Heidi Norbis

Socioeconomic differences in obesity among Mexican adolescents

Introduction

Over the course of the last few decades, obesity rates have increased markedly in Latin America. This region is currently undergoing rapid demographic, epidemiologic, and nutritional transitions. The nutritional transition that is being experienced in this part of the world is characterized by shifts in levels of physical activity and diet, although individual countries exhibit a great deal of heterogeneity in the patterns and trends of obesity (Popkin et al. 2004). Economic development, urbanization, and changing attitudes and behaviors are all contributing factors that have been proposed to explain the increasing prevalence of obesity in Latin America.

Mexico is a particularly interesting case to consider in the context of obesity in Latin America. No country in Latin America reports higher rates of obesity than Mexico (Filozof et al. 2001). For example, while the prevalence of adult obesity in Mexico in 2000 was approximately 28% for females and 19% for males, in Brazil, the other major economic power in Latin America, these indicators were 13% and 9% for females and males, respectively (WHO 2007). The obesity epidemic in Mexico is not limited to adults: data from the Mexican National Health Survey indicate that the prevalence of adolescent obesity in 2000 varied by age from 6.1% among 15 year olds to 9% among 10 year olds for boys, and from 5.9% among 12 year olds to 8.2% among 16 year olds for girls (del Rio-Navarro et al. 2004). Previous studies on Mexican adolescents link obesity to an increased risk of metabolic syndrome, including low HDL levels, hyperglycemia, and elevated concentrations of insulin (Halley-Castillo et al. 2007, Villalpando et al. 2007, Yamamoto-Kimura et al. 2006). In light of the young age distribution in Mexico, with over one-third of the Mexican population under the age of 18 (UNICEF 2006), the deleterious health effects of obesity among Mexican youth can have serious implications for the future. It is therefore critical to understand the patterns of obesity in this society in order to devise targeted interventions to address this growing problem. In thinking about ways to better understand the patterns of obesity in a society, socioeconomic status (SES) is an important avenue of inquiry. While some studies in developed countries examine the relationship between SES and adolescent obesity, few studies explore this relationship in developing countries. In Mexico, studies that examine SES and adolescent obesity focus on specific geographic regions, cities, or ethnic groups, but to my knowledge, no such analysis has been conducted on a national sample of adolescents.

SES and adolescent obesity

Various measures of SES have been linked to obesity, yet social patterning of obesity appears to depend on the social and economic context of a country. For example, research in developed countries, including the United States, finds an inverse relationship between SES and adolescent obesity, whereby the prevalence of obesity decreases with increasing levels of SES. In a national sample of Swedish adolescents 15-16 years of age, the prevalence of overweight and obesity is highest among those in the lowest income bracket and those with less educated parents (Sundblom et al. 2008). Similarly, data from NHANES III indicate that, in the United States, obesity is more prevalent among 6-18 year olds of low SES as measured by family income compared with their high-income counterparts (Wang 2001). Of particular relevance to the present study, in the United States an inverse relationship is found between the risk of obesity and SES among Mexican-American adolescents (Hernandez-Valero et al. 2007). Researchers speculate that high SES is protective against adolescent obesity in developed countries because parents of higher SES are both more aware of how to avoid obesity and more able to avoid obesity because they can afford healthier lifestyles, for example, by procuring nutritious foods for the household and by encouraging their children to participate in recreational activities that require physical exercise. The inverse relationship between SES and adolescent obesity in developed countries may also be attributable to SES differences in perceptions of appropriateness of weight status (Chang and Christakis 2003).

Nonetheless, the relationship between SES and obesity observed in developed countries may not be universal. Among adolescents residing in Quito, Ecuador, for example, high SES is a risk factor for *increased* BMI (Yepez et al. 2008). These findings are by no means unique, as the positive relationship between adolescent obesity and SES is documented in a number of other Latin American countries, including Brazil (Monteiro et al. 2004) and Colombia (McDonald et al. 2009). Studies in Mexican populations specifically suggest that social gradients in obesity do not follow the patterns observed in developed countries. In their study of Mexican adults, Buttenheim and colleagues find that, for urban men and rural men and women, household wealth as reflected in asset ownership is associated with greater obesity (Buttenheim et al. 2009). This pattern is also seen among older Mexicans: using data from the Mexican Health and Aging Study, Ruiz-Arregui and colleagues establish that older Mexicans with lower levels of educational attainment have a lower prevalence of overweight than older Mexicans with higher levels of educational attainment (Ruiz-Arregui et al. 2007). In their analysis of older Mexicans, Smith and Goldman find that those residing in urban areas exhibit social patterns of obesity similar to those in developed countries, with lower prevalence of obesity among those of higher SES; but conversely, among older Mexicans residing in rural areas, higher SES is associated with a higher prevalence of obesity (Smith and Goldman 2007). Should we expect that Mexican adolescents will exhibit similar SES patterns of obesity as Mexican adults?

To address this question, this study seeks to characterize the relationship between SES and obesity in a nationally representative sample of Mexican adolescents. I hypothesize that, unlike in developed countries where obesity primarily afflicts adolescents of low SES, obesity will be more prevalent among adolescents of high SES. There are two general mechanisms by which high SES can operate to increase adolescent obesity risk. First, more affluent households may have more access to processed and fatty foods, and sugary beverages. Here "access" refers to both physical access, for example the presence of supermarkets instead of small local shops or markets, and affordability. High SES also facilitates the acquisition of certain goods, specifically cars, T.V.'s, computers, and videogame systems, which are conducive to a more sedentary lifestyle.

In addition to SES, parental health status, in particular parental BMI, exhibits strong associations with adolescent obesity. This relationship is documented in developed countries (Maffeis et al. 1998, Robl et al. 2008, Whitaker et al. 1997) and in developing countries (Dieu et al. 2007, Monteiro et al. 2004), including Mexico (Flores et al. 2003). Parental BMI can affect the likelihood of adolescent obesity in at least four ways. First, there may be a strong genetic component to obesity so that children of obese parents have a predisposition for obesity. Another possible mechanism is that parental behaviors that result in high parental BMI, such as a lack of exercise and a poor diet, are likely to be adopted by adolescents and subsequently lead to adolescent obesity. It is also possible that both parental BMI and adolescent obesity are influenced by a third, unobserved environmental factor. Finally, both parental BMI and adolescent obesity may be partially determined by parental SES. In light of work conducted specifically on Mexican adults, both in a national sample (Buttenheim et al. 2009), and in sub-populations (Fernald 2007) high parental SES may be associated with both high parental BMI and adolescent obesity. Therefore, the second question this paper will attempt to address is how much of the parental BMI effect on adolescent obesity can be accounted for by parental SES.

Studies suggest that there are different patterns of obesity between Mexican boys and girls. In their sample of Mexican adolescents, Salazar and colleagues find that the factors associated with a BMI indicating obesity differ between boys and girls (Salazar-Martinez et al. 2006). Differences are also found in height and weight status between adolescent rural residents and urban residents (Malina et al. 2008). Differences between urban and rural residents may reflect that, even at similar levels of SES, urban and rural adolescents may differ in their level of physical activity, diet, and attitudes about ideal body size. Thus a final aspect of this study will be to explore the relationship between SES gradients and obesity among different sub-populations of adolescents to establish what factors underlie these differences and predispose particular groups of Mexican adolescents to obesity. I hypothesize that the proposed positive relationship between SES and adolescent obesity will be more pronounced in urban populations because those residing in urban areas typically have more access to a wider variety of foods, including unhealthy foods, more access to public and private transportation, and more access to the types of home appliances and electronic goods that are more conducive to a sedentary lifestyle.

Data and Research Methods

Study Sample

The present study uses data from the Mexican National Health Survey 2000 (ENSA 2000). ENSA 2000 is based on a random sample of basic geographic statistical units obtained in each of the Mexican states and in the Federal District (Mexico City) from a database updated periodically by the National Institute of Geography and Statistics. 47,360 households were sampled based on a stratified multistage sample that is representative of the Mexican population at the state level. Sample weights adjust for non-response and design effects. ENSA consists of five questionnaires. The head of the household responds to the first questionnaire, which covers the physical characteristics of the house and socioeconomic and general health questions about each member of the household. The second questionnaire is completed for every member of the household who has used health services in the past year. The final three questionnaires are completed for a randomly selected 0–9-year-old, 10–19-year-old, and an adult aged 20 or older in each household, respectively. Only "habitual" residents are considered household members. People that normally live in the home, those who normally live in the home but have been absent for a period no longer than 3 months, and those who have been absent for more than 3 months for study or work and their current residence is a shared accommodation and not a private home are considered habitual residents. Consequently, persons who have been absent for more than 3 months but reside in another private home are not considered "habitual" residents and are not included in the household roster. ENSA 2000 is described in further detail elsewhere (Valdespino et al. 2003).

For the purposes of this study, the head of household and the spouse of the head of household are defined as the father and mother, or vice versa, depending on their sex. The sample is restricted to adolescents cohabiting with both parents because a main area of interest is to investigate the distinct effects of maternal and paternal education on adolescent obesity. Of the 12,418 adolescents between the ages of 10 and 18, who are cohabiting with both parents, 583 are excluded because they are missing BMI data, leaving a base sample of 11,835. Additional observations are excluded because they do not have values for paternal education, maternal education, household asset data, or housing quality data. This leaves a sample of 10,227 adolescents of which a further 158 observations are excluded because they are considered outliers (i.e. their BMI values are beyond three standard deviations from the interquartile range). The final analytic sample is comprised of 10,069 adolescents. See Appendix A for a detailed analysis of missing data.

Measures

Obesity

BMI is calculated as weight in kilograms over height in meters squared, and age and sex-specific thresholds for adolescent obesity developed for international use by the International Obesity Task Force (IOTF) are used to define obesity (Cole et al. 2000). These thresholds are designed to correspond statistically with an adult BMI of 30. Although the ENSA sample contains adolescents ranging from 10 to 19 years of age, the IOTF thresholds are developed for only adolescents up to the age of 18; therefore, 19 year olds are excluded from the analysis. The Childhood Obesity Working Group of the IOTF thresholds are preferred over the CDC thresholds because earlier work on the ENSA sample finds that adolescents in the sample are shorter than their American counterparts (del Rio-Navarro et al. 2004).

Socioeconomic Status

A great deal of debate exists regarding how different components of SES interact to produce adolescent health outcomes (Braveman et al. 2005, Glendinning et al. 1992). For this analysis, SES is measured by parental education (disaggregated into maternal education and paternal education), housing quality, and household asset ownership.

Education

The association between parental education and adolescent health and well-being is documented in areas as diverse as mental health (Finkelstein et al. 2007), sexual and reproductive health (Manlove et al. 2007), smoking behavior (Fagan et al. 2005), and dental health (Lopez et al. 2006). The adolescent's own education level is not included in the analysis because this measure is dependent on the adolescent's age, and would therefore be censored (i.e. biased against younger adolescents in the sample).

Maternal and paternal education are analyzed separately because a considerable body of literature suggests that, in developing countries, maternal education has important influences on child health and mortality, independent of paternal education and other measures of SES (Caldwell 1979, Martin et al. 1983). With regard to obesity in developing countries, high maternal education has been associated with increased levels of obesity in some studies (Moussa et al. 1994), but not in others (Dieu et al. 2007). In terms of explaining mechanisms of influence, recent work by Wachs proposes that the relationship between maternal education and nutritional outcomes is partially mediated by maternal control of family resources and independence in resource decision-making, knowledge of nutrition and effective use of nutrition information, and maternal nutrition and health status (Wachs 2008). It is important to note that the majority of studies examining the effect of maternal health focus on child nutritional outcomes. The present study departs from this body of literature by considering the effect of maternal education on an adolescent outcome. This work is also unique in that it considers the effects of paternal and maternal education on obesity separately, which, to my knowledge is the first attempt to do so on an adolescent Mexican population.

The measures of parental education are grouped into three categories: fewer than 6 years, representing the illiterate and those who had not completed primary school; between 6 and 11 years, representing those who completed primary school but had not completed high school; and 12 years or greater, representing those who completed high school or more.

Household wealth

A rich and complex literature examines the relationship between household wealth and health outcomes among children and adolescents in developing countries (Gwatkin 2001). In general terms, household wealth can shape adolescent health by pathways such as food availability, housing quality, and access to medical care. In developing countries a positive relationship between various measures of household wealth and adolescent obesity is documented (Mendonza et al. 1990, Monteiro et al. 2004, Neutzling et al. 2000). In the present study, two variables, quality of housing and household asset ownership, reflect household wealth.

For housing quality, an index capturing quality of household dwelling is constructed from four items, including the presence or absence of running water, sanitation, good quality floors, and whether the household cooks with wood. Factor analysis is used to combine these variables into a single scale ranging from 0 to 1 (Cronbach's alpha = 0.70), with 1 reflecting higher housing quality. The distribution of this variable is bimodal, so two categories are created to analyze the effect of housing quality on the odds of obesity. For household asset ownership, an index of household assets is constructed, in a similar manner as the housing quality index, based on ownership of nine items: radio/stereo, television, VCR, blender, refrigerator, washer, telephone, water heater, and car/truck. Factor analysis is used to combine these variables into a single scale ranging from 0 to 1 (Cronbach's alpha = .83). The distribution of this variable is trimodal, so terciles are created to analyze the effect of household asset ownership on the odds of obesity. These scales are used in a similar study on the ENSA sample that examines the relationship between SES and two adult health outcomes, smoking and obesity (Buttenheim et al. 2009).[1]

Parental BMI

The mechanisms underlying the relationship between parental BMI and adolescent behavior related to obesity are not well elucidated. It is possible that adolescents whose parents are obese may modify their own behavior and make healthier lifestyle choices in order to avoid their parents' health problems. However, evidence suggests that this typically does not happen (Guerra-Juarez et al. 2007), perhaps because adolescents are heavily influenced by their parents' decisions regarding food choice, neighborhood, and behaviors that may help determine their weight.

[1] While measures of household income are available in the ENSA dataset, this variable is not used in the analysis. Measures of income are frequently misreported in surveys, so I exclude this variable for concern of introducing measurement error (Filmer and Pritchett 2001).

Information on parental BMI is drawn from the adult ENSA questionnaire and matched to the adolescent in the household. In practice, the adult questionnaire is administered to a randomly selected adult in the household: 47% of the time the head of household is the selected adult, 42% of the time the spouse of the head of the household is the randomly selected adult, and for the remaining 11% the randomly selected adult is another adult household member. For 2/3 of the adolescents the adult responding is female.

Statistical Analysis

After descriptive and bivariate analyses, I use logistic regression analysis to test the hypothesis that higher SES is associated with increased odds that an adolescent is obese, controlling for urban residence, gender, and age. The next logistic regression model examines how much of the parental BMI effect on adolescent obesity can be accounted for by parental SES. Using stratified models, an analysis of subpopulations is also conducted to examine differences in the relationship between SES and obesity between male and female adolescents, and between adolescents residing in rural versus urban settings. All models are estimated with STATA10 and account for non-response and design effects.

Results

Descriptive statistics

Table 1 presents the demographic characteristics of the sample. Slightly under half of the sample (48%) is comprised of males and the mean age is 13.4; 52% of the adolescents reside in urban areas. In this sample of adolescents, the overall prevalence of obesity is 8.2%. Obesity is more prevalent among boys: 7.7% of girls in the sample are obese, compared to 8.6% of boys. While younger adolescents tend to have a higher prevalence of obesity than older adolescents, this relationship is more pronounced among boys (Figure 1) than girls (Figure 2). Urban adolescents have a higher prevalence of obesity relative to their rural counterparts, with 10.0% obese among urban and 6.2% among rural adolescents.

With regard to the SES measures, the mean years of school completed is 6.6 years for mothers, and 7.1 years for fathers. On the housing quality scale, which ranged from 0 to 1, the mean score is 0.84. On the household asset scale, which also ranged from 0 to 1, the mean score is 0.61.

The odds of obesity and SES

In the bivariate associations, which are presented in Table 2 (Model 1), household asset ownership, housing quality, maternal (but not paternal) education, and parental BMI are all positively correlated with the odds of obesity. However, do these relationships persist in the multivariate models?

The first multiple logistic regression model, presented in Table 2 (Model 2), reveals that compared to adolescents in the low housing quality category, adolescents in the high housing quality category have 1.80 times the odds of obesity ($p<0.01$). Similarly, compared to adolescents in the lowest asset tercile, those in the middle asset tercile have 1.78 times the odds of obesity ($p<0.01$), and those in the highest asset tercile have 2.38 times the odds of obesity ($p<0.01$). Thus, while the coefficients for asset ownership and housing quality from the bivariate model are attenuated when parental education and demographic characteristics are included in the regression, the coefficients remain significant. With regard to the education variables, adolescents whose fathers completed 12 or more years of schooling have 0.53 times the odds of obesity of adolescents whose fathers completed fewer than 6 years of schooling ($p<0.01$), suggesting that high levels of paternal education may be protective against obesity. This result is interesting because the effect of high paternal education is not significant in the bivariate model. In contrast, maternal education, which is significant in the bivariate model, is no longer significant in the multiple logistic regression model.

When parental BMI and the SES variables are considered jointly (Table 2, Model 3), the estimated effects of household asset ownership and housing quality on the odds of obesity are modestly attenuated, but the positive and significant relationship between household wealth and adolescent obesity persists. The results from this regression suggest that adolescents in the high quality housing category have 1.72 times the odds of obesity of their counterparts in the low housing quality category ($p<0.01$).

Adolescents in the middle asset tercile have 1.66 times the odds of obesity of adolescents in the lowest asset tercile (*p<0.01*), and those in the highest asset tercile have 2.23 times the odds of obesity of adolescents in the lowest asset tercile (*p<0.01*). Unlike the asset and housing variables, the maternal education coefficient increases slightly when parental BMI is included in the analysis. Adolescents whose mothers have completed between 6 and 11 years of school have 1.34 times the odds of obesity of adolescents whose mothers have completed fewer than 6 years of school (*p<0.05*). In terms of the paternal education variable, again we see a protective effect of high levels of paternal education, with adolescents whose fathers completed 12 or more years of school having 0.54 times the odds of obesity of those in the lowest paternal education category (*p<0.01*). There is no change in the coefficient for parental BMI between the bivariate model and the multiple regression model: each point increase in parental BMI is associated with a 9% increase in the odds of obesity (*p<0.01*).

Sub-group analysis

The results for the sub-group analyses are presented in Table 3. An analysis of male obesity by residence reveals that household asset ownership significantly increases the odds of obesity among boys in the urban context (*p<0.01*) but not in the rural context. In rural areas housing quality appears to significantly increase the odds of obesity among boys (*p<0.05*) but this relationship is not observed in urban areas. The opposite relationship is found when I consider the factors that are associated with the odds of obesity among girls. For urban girls, housing quality appears to significantly increase the odds of obesity (*p<0.05*), and for rural girls, high asset ownership is associated with increased obesity (*p<0.05*). The influence of paternal education also differs between rural and urban girls: whereas paternal education has a protective effect against obesity among urban girls (*p<0.05*) no significant relationship is found between paternal education and the odds of obesity among rural girls. Like paternal education, age is associated with a decreased odds of obesity among urban girls but not rural girls, with each additional year of age for urban girls associated with a 12% lowered odds of obesity (*p<0.01*). Parental BMI is positively and significantly associated with the odds of obesity for all sub-groups that are considered (*p<0.01*).

Robustness of the analysis

The regression models presented in Table 2 are re-run using an alternative definition of obesity based on the CDC growth charts: obesity defined as age- and sex-specific BMI at or above the 95th percentile (CDC 2009). The sign, magnitude, and statistical significance of coefficients remain similar with this alternative definition of obesity.

A number of alternative parametrizations for the parental education variables are also tested. Regression models using education as a continuous variable (including quadratic and cubic terms) and as binary variables (no education versus any education, and fewer than 6 years of education versus more than 6 years of education), yield remarkably similar results as those presented in Table 2. The non-linear specifications on the continuous education variable are not statistically significant. Irrespective of the parametrization, maternal education is positively associated with the odds of obesity and high levels of paternal education are negatively associated with obesity.

Discussion

In the past few decades, research on socioeconomic gradients in health has burgeoned. While some of these studies investigate socioeconomic gradients in child health and mortality, the vast majority of the studies focus on adult populations, primarily in the developed world. Considerably less attention is devoted to socioeconomic gradients in adolescent health. Research on SES gradients in adolescent populations in the developing world is particularly lacking. This study attempts to address this deficiency by contributing to the literature on social inequalities in an increasingly important aspect of adolescent health, obesity. The findings presented here are of interest not only because they provide insight into the SES gradients in obesity among Mexican adolescents, but also because they generate questions for future research.

The results of this study corroborate earlier research that obesity is more common among Mexican adolescent boys than girls (Salazar-Martinez et al. 2006). One striking finding is the increase in prevalence of obesity among more recent cohorts of adolescent boys, illustrated in Figure 1. These trends in obesity validate del Rio-Navarro and colleagues' work. In their analysis of the entire ENSA sample, 10 year old boys have a prevalence of obesity of 14.7%, and the prevalence decreases with age, reaching 9.9% among 17 year old boys (del Rio-Navarro et al. 2004). This increase in the prevalence of obesity suggests that the burden of obesity-associated diseases is likely to expand as recent birth cohorts advance into and through adulthood. Indeed, longitudinal studies have concluded that obese adolescents have a high probability of becoming obese adults (Gortmaker et al. 1993, Parsons et al. 1999), and, as such, adolescent obesity has important implications for the future health burden. Understanding country-specific patterns of adolescent obesity can help us to better target policy to prevent and treat this condition, since childhood and adolescence represent the most fruitful times for these types of interventions.

In light of the high volume of immigration from Mexico to the United States there are important implications of Mexican obesity for policy in the United States. A comparison of the results from this study with work on Mexican-American adolescents residing in the United States yields some interesting observations. One prominent difference is that obesity prevalence among Mexican-American adolescents is considerably higher than among Mexican adolescents. According to data from the 1999-2002 NHANES, 24.7% of Mexican-American boys and 19.9% of girls 12-19 have a BMI value greater than the 95th percentile (Flegal et al. 2004), which is more than double the obesity prevalence of 8.0% among Mexican boys and 7.5% among girls aged 12-18 in this study. Another disparity is apparent from the strong inverse relationship between adolescent obesity and higher SES in the United States, which has been established with various measures of SES including income (Forrest and Leeds 2007) and maternal education (Hernandez-Valero et al. 2007). A similarity between Mexican and Mexican-American adolescents is the sex difference. A higher prevalence of obesity among boys in both populations may be partially explained by common cultural factors that stigmatize obesity among girls, but not boys (Sobal and Stunkard 1989). It is worth noting that in both Mexican and Mexican-American *adult* populations, obesity is more prevalent among women than men (Flegal et al. 2004, Buttenheim et al. 2009). Thus, this analysis suggests a potential reversal in the sex difference among Mexican and Mexican-American adults in the future.

This study considers two broad categories of SES: household wealth and parental education. The quality of housing construction and household asset ownership are both found to be positively correlated with obesity. These findings concur with overall results regarding wealth and obesity among Mexican adults (Buttenheim et al. 2009) and with studies on Mexican children. For example, in their analysis of the 1999 Mexican National Nutrition Survey, Hernandez and colleagues utilize a SES index, constructed using principal component analysis with similar variables as in this study, and find that higher SES increases the likelihood of obesity among children by 62% (Hernandez et al. 2003).

The findings are also consistent with my hypotheses. Because quality of housing construction and household assets both reflect the level of material well-being of the household, one can conjecture that these are precisely the households that can afford items such as cars, televisions, and computers that are conducive to a sedentary lifestyle. These are also the households that can afford rich, processed foods that are imported from the United States and elsewhere. It is also possible that attitudes towards obesity vary by level of household wealth. Brewis speculates that the value placed on children in families that are better off can result in indulgent feeding because food treats, such as sweets and soda, are a cultural index of parental caring (Brewis 2003). Varying perceptions of weight status may be another explanation. A study by Jimenez-Cruz and colleagues in northern Mexico finds that adults who perceive themselves as obese consider heavier children as healthy (Jiminez-Cruz et al. 2007). So perhaps it is the case that parents who are wealthier and heavier value child fatness as a sign of health and well-being.

One of the interesting findings to emerge from the analysis relates to the parental education variables, whereby increased maternal education appears to predispose adolescents to obesity, but high levels of paternal education appear to be protective, net of other SES measures and parental BMI. Paternal education typically receives less attention in the literature than maternal education, yet numerous studies find strong associations between paternal education and child health outcomes, independent of other measures of SES (Hatt and Waters 2006). The protective effect of paternal education vis-à-vis adolescent obesity is also documented, but this evidence is primarily from developed countries (Stea et al. 2009, Padez et al. 2005). In this study, the protective effect of paternal education is observed among adolescents whose fathers have completed 12 or more years of schooling relative to those that have completed fewer than 6 years. Why might high paternal education, but not high maternal education, decrease the likelihood of obesity? I suggest several plausible explanations. One possibility is that fathers who complete high school or beyond, more so than equally educated mothers, have greater exposure to American ideas of well-being, which stress the importance of exercise and nutrition. These fathers may be more inclined to emulate these behaviors, and, subsequently, their children may do so as well. Alternatively, paternal education could be a proxy for income, which is not explicitly considered in this analysis, with high income being protective against obesity. In contrast, increased levels of maternal education may result in an increased likelihood of obesity because more highly educated mothers tend to work outside the home, and may not be present to prepare meals, so that adolescents in the home are consuming more processed, ready-made type foods. Another speculation is that, highly educated mothers may be more indulgent of their children than less educated mothers. The finding that maternal and paternal education may operate in opposite directions, independent of other measures of SES, is unexpected and merits further investigation.

More generally, the results from this study suggest that distinct components of SES, parental education and household wealth, may have differential effects on the prevalence of obesity among adolescents. One observation is that the wealth variables are consistently significant predictors of obesity, whereas the education variables are significant in some models, but not in others. Additionally, it seems that the components of SES considered here can operate in opposite directions. Indeed, some components of higher SES appear to predispose adolescents to obesity, whereas others are protective. These results are in general agreement with Buttenheim and colleagues' observation that education and household assets can have varying relationships with health behaviors (Buttenheim et al. 2009). Undoubtedly, these indicators used to capture facets of SES reflect diverse social processes, and each appears to contribute to the risk of adolescent obesity through different pathways. While the literature typically finds support for a positive association between higher SES and obesity in Mexico (Fernald 2007), this study points to a more complex relationship: high SES measured in terms of assets and quality of housing appears to increase the prevalence of obesity, but high SES measured in terms of parental education seems to either increase the prevalence of obesity in the case of maternal education, or decrease the prevalence of obesity in the case of paternal education. Theory predicts that, as developing countries continue to grow economically and progress through the nutritional transition, their socioeconomic gradients will begin to mirror those in developed countries, but the current patterns of obesity among Mexican adolescents defy these simple categorizations. That is, Mexico, a middle-income country, does not seem to fit clearly into the developed world/developing country dichotomy with regard to socioeconomic gradients in obesity.

Including parental BMI along with SES variables did little to alter the magnitude of the coefficients. Nonetheless, consistently positive and significant associations are found between parental BMI and adolescent obesity, independent of socioeconomic and demographic variables. This corroborates research done by Hernandez-Valero on Mexican-American adolescents, where parental BMI increases the odds of obesity. Specifically, obese mothers are two times more likely to have an overweight child or at-risk-for-overweight child compared with their normal-weight counterparts, independent of demographic and SES measures (Hernandez-Valero et al. 2007). Part of the association between parental BMI and adolescent obesity is attributable to genetic susceptibility, yet parental health behaviors, such as food choice and exercise habits, may also influence adolescent obesity (Lopez-Alvarenga et al. 2007).

Overall the findings of the sub-group analyses are not consistent with my hypothesis that the SES gradient would be more pronounced in urban populations. Instead, the results suggest that SES risk factors for adolescent obesity vary by gender and residential setting. An interesting finding from the stratified analysis is that age and paternal education seem to decreases the odds of obesity only among urban girls. The negative association between age and obesity in this group may reflect a recent increase in adolescent obesity among urban girls, or perhaps, as adolescent girls in urban areas mature, they become increasingly exposed to media and societal messages that stress the value of thinness for women and feel increased pressure to conform to this ideal.

Limitations

Although this study contributes to our understanding of socioeconomic gradients and adolescent obesity, it suffers from several limitations. First, I consider measures of only parental SES, when indeed, the adolescents' own level of SES may be relevant. For example, among adolescents of a given age, the adolescents' level of education and adolescents' employment may influence the odds of obesity (Glendinning et al. 1992). This consideration may be particularly relevant for older adolescents.

Moreover, because the present study is a cross-sectional analysis it precludes any inference on causal relationships. A cross-sectional design is also not ideal because adolescent obesity, SES, and parental BMI, potentially vary over time. How these fluctuating characteristics interact dynamically over time to increase or decrease the risk of adolescent obesity, which is itself a cumulative phenomenon, is a question best addressed by longitudinal studies.

As in any study, there are important explanatory variables that are not included in the analysis. One such variable is the adolescents' weight at birth: weight at birth is linked to the subsequent development of obesity (Sorenson et al. 1997, Parsons et al. 2001) and is associated with the socioeconomic and parental variables considered here (Finch 2003). Moreover, this study does not explore the potential influence of neighborhood characteristics on individual level behavior. Neighborhood characteristics may shape an individual's obesity risk through mechanisms such as the availability of nutritious food, the existence of parks and spaces that are conducive to physical activity, prevailing attitudes about health and weight, and stress (Pickett et al. 2001). Including neighborhood SES could potentially enrich a study of this nature by elucidating more complex relationships among community SES, household SES, and individual risk of obesity.

A final limitation of this study is that only adolescents who are cohabiting with both parents are included in this analysis, so the results are not generalizable to adolescents who reside in single-parent homes, including children of divorced parents. This study also excludes parents who have been absent from the home for a period greater than three months, because these individuals are not considered “habitual” household members and are therefore not listed on the household roster. Cleary long-term migrants fall into this category. Certainly, SES patterns of obesity among adolescents who cohabit with both parents may be different from the SES patterns of obesity among adolescents with divorced parents or with a migrant parent.

Conclusion

This study uses data from the Mexican National Health Survey 2000 in order to contribute to the discussion on adolescent obesity in developing countries. Three questions are addressed. First, what do the social patterns of obesity look like among Mexican adolescents? Second, how much of the parental BMI effect on adolescent obesity can be accounted for by parental SES? And finally, are there differences in SES gradients among Mexican boys and girls, rural residents and urban residents? Some of the results concur with previous research and are consistent with expectations. However, the finding that maternal and paternal education appear to work in opposing directions to shape obesity risk among adolescents is an interesting finding that warrants further study. One of the more salient predictors for adolescent obesity was parental BMI. This suggests that environmental factors, including SES and parental lifestyle behaviors, can provide a context in which a genetic susceptibility for obesity is expressed. Nonetheless the picture of adolescent obesity in Mexico, as in other developing countries, is dynamic so that further economic development, changing cultural norms and family structure may influence the future course of adolescent obesity in unpredictable ways. Whether, for example, SES trends in adolescent obesity in Mexico will widen or reverse remains an open question.

Table 1. Variables, descriptions, and weighted summary statistics

Variable	Description	Mean	Standard Deviation/ Error
SES			
Housing quality	Housing scale ranges from 0 to 1, with higher values indicating better housing quality	0.840	0.259
Household assets	Household asset scale ranges from 0 to 1, with higher values indicating more household assets	0.611	0.277
Maternal education	Years of education completed by the adolescent's mother	6.64	3.83
Paternal education	Years of education completed by the adolescent's father	7.19	4.40
Parental BMI	kg/m^2 for parent	27.9	4.92
Obesity	1 if BMI above IOTF guidelines	0.081	0.273
Age	Age of adolescent as reported by head of household at time of survey	13.4	2.49
Male	1 if male, 0 if female	0.484	0.499
Urban	Current residence in community of >2,500 residents	0.518	0.499

Table 2. Odds ratios from models predicting obesity for Mexican adolescents 10-18

Model	1 Bivariate	2 Multiple	3 Multiple
Male		1.00 [0.01]	1.00 [0.07]
Age		0.96 [-1.66]	0.95 [-1.91]
Urban		0.93 [-0.46]	0 .94 [-0.43]
Household asset ownership (lowest tercile excluded)			
Assets: Medium	2.17** [4.54]	1.78** [2.96]	1.66** [2.66]
Assets: High	2.74** [5.07]	2.38** [3.70]	2.23** [3.45]
Housing quality (lowest group excluded)			
Housing quality: High	2.38** [5.21]	1.80** [3.01]	1.72** [2.82]
Maternal education (<6 category excluded)			
Maternal education 6-11	1.49** [2.94]	1.30 [1.77]	1.34* [2.00]
Maternal education 12+	1.43* [2.00]	1.32 [1.31]	1.40 [1.58]
Paternal education (<6 category excluded)			
Paternal education 6-11	1.29 [1.96]	0.96 [-0.23]	0.97 [-0.17]
Paternal education 12+	0.93 [-0.40]	0.53** [-2.98]	0.54** [-2.86]
Parent BMI	1.09** [10.30]		1.09** [9.50]
N	10,069	10,069	10,069
Pseudo-R²		0.032	0.057

Source: ENSA 2000. T-statistics are reported in brackets. Odds ratios in column 1 are from bivariate analyses, with each variable entered separately, controlling for demographic characteristics. The individual coefficient is statistically significant at the **1% significance level and at the *5% significance level.

Table 3. Odds ratios from models predicting obesity for sub-groups of Mexican adolescents 10-18

Model	**Urban Males**	**Rural males**	**Urban females**	**Rural females**
Age	0.95	0.97	0.88**	1.09
	[-1.20]	[-0.55]	[-3.22]	[1.74]
Household asset ownership				
(lowest tercile excluded)				
Assets: Medium	2.62**	1.14	1.88	1.17
	[2.67]	[0.43]	[1.27]	[0.47]
Assets: High	3.60**	1.24	2.10	3.33*
	[3.30]	[0.49]	[1.34]	[2.43]
Housing quality				
(lowest group excluded)				
Housing quality: High	0.95	2.23*	2.74*	1.52
	[-0.11]	[2.42]	[2.44]	[1.18]
Maternal education				
(<6 category excluded)				
Maternal education 6-11	1.39	1.70	1.15	1.22
	[1.26]	[1.77]	[050]	[0.65]
Maternal education 12+	1.66	2.39	1.00	1.27
	[1.60]	[1.57]	[0.02]	[0.45]
Paternal education				
(<6 category excluded)				
Paternal education 6-11	1.12	0.95	0.83	0.94
	[0.44]	[-0.16]	[-0.66]	[-0.16]
Paternal education 12+	0.53	1.04	0.38*	1.09
	[-1.84]	[0.10]	[-2.39]	[0.19]
Parent BMI	1.07**	1.09**	1.09**	1.13**
	[4.40]	[3.93]	[4.66]	[5.63]
N				
	2,583	2,292	2,642	2,552

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

Figure 1. Prevalence of obesity among boys by age

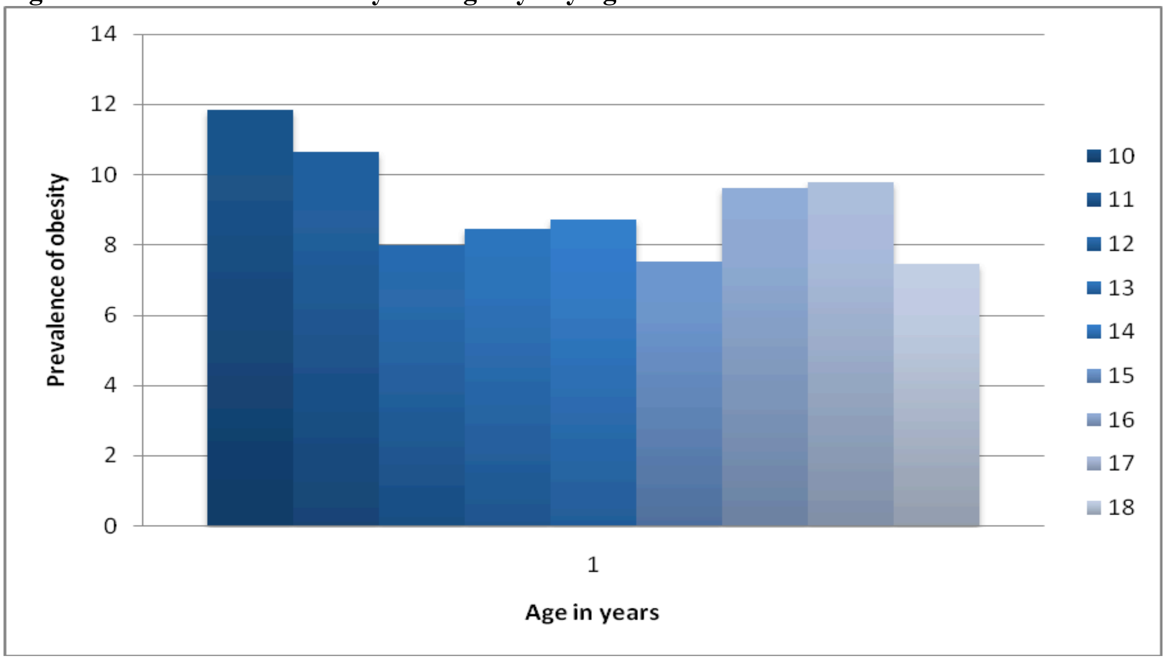
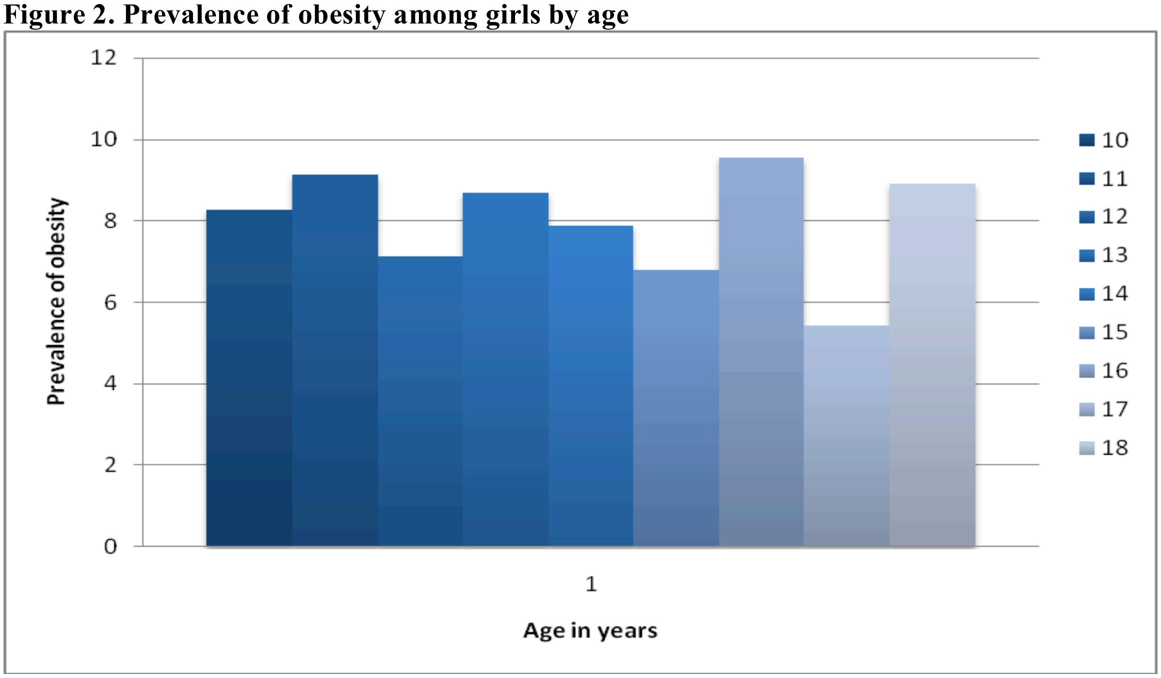


Figure 2. Prevalence of obesity among girls by age



Appendix A.

Analysis of missing variables and sample selection

Most observations are excluded due to missing values for paternal or maternal education. 1,720 adolescents are missing values for at least one of these two variables. An analysis of these two variables reveals some noteworthy differences between adolescents who have missing values for these variables and those who do not. Adolescents who are missing data on paternal education are less likely to be of high SES, as measured by asset ownership, housing quality, and maternal education. There is no significant relationship between having missing paternal education and adolescent obesity, parental BMI, gender, age, or urban residence. A similar picture with regard to SES emerges when I examine exclusion based on missing maternal education: adolescents of higher SES, by all measures of SES, are less likely to have missing values for maternal education. As with paternal education, adolescent obesity is not related to missing maternal education. Unlike missingness on paternal education, having missing values for maternal education is also significantly related to age, with older adolescents being more likely to have missing values for maternal education. Consequently, after excluding adolescents who are missing paternal and maternal education data, the resulting sample is generally of higher SES and younger than the base sample, but importantly, inclusion in the study sample is not related to obesity status.

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