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Socioeconomic differences in obesity among Mexican adolescents

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Abstract

Objective—We investigate socioeconomic disparities in adolescent obesity in Mexico. Three questions are addressed. First, what is the social patterning of obesity among Mexican adolescents? Second, what are the separate and joint associations of maternal and paternal education with adolescent obesity net of household wealth? Third, are there differences in socioeconomic status (SES) gradients among Mexican boys and girls, rural residents and non-rural residents?

Methods—Using data from the Mexican National Health Survey 2000 we examined the slope and direction of the association between SES and adolescent obesity. We also estimated models for sub-populations to examine differences in the social gradients in obesity by sex and non-rural residence.

Results—We find that household economic status (asset ownership and housing quality) is positively associated with adolescent obesity. High paternal education is related to lower obesity risk, whereas the association between maternal education and obesity is positive, but not always significant.

Conclusion—The household wealth components of SES appear to predispose Mexican adolescents to higher obesity risk. The effects of parental education are more complex. These findings have important policy implications in Mexico and the United States.

Keywords

Obesity; socioeconomic status; Mexico; adolescents; parental education

Introduction

In recent years, obesity rates have increased markedly in Latin America, although patterns and trends differ between countries (1). Mexico has one of the highest obesity rates in the region (2), and the Mexican obesity epidemic is not limited to adults: del Rio-Navarro et al.

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(2004) showed that adolescent obesity prevalence in Mexico in 2000 for boys ranged from 9.0% among 10-year-olds to 6.1% among 15-year-olds, and for girls, from 5.9% among 12-year-olds to 8.2% among 16-year-olds (3). However, most research on the socioeconomic correlates of obesity has focused on adults. Thus, we know little about the social gradient in adolescent obesity in Mexico.

Across countries, the relationship between socioeconomic status (SES) and obesity depends on the level of socioeconomic development and the stage of the nutrition transition (4). In industrialized countries, SES is typically inversely associated with adolescent obesity, whereby obesity prevalence decreases with increasing SES. This relationship has been documented throughout Western Europe (5,6) and in the United States (7). The relationship has also been documented among Mexican-American adolescents in the United States (8). Adolescent obesity may be inversely related to SES because higher SES parents know more about obesity risks and prevention and can afford healthier lifestyles than lower SES parents. For example, they may be better able to purchase nutritious food and enroll their children in physically active recreational activities (9). Perceptions of appropriate body weight and size also appear to differ by SES, with persons of higher SES more likely to perceive themselves as overweight than their lower SES counterparts (10).

However, this inverse relationship is not universally observed in societies at earlier stages of the nutrition transition (11). Among Ecuadorean adolescents, for example, high SES is associated with *increased* body mass index (BMI) (12). A positive relationship between adolescent obesity and SES has also been documented in Brazil (13) and Colombia (14). In Mexico, higher social status has been shown to be associated with adult obesity (15,16,17), but less is known about adolescent gradients.

In this paper, our goal is to increase understanding of adolescent obesity in Mexico and to provide data on which to base adolescent obesity reduction programs. We investigate three questions. First, is the relationship between SES and obesity positive for Mexican adolescents as it is for adults? Higher SES may increase adolescent obesity risk in Mexico because affluent households may have more access to, and be better able to afford, processed and fatty foods and sugary beverages than poorer households. Higher SES also facilitates the purchase of cars, televisions, computers, and videogame systems, all of which may contribute to a more sedentary lifestyle (11). Second, do maternal and paternal education have different associations with adolescent obesity? Wachs (18) proposes that the relationship between maternal education and children's nutritional outcomes is partially mediated by maternal control of family resources, independence in resource decision-making, knowledge of nutrition and effective use of nutrition information, and maternal nutritional and health status. Thus, more educated mothers may be more aware of the dangers of obesity and more successful at preventing obesity in their children, despite high household SES. By contrast, paternal education may affect children's nutritional status primarily through its effects on household income and assets. Third, does the SES-obesity gradient vary among adolescent sub-populations? In their sample of Mexican adolescents, Salazar and colleagues found that the factors associated with obesity differ between boys and girls (19). Differences are also found in height and weight status between rural and non-rural adolescents (20). These observed disparities may reflect that, even at similar levels of SES, non-rural and rural adolescents may differ in their level of physical activity, diet, and attitudes about ideal body size. We anticipate that, holding SES constant, non-rural adolescents are more likely to experience obesity because of a more sedentary life and greater access to high caloric foods.

Data and research methods

Study sample

We used data from the *Encuesta Nacional de Salud 2000* (the Mexican National Health Survey, here-after ENSA), which is based on a representative probability sample of the population in each Mexican state and the Federal District (Mexico City). A total of 47 360 households were selected through a stratified multistage sampling plan. Sample weights were calculated and modified to adjust for non-response and design effects. ENSA collected data from the household head and on a randomly selected 0–9-year-old, 10–19-year-old, and adult (aged 20 or older) in each household. ENSA 2000 is described in further detail by Valdespino et al. (21) and Sepúlveda et al. (22).

We restricted our sample to adolescents cohabiting with both parents because we wanted to investigate the distinct effects of both maternal and paternal education on adolescent obesity. A total of 6 525 out of 19 688 adolescents in ENSA do not cohabit with both parents. Cohabitation with both parents is positively associated with housing quality and age but negatively associated with male gender and asset ownership. However, cohabitation is not directly related to obesity status of the adolescent (results not shown). We excluded 19-year-olds from the sample because the International Obesity Task Force (IOTF) standards used in this analysis are defined only up to the age of 18 (23).

Of the 12 418 adolescents aged 10 to 18 years cohabiting with two parents, 583 were excluded because they were missing anthropometric data, leaving a base sample of 11 835. We excluded an additional 1 766 cases due to missing data for independent variables or because their BMI values were beyond three standard deviations from the interquartile range. The final analytic sample consists of 10 069 adolescents. Adolescents included in the sample tend to be of higher SES than adolescents who were excluded. There was no significant relationship between inclusion in the sample and adolescent obesity, gender, or non-rural residence (results not shown). The project was approved by the Institutional Review Boards of Princeton University and the University of California, Los Angeles.

Measures

Adolescent anthropometric data (height and weight) were measured using standardized procedures by trained personnel. BMI was calculated as weight in kilograms divided by height in meters squared. We used the IOTF's age- and sex-specific thresholds to define adolescent obesity (23).

SES measures included maternal and paternal education, housing quality, and household assets. The continuous maternal and paternal education variables were categorized into: low (fewer than 6 years of completed schooling); medium (6–11 years completed); and high (12 or more years completed). Models that included the adolescent's own level of education interacted with age were also estimated (results not shown). Including this variable did little to alter the household SES and parental education effects and the variable did not reach statistical significance.

We used two variables, quality of housing and household asset ownership, to measure household wealth. To measure housing quality, we created an index from four items: the presence of running water, sanitation, good quality floors, and whether the household cooks with wood. We used factor analysis to combine these items into a single factor-based scale ranging from 0 to 1 (Cronbach's $\alpha=0.70$), with higher values reflecting better housing quality. Preliminary analysis showed that the scale had a bimodal distribution, so we created a dummy variable reflecting whether a particular household was above or below the mean for housing quality. Following Filmer and Pritchett (24), we also constructed an index of

household assets using the same factor analytic procedure. The index includes ownership of: radio/stereo, television, VCR, blender, refrigerator, washer, telephone, water heater, and car/truck (Cronbach's $\alpha=0.83$). Because the distribution of this variable was trimodal, we coded it into terciles. While individual income data were collected in ENSA, exploratory analyses indicated that these data were less reliable than the household asset and housing quality measures.

Finally, we control for three demographic characteristics that are associated with obesity: non-rural residence, gender, and age. In ENSA, non-rural locales are defined as those with greater than 2,500 inhabitants. Gender is coded 1 for males and 0 for females. Age is analyzed as a continuous variable.

Statistical analysis

Our analysis proceeds in four stages. First, we describe the characteristics of the sample. Second, we use multiple logistic regression to investigate the slope and direction of the association between SES and adolescent obesity, controlling for demographic characteristics. Third, we examine the joint effects of paternal and maternal education on adolescent obesity net of household wealth and demographic characteristics by interacting the parental education variables. Finally, we estimate models for sub-populations to examine differences in the social gradient in obesity by sex and non-rural residence. All models are estimated with STATA 10. Sample weights adjust for non-response (22) and we adjust for design effects with the *svy* command in STATA (25).

Results

Descriptive statistics

Table I presents the demographic characteristics of the sample. The sample is roughly evenly divided by sex and the mean age is 13.4 years. A total of 52% of respondents live in non-rural areas. The overall prevalence of obesity is 8.2%, with a slightly higher rate among boys than girls. Obesity prevalence is higher among younger rather than older adolescents, particularly among boys (Figure 1). Non-rural adolescents have higher rates of obesity (10%) than their rural counterparts (10.0% versus 6.2%, $p<0.01$).

The mean years of completed schooling is 6.6 for mothers and 7.1 for fathers, with a correlation of 0.64 between the two variables. The mean housing quality score is 0.84 (on a scale of 0 to 1) and close to 65% of adolescents are in the high quality housing category. The mean household asset score is 0.61 (on a scale of 0 to 1) and 26% of adolescents are in the highest asset ownership category. The housing quality and asset scales have a correlation of 0.52.

Obesity and SES

Logistic regression models of adolescent obesity are presented in Table II. Model 1 explores the effects of maternal and paternal education controlling for demographic characteristics (non-rural residence, gender, and age) but no other measures of SES. In this model only maternal education is significantly related to the odds of adolescent obesity. The results suggest a positive association between maternal education and adolescent obesity: adolescents whose mothers are in the medium education category have 1.49 times the odds of obesity as adolescents with mothers in the lowest education category ($p<0.01$) and those whose mothers completed 12 years of schooling or greater have 1.70 times the odds of obesity ($p<0.01$).

Model 2 is an extension of Model 1 and incorporates the household wealth variables. These results reveal that compared with adolescents in low quality housing, adolescents in high quality housing have 1.80 times the odds of obesity ($p<0.01$). The results are similar for assets: adolescents in the middle tercile have 1.78 times ($p<0.01$), and those in the highest tercile have 2.38 times ($p<0.01$) the odds of obesity of adolescents in the lowest asset households. The parental education variables' influence on obesity changes considerably between Model 1 and Model 2. In Model 2, which controls for the household wealth variables, adolescents whose fathers completed 12 years of schooling or more have 0.53 times the odds of obesity compared with adolescents whose fathers completed fewer than 6 years of schooling ($p<0.01$), suggesting a protective effect of high paternal education. In contrast, the maternal education odds ratios are attenuated and are no longer statistically significant.

Building on Model 2, Model 3 adds interaction terms between maternal and paternal education to the preceding model. The effects of household assets and housing quality are essentially unchanged and the only significant education interaction occurs when both parents have completed at least 12 years of schooling: adolescents whose parents are both in the highest education category have 0.55 times the odds of obesity compared with adolescents whose parents both have fewer than 6 years of education ($p<0.05$). In other words, adolescents whose parents have both graduated from secondary school have a lower risk of obesity than those with little schooling, *ceteris paribus*. A test of the joint significance of the education interaction terms indicates that, as a group, the variables are statistically significant ($p<0.01$).

We tested several alternative parameterizations for parental education (results not shown). Regression models using education as a continuous variable (including a quadratic term), a binary variable (fewer than or equal to 6 years versus greater than 6 years of education), and other categorical specifications yielded remarkably similar results to those in Table II. In these models, maternal education is positively (but not always significantly) associated with obesity and high levels of paternal education are negatively associated with obesity. The model with the continuous education specification with a quadratic term suggests a non-linear relationship between obesity and maternal education, with the highest levels of maternal education potentially associated with lower obesity.

We also re-estimated the models presented in Table II using alternative outcomes: obesity as age- and sex-specific BMI at or above the 95th percentile based on the CDC growth charts (26), and a linear BMI term. The sign, magnitude, and statistical significance of coefficients using these alternative outcome measures are very close to those in Table II.

Sub-group analysis

The sub-group analyses by sex and residence are presented in Table III. Household assets appear to significantly increase the odds of obesity for non-rural boys ($p<0.01$) and rural girls ($p<0.01$), whereas housing quality increases the odds of obesity for boys in rural areas ($p<0.01$) and girls in non-rural areas ($p<0.05$). Parental education is not significantly associated with obesity for boys. For girls, the only significant parental education odds ratio pertains to the highest paternal education group (greater than or equal to 12 years) in non-rural areas ($p<0.05$). Non-rural girls with well-educated fathers are significantly less likely to be obese than non-rural girls with fathers who have low education.

Age is associated with decreased odds of obesity among non-rural girls ($p<0.01$), with each year of age lowering the odds by 11%. However, the odds ratio for age is not significant for any other group.

Discussion and Implications

Our study of adolescent obesity in Mexico examined two aspects of SES: household wealth and parental education. Household wealth can shape adolescent health through food availability, housing quality, and access to medical care (27). In lower income countries, household wealth is generally positively associated with adolescent obesity (13, 28, 29). Our results confirm that housing quality and household assets are both positively correlated with obesity, and are consistent with Buttenheim et al.'s (15) results for Mexican adults, as well as previous studies of children (30). The findings are also consistent with our hypothesis that financial and material well-being are likely to be positively associated with obesity. Households with more assets can better afford cars, televisions, and computers, all of which are conducive to sedentary behavior, and high caloric and processed foods. Alternatively, Brewis (31) speculates that well-off families place a high value on pampering children including the provision of indulgent food treats, such as sweets and soda. Jimenez-Cruz et al. (32) suggest that adults who perceive themselves as obese consider heavier children to be healthy. As adult weight is associated with economic status in Mexico, well-off adults may be more likely to accept fatness in their children.

The second SES measure we considered was parental education, which is associated with many aspects of adolescent health (33–36). Previous literature suggests that maternal education in particular may have important effects on children's health independent of other measures of household or family SES (37–39). Higher maternal education in poorer countries has been associated with increased levels of child obesity in some studies (40), but not others (41). Less is known about the effects of maternal education on adolescent health outcomes, including obesity. In our analyses the association between maternal education and obesity was consistently positive, but this variable did not reach statistical significance in all of the models. In contrast, we find that paternal education has a negative association with adolescent obesity. Specifically, we show that fathers with 12 or more years of education are less likely to have obese adolescents than those with fewer than 6 years of schooling. As father's education is likely to be strongly related to family economic status in Mexico, this finding contrasts sharply with our results for other economic status variables and merits further investigation.

Although we expected that non-rural adolescents would be more obese than their rural counterparts, our results show that the situation is more complex. In general, better economic status is associated with increased obesity for girls and boys in both non-rural and rural settings. None of the maternal education coefficients is significant in the sub-group analyses and both age and paternal education coefficients are significant only among non-rural girls. We speculate that older adolescent girls in non-rural areas may be more exposed and sensitive to norms about slenderness and physical attractiveness. The complex results for the sub-group analyses may reflect the definition of "non-rural" in the ENSA dataset. Non-rural settlements are those that have greater than 2 500 inhabitants and therefore a wide range of settlements with diverse social and economic characteristics are included in this group.

This study has several important strengths. It is among the first to examine the effects of SES on adolescent obesity in Mexico using a large, nationally representative sample. This sample allows us to examine several different facets of SES and to identify differences by gender and non-rural residence. Unlike most previous studies, we investigate the distinct and joint effects of maternal and paternal education. Despite its strengths, the study also has several limitations. First, we do not include measures of adolescents' own employment status or income, which may be important (42), especially for older adolescents. Second, the cross-sectional nature of the study limits our ability to examine the effects of SES on

subsequent obesity risk. Third, like any study, we have not included all relevant variables. One potentially important omitted variable is the adolescent's birth weight, which has been linked to subsequent development of obesity (43,44) and is associated with SES (45). Finally, we include only adolescents who live at home with two parents, so the results are generalizable only to this population.

The high and apparently increasing prevalence of adolescent obesity in Mexico is a serious problem both for adolescents and for Mexican society as a whole. As in other populations, obesity among Mexican adolescents is linked to an increased risk of the metabolic syndrome, including low high-density lipoprotein (HDL) levels, hyperglycemia, and elevated insulin concentration (46–48). Furthermore, adolescent obesity is a strong predictor of obesity in adulthood (49,50). Our results confirm del Rio-Navarro et al.'s (2004) finding, also based on ENSA 2000, that obesity prevalence is higher among younger rather than older Mexican adolescents (i.e., 14.7% of 10-year-old boys vs. 9.9% of 17-year-old boys), which does not bode well for the future.

The results of this study suggest that adolescents in moderate to high economic status households should be an important target of obesity prevention programs and campaigns. Adolescent boys, in particular, should be a key target group in these settings. Adolescents whose families are better off are likely to have greater access to mass media, suggesting that media messages and programming directed at changing norms may be effective, particularly as part of a multifaceted public health program. As the nutrition transition proceeds, however, the obesity epidemic is likely to spread throughout Mexican society. As living standards continue to rise, children and adolescents in poorer families may emerge as the highest risk groups while obesity among wealthier families may decrease, similar to the current situation in developed countries. Thus, it is essential to monitor changes in the obesity epidemic by SES over time and adapt public health and clinical practice accordingly. Younger adolescent cohorts have been exposed to more sedentary and poorer dietary environments from an earlier age and the prevalence of obesity is likely to increase in these cohorts as they age. As childhood and adolescence may be the most fruitful ages for behavioral change, understanding the socioeconomic patterns of adolescent obesity in countries such as Mexico can help us to target prevention and treatment policies more effectively.

Mexican obesity rates also have important implications for the United States, given the high volume of immigration from Mexico. However, comparisons between Mexican-origin adolescents in the United States and those in Mexico show that there are both similarities and differences. First, obesity prevalence is considerably higher among Mexican-American compared with Mexican adolescents. In 1999–2002, 24.7% of Mexican-American boys, aged 12–19 years, and 19.9% of girls had a BMI greater than the 95th percentile (51). In our Mexican sample of 12–18 year olds, these figures are 8.6% among boys and 7.7% among girls. Plausible explanations for this discrepancy include differences in diet, activity patterns, and the built environment (52). Moreover, because of discrimination and low social status, Mexican-American adolescents may experience more psychosocial stress than their Mexican counterparts, which, in turn, may predispose them to higher obesity risk. A second disparity is the well-established, strong inverse relationship between adolescent obesity and SES in the United States (8,53) compared with our finding of a positive relationship between wealth and obesity in Mexico. In contrast, the two populations are characterized by similar sex differences. Among both Mexicans and Mexican-Americans, boys are more likely to be obese than girls, whereas women are more frequently obese than men (15,51).

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Figure 1.
Percent obese by sex and age.

Table I

Percent distribution and mean values of analysis variables, Mexico 2000.

Description	
Mean housing quality score	0.84
Percentage of adolescents who reside in high housing quality	64.7%
Mean asset ownership score	0.61
Percentage of adolescents in highest asset ownership category	25.9%
Mean years of school completed by fathers	7.1
Percentage of adolescents whose fathers are in highest education category	18.9%
Mean years of school completed by mothers	6.6
Percentage of adolescents whose mothers are in highest education category	14.9%
Percentage of adolescents who reside in non-rural locales	51.9%
Percentage of adolescents who are male	48.4%
Mean age of adolescents in the sample	13.4
Mean BMI of adolescents in the sample	20.9
Percentage of adolescents in the sample who are obese by IOTF standards	8.2%
Percentage of non-rural adolescents who are obese	10.0%
Percentage of rural adolescents who are obese	6.2%
Percentage of male adolescents who are obese	8.6%
Percentage of female adolescents who are obese	7.7%

Source: ENSA 2000.

Table II

Odds ratios from logit models of obesity for Mexican adolescents, aged 10–18 [N=10 069].

	Model 1	Model 2	Model 3
Household asset ownership (ref = Low)			
Medium		1.78** [1.21–2.61]	1.75** [1.19–2.58]
High		2.38** [1.50–3.77]	2.34** [1.48–3.70]
Housing quality (ref = Low)			
High		1.80** [1.22–2.65]	1.79** [1.21–2.64]
Maternal education (ref = Low, <6 years)			
Medium, 6–11 years	1.49** [1.13–1.97]	1.30 [0.97–1.73]	
High, 12+ years	1.70** [1.14–2.56]	1.32 [0.87–1.99]	
Paternal education (ref = Low, <6 years)			
Medium, 6–11 years	1.11 [0.85–1.46]	0.96 [0.73–1.27]	
High, 12+ years	0.72 [0.48–1.08]	0.53** [0.35–0.80]	
Paternal-Maternal education (ref = Low-Low)			
Low-Med			1.00 [0.65–1.55]
Low-High			0.99 [0.27–3.57]
Med-Low			0.70 [0.44–1.11]
Med-Med			1.16 [0.81–1.65]
Med-High			1.40 [0.84–2.32]
High-Low			0.66 [0.24–1.79]
High-Med			0.70 [0.43–1.15]
High-High			0.55* [0.34–0.90]
F statistic joint significance of education variables			2.81**

Source: ENSA 2000. 95% Confidence Intervals are reported in brackets. All models control for non-rural residence, gender, and age. The individual coefficient is statistically significant at the **1% significance level and at the *5% significance level.

Table III

Odds ratios from logit models of obesity for Mexican adolescents, aged 10–18, by sex and non-rural/rural residence.

Model	Non-Rural Males	Non-Rural Females	Rural Males	Rural Females
Age	0.95 [0.88–1.03]	0.89** [0.83–0.96]	0.97 [0.87–1.08]	1.11 [0.99–1.23]
Household asset ownership (ref = Low)				
Medium	2.57** [1.28–5.19]	1.97 [0.73–5.31]	1.25 [0.66–2.34]	1.35 [0.68–2.66]
High	3.60** [1.70–7.63]	2.16 [0.73–6.38]	1.23 [0.51–2.92]	4.05** [1.49–10.97]
Housing quality (ref = Low)				
High	0.98 [0.44–2.20]	2.58* [1.17–5.69]	2.48** [1.28–4.77]	1.55 [0.74–3.23]
Maternal education (ref = Low, <6 years)				
Medium, 6–11 years	1.32 [0.79–2.20]	1.11 [0.64–1.91]	1.71 [0.96–3.06]	1.14 [0.63–2.05]
High, 12+ years	1.54 [0.83–2.86]	0.97 [0.44–2.13]	2.34 [0.78–6.98]	1.20 [0.43–3.32]
Paternal education (ref = Low, <6 years)				
Medium, 6–11 years	1.17 [0.68–2.00]	0.76 [0.45–1.28]	0.96 [0.52–1.75]	0.94 [0.48–1.82]
High, 12+ years	0.53 [0.27–1.05]	0.36* [0.16–0.78]	1.01 [0.42–2.45]	1.10 [0.45–2.68]
N	2 583	2 642	2 292	2 552

Source: ENSA 2000. 95% Confidence Intervals are reported in brackets. The individual coefficient is statistically significant at the **1% significance level and at the *5% significance level.