/week) was associated with decreased risk (OR 0.56, 95% CI 0.35–0.88) and increased burrito consumption neared being associated with decreased risk (>1×/week; OR 0.64, 95% CI 0.40–1.00) (Table 4).

DISCUSSION

In this study with Mexican school children on the border with the United States, we found that factors associated with higher and lower SES increased risk for obesity. While several studies have evaluated acculturation in relation to risk for obesity among Latinos in the United States, this is the first study to evaluate the relationship between acculturation and risk for obesity among Mexican children in a US–Mexican border area. We found increased acculturation to US culture and/or increased SES, indicated by TV watching in English, was associated with increased risk for obesity in this population of school children in Tijuana and Tecate, Baja California. Watching TV in English could also be an indicator of high SES, since cable or satellite, which require a monthly payment, are broadcast primarily in English. The use of English language in the home was also used as a gauge for acculturation, but no association was observed. We also found that watching TV in English was associated with increased soda consumption (30.3% of those who watched TV in English drank soda daily, in contrast with 19.8% of those who rarely watched TV in English; $p<0.01$), possibly explaining the association between this measure of acculturation and obesity. However, we found no association between increased consumption of soda (≥1×/week) and risk for obesity in children.

Increased video game playing (≥1×/week) was also associated with increased risk for abdominal obesity, suggestive of more of sedentary lifestyle but also associated with increased access to resources and capital suggestive of higher SES children. Our results are consistent with previous studies in Tijuana and Ensenada showing that high SES children had higher prevalence of overweight and obesity.[8,16]

Perceived child food insecurity was associated with increased risk for obesity, similar to our previous studies with Mexican children in Tijuana that have found that food insecurity can co-exist in populations with high background rates of obesity.[17] Another

TABLE 2 Prevalence and unadjusted odds ratios (OR) for child obesity, by selected child characteristics, among 590 Mexican children in Tijuana and Tecate 2003–2004

	Prevalence of Obesity (*n*)[a]	OR (95% CI)
Demographics		
Sex		
Male	28.2 (83/294)	1.00
Female	20.4 (60/294)	0.65 (0.45–0.95) [b]
Age group (years)		
8–9	23.4 (32/137)	
10–11	24.0 (70/292)	
≥12	25.8 (41/159)	1.02 (0.88–1.19)[c]
Acculturation		
TV viewing in English		
Yes	27.8 (90/324)	1.52 (1.03–2.24)[b]
No	20.2 (53/263)	1.00
Speak English at school		
Yes	22.2 (14/63)	0.87 (0.47–1.64)
No	24.6 (129/524)	1.00
Travel to other states in Mexico		
Yes	23.5 (101/429)	0.83 (0.55–1.26)
No	27.1 (42/155)	1.00
Physical activity and TV/video viewing		
Participation in sports teams		
Yes	26.9 (52/193)	1.23 (0.83–1.83)
No	23.0 (91/395)	1.00
Walk to school		
Yes	23.9 (71/297)	1.07 (0.73–1.56)
No	25.2 (71/282)	1.00
TV (Daily)		
Yes	21.9 (72/329)	0.74 (0.51–1.08)
No	27.5 (71/258)	1.00
Play in the street or park		
≥3 times per week	23.0 (71/309)	0.87 (0.59–1.26)
<3 times per week	25.6 (71/277)	1.00
Food preferences and habits		
Fast food (favorite food)		
Yes	23.8 (36/151)	0.97 (0.63–1.50)
No	24.4 (106/435)	1.00
Mexican food (favorite food)		
Yes	23.2 (58/251)	0.90 (0.61–1.32)
No	25.1 (84/335)	1.00
Hunger (to bed hungry in last year)		
Yes	26.4 (23/87)	1.14 (0.68–1.91)
No	24.0 (120/501)	
Hunger (Insufficient money to buy food in last year)		
Yes	30.2 (42/139)	1.49 (0.98–2.28)
No	22.5 (101/449)	1.00
Hunger (Eat less because of insufficient money to buy food in last year)		
Yes	31.6 (24/76)	1.52 (0.90–2.56)
No	23.3 (119/510)	1.00
Perceived food insecurity		

TABLE 2 ***Continued***

	Prevalence of Obesity (*n*)[a]	OR (95% CI)
Yes	29.9 (69/231)	1.63 (1.11–2.38)
No	20.8 (74/356)	1.00
Breakfast (Daily) [b]		
Yes	21.7 (78/359)	0.67 (0.46–0.98)
No	29.3 (65/222)	1.00
Breakfast at school		
Yes	26.1 (40/153)	1.14 (0.75–1.74)
No	23.7 (103/434)	1.00
Food/beverage restriction by parents		
Yes	19.1 (28/147)	0.66 (0.42–1.06)
No	26.1 (115/440)	1.00
Eating food in front of TV		
Always/Often/Sometimes	23.5 (110/468)	0.83 (0.52–1.31)
Never/Rarely	22.5 (32/118)	1.00
Regular multivitamin use		
Yes	20.8 (62/298)	0.67 (0.50–0.98)
No	28.1 (81/288)	1.00
Food consumption		
McDonald's/fast food		
≥1/week	22.2 (57/257)	0.81 (0.55–1.19)
≤1/month	26.0 (86/331)	1.00
Soda/sweetened beverages		
≥1×/week	24.4 (114/467)	1.00 (0.63–1.60)
≤1×/month	24.4 (29/119)	1.00
Beans/frijoles		
>2×/week	26.4 (70/265)	1.24(0.85–1.81)
≤2×/week	22.4 (72/321)	1.00
Salsa picante		
≥1×/month	24.3 (92/379)	0.99 (0.67–1.47)
never	24.4 (51/209)	1.00
Pizza		
≥1×/week	22.2 (77/347)	0.75 (0.51–1.09)
≤1×/month	27.6 (66/239)	1.00
Fruit juice		
>2×/week	23.2 (81/349)	0.84 (0.57–1.24)
≤2×/week	26.4 (61/231)	1.00
Tacos[b]		
≥1×/week	20.9 (74/354)	0.63 (0.43–0.92)
≤1×/month	29.6 (68/230)	1.00
Burritos		
≥1×/week	25.5 (81/318)	1.00
≤1×/week	23.0 (60/261)	0.87 (0.60–1.28)
Tortas		
≥1×/week	22.4 (57/254)	0.83 (0.57–1.22)
≤1×/month	25.8 (86/334)	1.00
American food (pastas, potatoes)		
≥1×/week	25.7 (48/187)	0.90 (0.61–1.35)
≤1×/month	23.8 (95/399)	1.00
Soda at school		
≥daily	22.9 (38/166)	0.90 (0.59–1.38)

TABLE 2 ***Continued***

	Prevalence of Obesity (*n*)[a]	OR (95% CI)
<daily	24.7 (104/421)	1.00
Sweetened beverage with dinner		
Yes	23.0 (91/395)	0.80 (0.53–1.20)
No	27.3 (48/176)	1.00

CI confidence interval

[a]Total $n=590$, but categories do not always add up to 590 due to missing data

[b]$p<0.05$

[c]Evaluated continuously.

TABLE 3 Adjusted logistic regression for risk of child obesity among 571 Mexican children, Tijuana and Tecate, Mexico[a]

Variable	Odds ratio (95% CI)
TV in English	
Yes	1.60 (1.06–2.41)
No	1.00[b]
Perceived food insecurity	
Yes	1.57 (1.05–2.36)
No	1.00[b]
Taco consumption	
≥1×/week	0.64 (0.43–0.96)
≤1×/month	1.00[b]
Breakfast (Daily)	
Yes	0.69 (0.46–1.04)
No	1.00[b]
Pizza	
≥1×/week	0.71 (0.48–1.07)
≤1×/month	1.00[b]
Child sex	
Female	0.64 (0.43–0.96)
Male	1.00[b]
Age group (years)	
8–9	1.00[b]
10–11	1.16 (0.70–1.93)
≥12	1.24 (0.79–2.22)
Parents restrict certain foods	
Yes	0.64 (0.40–1.05)
No	1.00[b]
Regular multivitamin use	
Yes	0.63 (0.42–0.94)
No	1.00[b]

CI confidence interval

[a]Fixed model including covariates that were significant at $p<1.0$ in bivariate analysis and known risk factors for obesity

[b]Reference category

TABLE 4 Adjusted logistic regression for risk of child waist circumference >90th percentile among 571 Mexican children, Tijuana and Tecate, Mexico[a]

Variable	Odds ratio (95% CI)
Parents restrict certain foods	
Yes	2.00 (1.15–3.48)
No	1.00[b]
Regular multivitamin use	
Yes	0.67 (0.43–1.05)
No	1.00[b]
Taco consumption	
≥1×/week	0.56 (0.35–0.88)
<1×/week	1.00[b]
Breakfast (Daily)	
Yes	0.69 (0.45–1.07)
No	1.00[b]
Burritos	
>1×/week	0.64 (0.40–1.00)
≤1×/week	1.00[b]
Child sex	
Female	0.71 (0.46–1.11)
Male	1.00[b]
Age group (years)	
8–9	1.00[b]
10–11	2.47 (1.29–4.73)
≥12	2.21 (1.09–4.49)
Video game playing	
≥1×/week	1.81(1.11–2.97)
<1×/week	1.00[b]
American food (pasta, potatoes)	
≥1×/week	0.80 (0.50–1.27)
<1×/week	1.00[b]
Walk to school	
Yes	1.44 (0.93–2.42)
No	1.00[b]

CI confidence interval

[a]Fixed model including covariates that were significant at $p<1.0$ in bivariate analysis and known risk factors for obesity

[b]Reference category

study from Mexico City also reported the highest rate of obesity in children with food insecurity.[3] It is possible that a biphasic distribution of risk for obesity exists in children on the border area, with increased risk both among the lowest and highest income children, recently suggested by Villa-Caballero et al.[7] to explain obesity curves in children in Tijuana. Rosas et al.[18] also found that higher SES and household food insecurity were independently associated with childhood obesity in Mexico among low-income 5-year-old children who were beneficiaries of Opportunidades.

Increased consumption of tacos (≥1×/week) was associated with reduced risk for obesity and abdominal obesity in the school children assessed. Increased consumption of burritos (>1×/week) also neared significance. Although we did not evaluate what types of tacos or burritos were consumed and whether the tacos were prepared at home or bought from a street vendor or at a restaurant, it is possible that

increased consumption may be associated with the dietary patterns of middle income children. Previous research by Janet Long-Solis[19] in Mexico City has suggested that higher income families do not buy foods from street vendors, who most commonly sell tacos, and indigenous and migrant families that are at the lowest SES levels may also not have enough disposable income to regularly consume street foods. Previous reports indicate that indigenous families have mainly a diet that is primarily corn and bean-based. Among our population of middle income, public school children, families on either end of that spectrum of SES who might be at greater risk for obesity, may eat less of the widely available foods sold from street vendors, resulting in overall decreased taco consumption.

Unique to this study with Mexican children, we found that regular multivitamin use was associated with reduced risk for obesity. Although previous studies have shown that obese children are more at risk for micronutrient deficiencies including iron and vitamin B_{12},[20,21] this is the first study with Mexican children to indicate that multivitamin supplements may play a protective role. Other, unmeasured aspects of attentive parenting could be associated with multivitamin usage, that lower obesity risk. Future studies should investigate the role of multivitamin usage as well as assess how different parenting styles might influence risk for obesity in Mexican children.

Lastly, similar to previous studies with Mexican children,[17,18] we found that school aged girls were at decreased risk for obesity in comparison with boys suggesting the need to specifically target Mexican school-aged boys. We also found that children who had more parental dietary restrictions were more likely to have abdominal obesity, which is consistent with previous obesity research in children.[22] Data were not collected longitudinally, so we are unable to make any conclusions about causal relationships. Additional limitations of the study were that we did not conduct dietary recalls but collected only food frequency information, so we are unable to estimate child total energy intake.

Our study suggests the need to further evaluate how overall patterns of eating are related to food insecurity, acculturation and to SES in children living in border towns in Baja California. Further studies are needed to identify processes of acculturation on both sides of the US–Mexican border that contribute to increased risk for obesity in children in relation to SES that may eventually lead to specific interventions to reverse these trends.

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