BMI Tracking in Mexican American Children in Relation to Maternal BMI

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Objective: To assess body mass index (BMI [kg/m^2]) tracking over a four-year period in 4- to 8-year-old Mexican American (MA) children and to explore associations between mother and child's BMI.

Design: A longitudinal study design was used to assess 138 subjects (69 MA children and 69 MA mothers). Children were classified as normal weight if age- and sex-specific BMI was < 85th percentile and overweight or at-risk for overweight if BMI was ≥ 85th percentile. Mothers with a BMI < 25 kg/m^2 were classified as normal weight and overweight if BMI was ≥ 25 kg/m^2.

Results: The percentages of children overweight or at-risk for overweight were 34.8%, 36.2%, 40.6% and 39.1% for years 1–4, respectively. A positive correlation was found between the children's BMI status across the four years of the study (r=.90 to .95, P<.001). Furthermore, at-risk for overweight or overweight children in year 1 were highly likely to be overweight or at-risk for overweight in year 4 (adjusted OR: 67.7, 95% CI: 11.7–386.4, P<.001). The correlation coefficients between mothers and daughters' BMIs during the four years were significant (P<.01), but not between mothers and sons' BMIs.

Conclusion: Overweight or at-risk for overweight status tracks well during childhood and early adolescence among low-income MA children. Sex differences were found concerning associations between mother and their child's BMI. (*Ethn Dis*. 2007;17:707–713)

Key Words: BMI, Mexican American, Children, Mothers

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Introduction

Obesity is a major health problem in the United States for all ages and ethnic groups.[1,2] Critical periods for obesity have been shown to occur during childhood and adolescence.[3] Serdula et al[4] reviewed the epidemiologic literature published between 1970–1992 and found that approximately one-third (26%–41%) of overweight preschool children and one-half (41%–63%) of overweight school-age children became overweight as adults. The risk for becoming an overweight adult was 2- to 6.5-fold higher for overweight children than for their normal weight peers. More recently, studies have revealed that childhood obesity tracked into adulthood obesity or overweight with a probability between 40% and 70%.[5–13] Research also indicates that body mass index (BMI) within Caucasian childhood and adolescence tracks well.[14–16]

While studies on tracking of BMI within childhood and adolescence have been conducted, we have found a paucity of research tracking BMI in Mexican American children. Since Mexican American children are at the highest risk of childhood overweight,[17,18] research in this area deserves a high priority. Approximately 19% of Mexican American children were overweight in 2003–2004 compared with 16% of non-Hispanic White children.[18] Marshall et al[19] assessed the tracking of BMI in children (including Mexican Americans) for three years (fourth to sixth grade). The three-year correlations of BMI were r=.89 for boys and r=.83 for girls. Similar results were revealed in a study conducted with 9- to 13-year-old Spanish children followed for six years.[20] None of these studies included younger children (preschool to early adolescence). To our knowledge, only one prospective study of BMI in Mexican American children ages 5–11 exists.[21] Results from this study indicate that children in kindergarten with a high BMI (>23.7) have a 91% probability of being obese by the 5th grade.[21] None of these studies on BMI in Mexican American Children assessed the role of parental obesity, which has been documented in Caucasians to influence changes in children's BMI during childhood and adolescence.[7,9,12,22] The primary purpose of this longitudinal study was to assess BMI trends in low income Mexican American children from early childhood (4–8 years old) to mid-childhood (7–12 years old). Additionally, we examined the relationships between BMI status at ages 4 through 8 and BMI status four years later in children and assessed the association between a mother's BMI and their child's BMI.

Method

Subjects

The baseline sample consisted of 160 subjects (80 Mexican American mother-child dyads) who participated in a four-year study entitled *Al Bienestar del Niño (To the Wellbeing of the Child)* to investigate the development of health behaviors in Mexican American children.[23] Twenty-two subjects (11 children and their respective mothers) were lost to followup, reducing the sample for statistical analyses to 138 subjects (69 mothers-child dyads). No significant demographic differences were found between the families who remained in the study and those who dropped out (P>.05). The Baylor College of Medicine Committee for the Protection of Human Subjects reviewed and approved the consent

form, instruments, and research protocols.

Recruitment

United States Census data for a large metropolitan city in the southwest were examined to identify an inner-city neighborhood densely populated by Mexican Americans. Support from several neighborhood leaders (eg, Catholic priest, social agencies directors, etc.) was obtained to help recruit families for the study. Families were primarily recruited from Catholic churches and social service agencies. Families were also recruited through referrals and printed fliers distributed at the neighborhood bus stops, laundromats, and shops. Announcements concerning the purpose of the study, its procedures, and the eligibility criteria were given at the end of Catholic mass and in waiting areas at social agencies or other selected recruitment sites. Interested families were given more detailed information about what their participation would entail and contact information for research team, who answered questions about the study during early recruitment stages.

Retention Strategies

An extensive amount of time and effort was required by the research team to maintain high levels of subjects' involvement. In some cases, families had to be located following a change of residence; this task was difficult due to multiple changes and the absence of telephones or forwarding addresses. Tracking data showed that families changed residence a minimum of 44 times in year 2 and a maximum of 64 times in year 3. To maximize subject retention, several strategies were utilized including: 1) the maintenance of a database containing current phone numbers of neighbors, relatives and/or friends of the subjects in case they moved; 2) mailing annual contact letters, Christmas, Mother's day, Father's day, Valentines day, and birthday cards to the study families; 3) holding Christmas parties at the churches for participating families who received donated gifts, clothes, toys, and food; and 4) providing interim incentives (eg, gift certificates and raffle tickets for a stereo or television) to families at the measurement sessions to compensate them for their participation.

Procedure

Family background and anthropometry data were collected during two measurement sessions held each year during the four-year study period. At the first measurement session, a Hispanic bilingual research assistant interviewed the mother in her preferred language about the family's background (eg, age, education, occupation etc.). The family background interview was conducted during a home visit after the mother had signed the consent form. During the second measurement session, a bilingual research assistant assessed mothers' and children's height and weight at a nearby university laboratory. Individual height and weight measurements were made in a secure room in order to protect the privacy of the subjects. To ensure a high rate of participation, transportation and child care for the families were provided and each family received $40 annually for their participation.

Measures

To assess family background, we used an instrument with 16 questions about the mother's age, education, occupation, place of birth, and family income. Mothers also were asked if they perceived having a weight problem and if they perceived their children to have a weight problem.

Measures of body weight and height were obtained from children and their mothers once each year during the four-year study period. A balance beam scale was used to assess weight to the nearest .1 kg and a secured stadiometer was used to measure height to the nearest .1 cm. A bilingual research assistant instructed each subject to remove his or her shoes and socks before stepping on the scale. Height was measured with the child or mother standing with both heels and buttocks against a vertical stadiometer. Each subject's height and weight was assessed twice and the average of the two measures was used. A standardized weight was used to calibrate the scale on a daily basis.

Body mass index (kg/m^2) was calculated for the children and mothers. Child BMI values were then used to identify the age- and sex-specific percentile for each subject using the Centers for Disease Control and Prevention (CDC) guidelines (http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm). Children with a BMI $< 85^{th}$ percentile were classified as normal weight and those with a BMI $\geq 85^{th}$ percentile were classified as at-risk for overweight and overweight. Each mother's obesity status was determined using the World Health Organization obesity classification. Mothers with a BMI $<25\ kg/m^2$ were classified as normal weight and mothers with a BMI $\geq 25\ kg/m^2$ were classified as overweight.

Statistical Analysis

All statistical analyses were conducted using STATA statistical packages, version 8.2. The significance level for all analyses was set at $P<.05$. Data were inspected for outliers, missing or undefined values. The first step of the analysis consisted of exploratory examinations of the distributions of all the variables. An unpaired *t* test was used to test for sex differences in the children's height, weight and BMI. No significant differences were found. The primary variables of interest were the BMI of the child (continuous variable) from year 1 (4 to 8 years of age) through year 4 (7 to 12 years of age) and the BMI of the mother (continuous variable). All BMI variables were examined with respect to their distribution

Table 1. Sample demographic characteristics at baseline

Mother Age	
Mean	31.0 years
SD	5.4 years
Range	22–50 years
Child Age	
Boys (*n*=33)	
Mean	6.7 years
SD	1.3 years
Range	4–8 years
Girls (*n*=36)	
Mean	6.9 years
SD	1.4 years
Range	4–8 years
Maternal Education	
Less than 8th grade	63%
Some high school	20%
High school graduate	9%
Some college	5%
Vocational/technical	3%
Maternal Occupation	
Technician	1%
Labor/service operators	10%
Retail	6%
Homemakers	83%

SD = Standard Deviation.

(normality) using frequency distributions, scatter plots, and skewness values. These examinations revealed that BMI variables for both mother and child were not normally distributed and were skewed to the right. To normalize the BMI distributions for mothers and children, correlations were calculated using $\log_{10}$(BMI). Following the log transformation procedure, the BMI variables were re-checked for normality. Skewness and kurtosis indicated that they were fairly normally distributed.

The association between a child's BMI status at ages 4 through 8 and their BMI status four years later was assessed using Pearson Product Moment correlation coefficients. The association between a mother's BMI status and her child's BMI status also was assessed using Pearson's correlation coefficients. Unconditional logistic regression was conducted to: 1) determine if the overweight status of the child in year 1 predicted the overweight status of the child in year 4; 2) test the interaction between gender and BMI status and; 3) examine the association between mother's and child's BMI to determine if mother's overweight status is a significant predictor of their child's overweight status.

RESULTS

The mean age of our sample of 138 subjects was 31.0 years for the mothers, 6.7 years for boys and 6.9 years for girls (Table 1). Most of the mothers had low levels of educational attainment, with almost two thirds having less than an 8th grade education. The majority of mothers (83%) did not work outside of the home, and the median family income was <$20,000 per year. Almost all mothers (90%) were born in Mexico and spoke only Spanish. Seventy-eight percent of the boys and 85% of the girls preferred speaking English during the interview.

Prevalence of overweight among Mexican American children and mothers across four years

Year 1 data indicated that there was a steady increase in body weight, body height, and BMI in children from years 1 to 3 with no significant changes between years 3 and 4 (Table 2). A corresponding rise in the prevalence of overweight or at-risk for overweight was noted from years 1 to 3 with a leveling off between years 3 and 4. At baseline, 34.8% of the children were at-risk for overweight or overweight compared with 36.2%, 40.6% and 39.1% for years 2–4, respectively. Of the 45 normal weight children at year 1, three (6.7%) became at-risk for overweight or overweight by year 4 whereas only one child (4.2%) changed status from at-risk for overweight or overweight to normal weight.

The prevalence of overweight among Mexican American mothers is also shown in Table 2. At years 1 and year 2, 72.5% of the mothers were overweight; we found an increase of 10.1% in the proportion of mothers who were overweight at years 1 and 2 compared with years 3 and 4. Despite the high prevalence of overweight among mothers and their children, 73% of the mothers perceived that they did not have a weight problem. Moreover, 96% of the mothers perceived that their child did not have a weight problem.

Presented in Table 3 are the correlation coefficients for the relationships between children's BMI at year 1 and their BMI at years 2, 3, and 4. These correlation coefficients are strong and statistically significant ranging from .90–.95 ($P<.001$), indicating a significant positive relationship between the children's BMI from year 1 through year 4. In light of these results, we decided to run a logistic regression to determine if the BMI of the child at year 1 was a significant predictor of child's BMI at Year 4. Results showed that children who had BMIs $\geq$ 85th

Table 2. Prevalence of at-risk for overweight, or overweight, among Mexican American mothers and their children

	Year 1	Year 2	Year 3	Year 4
Age range (years)				
Child	4–8	5–9	6–10	7–12
Mother	22–48	23–49	24–50	25–50
Weight (kg)				
Mean (SD)				
Child	23.5(7.0)	27.7 (9.1)	33.0 (11.0)	33.0 (11.0)
Mother	71.5 (14.9)	71.7 (16.4)	73.1 (15.7)	73.6 (15.9)
Height (m)				
Mean (SD)				
Child	1.17 (0.0)	1.24 (0.0)	1.30 (0.0)	1.35 (0.0)
Mother	1.56 (0.0)	1.56 (0.0)	1.56 (0.0)	1.56 (0.0)
BMI (kg/m^2)				
Mean (SD)				
Child	16.9 (3.4)	17.6(4.0)	19.2(4.2)	19.5 (4.8)
Mother	29.2 (6.1)	29.2 (6.0)	30.0 (6.4)	30.0 (6.6)
Obesity status-child				
Normal weight	45(65.2%)	44(63.8%)	41(59.4%)	42 (60.9%)
ARFO/overweight	24(34.8%)	25(36.2%)	28(40.6%)	27(39.1%)
Obesity status-mother				
Normal weight	19(27.5%)	19(27.5%)	12(17.4%)	12(17.4%)
ARFO/overweight	50(72.5%)	50(72.5%)	57(82.6%)	57(82.6%)

ARFO = At risk for overweight.

percentile in year 1 were significantly more likely to have BMIs $\geq$ 85th percentile in year 4 after adjusting for sex (adjusted OR: 67.7, 95% CI: 11.7–386.4, $P<.001$).

Associations between Children's BMI and Maternal BMI

For mothers and daughters, BMIs were significantly correlated each year of the study, indicating a consistent positive relationship ($r=.49$, .41, .43, .39 for study years 1–4, respectively). However, correlations between mother's and son's BMI were not significant for any year of the study ($r=.28$, .21, .15, .21 for study years 1–4, respectively). Unconditional logistic regression revealed that maternal overweight status (BMI$\geq$ 25) is a significant predictor of child's overweight status (BMI $>$ 85th percentile) especially in years 1 and 2, after adjusting for mother's age and child's age (year 1 adjusted OR: 4.8, 95% CI 1.02–22.23; year 2 adjusted OR: 1.2, 95% CI 1.05–1.31). For years 3 and 4, there also appears to be a positive association between mother's and child's BMI (year 3 adjusted OR: 2.7, 95% CI 0.61–11.81; year 4 adjusted OR: 3.3, 95% CI: 0.63–17.63). The results, however, were not statistically significant ($P>.05$). We also tested for an interaction effect between sex and BMI status in the logistic model. Results indicated no significant interaction effects were present (OR: 4.4, 95% CI:0.12–159.52, $P=.418$).

DISCUSSION

This study assessed the tracking of BMI in Mexican American children from early childhood (4- to 8-years-old) to mid-childhood (7- to 12-years-old) and the relationship between mother and child BMIs during this four-year period. During each of the four years of the study, between 35% and 41% of the children were classified as either at-risk for overweight or overweight. Similarly, a high percentage (>70%) of the mothers were overweight. The high prevalence rates of overweight and at-risk for overweight found in this study are similar to those observed in other studies using national samples of Mexican American adults and children.[2,17,18,24] Interestingly, although most of the Mexican American mothers and more than one third of the children in this study were actually overweight or at-risk for overweight, the majority of the mothers reported that neither they nor their child had an overweight problem indicating that a mother's perception of their own and their child's weight status was not accurate. This is consistent with Baughcum et al[25] who found that a high percentage of low-income mothers failed to view their overweight preschool children as overweight. These findings suggest that excess weight is not only a major health problem in Mexican American families but one that is not recognized within the families as a problem, possibly because of misperception of what constitutes an overweight status. Thus, public health education should focus on providing Mexican American mothers with information about weight guidelines for themselves and their children.

The tracking of BMI across four years in Mexican American children was

Table 3. Correlations between the BMI of the child at year 1 through year 4 using logarithmic transformations for BMI variable

Age Range	5–9 years	6–10 years	7–12 years
4–8 years	0.92*	0.92*	0.94*
5–9 years		0.90*	0.92*
6–10 years			0.95*
7–12 years			1.00

* Statistically significant at $P<.001$.

strong with correlations ranging from $r=.90$ to .95. This suggests that overweight tracks well across childhood and early adolescence. Most children who were at-risk for overweight, overweight or normal weight at year 1 maintained their weight classification over a three-year period. Only 5.8% of the children changed weight classification (6.7% became at-risk for overweight or overweight and 4.2% became normal weight). Despite the small sample size of this study, these results are consistent with large and national cross-sectional studies that suggest an upward trend in overweight of about one percent increase per year and that overweight tracking between childhood and early adolescent is high.[15,16,18,19,21] Taken in aggregate, there does not appear to be much flux in weight status in Mexican American children and adolescents. Interventions targeting overweight children in this population may benefit from this aspect because the identification of children at risk for overweight or overweight would be very accurate (high sensitivity) and those not at risk would be classified accordingly (high specificity), thus reducing the potential of socially stigmatizing normal weight children.

Previous research has demonstrated significant association between a mother's BMI and her child's BMI, but most of the studies employed a cross-sectional design and focused on children between the ages 3 and 7 years of age.[26–32] Results from the present longitudinal study suggest that mothers' BMIs are positively correlated with their daughters' BMIs. The highest correlation was observed when the daughters were 4 to 8 years of age and the correlation coefficients tended to decrease as the girls aged. The correlations between maternal and boys' BMI, though not statistically significant. were in the right direction, so with a larger sample they might be significant.

The overweight status of mothers significantly predicted daughters' overweight status at the younger years (4 to 8 years old), but not at older ages. Children, 4 to 8 years of age with mothers who exhibited higher BMIs, were four times more likely to be overweight or at risk of becoming overweight than children in this age group who had mothers with lower BMIs. Thus, results from this study reveal a diminishing association between maternal BMI and child BMI as the child ages, suggesting the influence of other psychosocial and behavioral factors contributing to the development of obesity among Mexican American children. Studies have shown an increase in peer influences on eating and exercise behavior with increasing age among children and adolescents, thus potentially diminishing the parental influences.[33–35] Additionally, studies have shown an increasing sedentary behavior with increasing age in children and adolescents.[36]

Several limitations of this study may affect the generalizability of the study's findings. One limitation of this study includes issues of multicollinearity. There was an overlap of the children's ages over the 4-year-study period. In year 1, the children ranged from ages 4 to 8 years, 5 to 9 years in year 2, 6 to 10 years in year 3 and 7 to 12 years in year 4, thus raising the issue of multicollinearity. Some of the strength of the correlations seen between the BMIs for the children from years 1 through 4 could potentially be attributed to this overlap. Therefore, the results must be interpreted with some caution. Another limitation is the lack of data on sexual maturation. Sexual maturation or puberty status could be a potential confounder since studies show that obesity is associated with sexual maturation among adolescents, particularly among girls.[37–41] However, the data analysis was primarily exploratory using correlation coefficients as measures of associations.

Another limitation is that our sample was restricted to immigrant mothers and their children from a low-income, inner-city community with limited acculturation levels. We have no way of knowing how variations in income or social class might influence the results, which may be different in higher socioeconomic status, Mexican American populations. Our study's participants were entirely of Mexican descent; the results may not apply to other Hispanic families such as Cubans and Puerto Ricans. Future research should examine these issues across a wide range of social classes, acculturation levels, diverse BMI status, and ethnic groups.

Despite the limitations mentioned above, to our knowledge, this is one of the few longitudinal studies conducted with low-income immigrant, Spanish-speaking Mexican American mothers and their children, which is a difficult population to follow due to several factors such as high mobility, immigrant status, and limited transportation. This study provides relevant public health information and serves to bridge a gap in the literature regarding knowledge about the rising prevalence of obesity among intergenerational Mexican American families.

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