Published in final edited form as:

Soc Sci Med. 2012 January ; 74(2): 125–134. doi:10.1016/j.socscimed.2011.10.007.

Canaries in a Coalmine: Immigration and Overweight among Mexican-origin Children in the US and Mexico

Jennifer Van Hook,

The Pennsylvania State University

Elizabeth Baker,

RAND Corporation

Claire E. Altman, and

The Pennsylvania State University

Michelle Frisco

The Pennsylvania State University

Abstract

The prevalence of overweight is higher for Hispanic children of immigrants than children of natives. This does not fit the pattern of the epidemiological paradox; the widely supported finding that immigrants tend to be healthier than their U.S.-born peers, and it suggests that exposure to the U.S. increases immigrant children's risk of overweight. This study's primary contribution is to better assess how exposure to the U.S. environment affects childhood overweight among a homogenous ethnic group, Mexican-Americans. We do so by using an innovative binational study design to compare the weight of Mexican-American children of immigrants, Mexican-American children of natives, and Mexican children in Mexico with different propensities of having immigrant parents. Cross-sectional data are derived from a pooled sample of 9,982 6–19 year old children living in either Mexico or the United States in the early 2000s. Mexican-resident children with a very high propensity to have immigrant parents have significantly lower percentile BMIs and lower odds of overweight than Mexican children with lower propensities of emigration and U.S.-resident Mexican-American children. This suggests that selection into immigration streams does not account for the high prevalence of overweight among children of Mexican immigrants. Rather, U.S. exposure significantly raises children of Mexican immigrants' risk of being overweight. Moreover, second generation children have the highest percentile BMIs and greatest odds of overweight of all comparison groups, including children of natives. This suggests that they experience risks above and beyond the effects of exposure to American society.

Keywords

Mexico; Mexican-American; immigration; acculturation; child obesity; overweight; epidemiological paradox; USA

© 2011 Elsevier Ltd. All rights reserved.

Corresponding author: Jennifer Van Hook, jvanhook@psu.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Introduction

Like canaries in a coalmine, immigrants and their descendants are frequently studied to assess how macro-level environments influence health and mortality. Most research conducted across age groups and outcomes indicates that newly-arrived and less acculturated immigrants are healthier and live longer than natives. Unfortunately, this health advantage erodes with duration of U.S. residence and does not extend to the next generation. Known as the epidemiological paradox (Cho et al., 2004; Franzini et al., 2001; Hummer et al., 1999), these findings are often interpreted as evidence that the health advantages that immigrants and their children have erode with exposure to American society and lifestyles (Abraído-Lanza et al., 2006).

Much of the literature supporting the epidemiological paradox focuses on Hispanic adults and children because more U.S. immigrants come from Mexico and Latin America than any other world region (Office of Immigration Statistics, 2011). That said, an unfortunate exception to the epidemiological paradox was recently uncovered. Among Hispanics, children of immigrants are actually *more* likely to be overweight than children of more settled Hispanic immigrants and children of U.S. natives (e.g., Balistreri and Van Hook, 2009; Van Hook and Baker, 2010; Van Hook et al., 2009).

This finding is troubling. Overweight children tend to become obese adults and suffer from a wide range of obesity-related morbidity (Daniels, 2006). Thus, children of Hispanic immigrants arrive in the United States with a major health disadvantage that could jeopardize their integration into U.S. society and burden the U.S. health care system.

This finding is also counterintuitive. If more settled children of Hispanic immigrants and children of U.S. natives are leaner than recently arrived children of Hispanic immigrants, it suggests that increased time in the U.S. *reduces* the risk of obesity. This seems unlikely for two reasons. First, the U.S. has a higher childhood overweight prevalence than most immigrant-sending countries, including Mexico, the country that sends the most Hispanic immigrant children to the U.S. Only 19.5% of children ages 5–11 in Mexico were overweight in the late 1990s compared with 39% of Mexican-American children in the United States (Hernandez et al., 2003; Ogden et al., 2002). Second, this finding runs counter to evidence that immigrant adults *gain* weight as duration of U.S. residence increases (Antecol and Bedard, 2006; Park et al., 2009). Childhood and adult obesity are distinct problems, but both are linked to macro-level features of the U.S. environment like low food prices and snack food availability (Nestle, 2003).

This study explores alternative explanations for this exception to the epidemiological paradox. First, we assess whether it is attributable to prior research treating Hispanics as a homogenous ethnic group by confining our analysis to a single national origin group. We focus on Mexicans, a group that composes three-quarters of Hispanic children (Ruggles et al. 2010). We also explore whether prior research is making inappropriate subgroup comparisons. Prior research only compares Hispanic children currently living in the U.S. They are differentiated by generational status or duration of U.S. residence. Missing is a comparison of these children to children with no U.S. exposure (i.e., children in Mexico). Without Mexican children in the analysis, one cannot assess the effects that exposure to the U.S. environment has on childhood weight because children who emigrate from Mexico may have been overweight prior to U.S. entry. They may also weigh more if their parents are unfamiliar with the U.S. food environment or preoccupied with the challenges of labor migration.

We utilize an innovative binational study design to compare the weight of children living in Mexico and Mexican-origin children in the U.S. We recognize that children in Mexico do

not all have equal likelihoods of emigrating and use propensity score methodology to identify subgroups of Mexican children with different emigration propensities. We then compare the weight of these Mexican subgroups to the weight of Mexican-origin children in the U.S. This includes Mexican-American children who were born in Mexico, who we refer to as “1st generation children”; U.S.-born Mexican-American children with one or both parents born in Mexico, or “2nd generation children”; and U.S.-born Mexican-American children with U.S.-born parents, or “children of natives”. We also refer to 1st and 2nd generation children combined as “children of immigrants”. The binational comparisons we will make begin to evaluate whether heavy children in Mexico are systematically selected into U.S. migration streams or whether exposure to the U.S. environment explains the high prevalence of overweight among Mexican children of immigrants. As a result, we contribute to literature on the epidemiological paradox and the health of children of Mexican immigrants by evaluating how exposure to the U.S. environment and selection into immigrant streams influences their weight.

Background

Social scientists have typically viewed obesity among immigrants through a health acculturation lens, which is a prominent explanation for the epidemiological paradox (Abraído-Lanza et al., 2006). Acculturation refers to diminishing cultural differences between immigrants and citizens in a host society (Alba and Nee, 2003). Some dimensions of acculturation are positive (e.g., less linguistic isolation), but individual-level acculturation of U.S. health behaviors like diet increases the risk of obesity and worse health among adults. Studies using crude proxies of acculturation (duration of U.S. residence, generational status, language spoken), find that adult Hispanic immigrants change their diet following immigration (Akresh, 2007) and with increased acculturation (Ayala et al., 2008; Satia-Abouta et al., 2002). Thus, it is not surprising that duration of U.S. residence (Antecol and Bedard, 2006; Park et al., 2009) and early age at U.S. arrival (Roshania et al., 2008) both predict overweight among adult immigrants.

Research on children is less consistent with the acculturation model and the epidemiological paradox. Hispanic children of newly-arrived immigrants weigh more than children of longer-resident immigrants and natives (Baker et al., 2008; Balistreri and Van Hook, 2009). Further, kindergarteners with English-speaking immigrant parents weigh less than those with non-English-speaking immigrant parents (Van Hook and Baker, 2010). Another study found no difference in the overweight prevalence of native- and foreign-born Mexican adolescents (Gordon-Larsen et al. 2003). Additionally, U.S. children of immigrants, particularly Hispanics, do less physical activity than children of natives (Singh et al., 2008), and a review of studies on dietary acculturation showed no associations between children’s diets and parental acculturation (Arredondo et al., 2006).

In sum, previous research on Hispanic children of immigrants contradicts the notion that health acculturation, as proxied by measures of exposure to the U.S., increases children’s risk of overweight. At a minimum, these puzzling patterns should be confirmed within national origin groups because Hispanics are composed of several subgroups with distinctive cultures, immigration experiences (Bean and Tienda 1987) and possibly different biological or genetic dispositions for obesity (Bogin and Loucky 1997). We focus on Mexicans because they comprise the largest group of U.S. Hispanic immigrants.

We also consider whether this contradiction derives from inappropriate subgroup comparisons. As noted previously, most empirical assessments of immigrant health are limited to comparisons *among* U.S. residents. The newest immigrants’ outcomes are interpreted as baseline health prior to exposure to the U.S. environment. Changes in health

over time and across immigrant generations are then attributed to acculturation. Critics of the health acculturation model (Abraido-Lanza et al., 2006; Hunt et al., 2004; Jasso et al., 2004; Viruell-Fuentes, 2007) argue that this interpretation overlooks other explanations for differences in the health of newly-arrived and more settled immigrants. We consider these alternative perspectives here and ask whether they may help explain the counterintuitive pattern of childhood overweight observed for Mexican-origin children in the U.S.

Selective Migration posits a “healthy migrant” effect to explain newly-arrived immigrants’ health advantages (Jasso et al., 2004). Referring to the “canary in the coalmine” metaphor, the bird might have been healthy *before* being lowered into the coalmine. We ask whether it alternatively could have been unhealthy and evaluate whether selective migration explains the high overweight prevalence among children of Mexican immigrants. Less healthy (heavier) children may be selected into migration streams.

The scant research on immigrant selection focuses on adults only. It provides weak evidence of a healthy migrant effect among adult Mexican immigrants (Akresh and Frank, 2008; Rubalcava et al., 2008). This may partially result from circular migration since Mexican male labor migrants often make multiple trips between Mexico and the United States (Massey et al., 2003). This may blur distinctions between migrants and non-migrants, making it difficult to assess how selection impacts health. These distinctions are clearer for children. When families bring children to the U.S., this often signals permanent settlement and the end of circular migration (Dreby, 2010; Massey et al., 2003).

Nothing is known about health selectivity among children of immigrants. Most children of immigrants are U.S. born (Landale et al., 2011) or emigrated with parents. If they are health selected into migration streams, this likely occurs through selection of their parents, who strongly influence children’s genetic make-up, diet, activities, and weight, and who made the decision to migrate.

Some evidence suggests that Mexican families that have overweight children are more likely to emigrate. Among children living in Mexico, those living in migrant-sending households emigrate more often (Kandel and Massey, 2002), and they are more likely to become overweight than other Mexican children (Baker et al., 2010; Creighton et al., 2011). This may result from economic remittances received by migrant-sending households (Massey et al., 1987). Rising income leads to increased consumption of calorie dense food, more sedentary (in)activity (Popkin and Gordon-Larsen, 2004), and more obesity (Monteiro et al., 2004) in poorer countries. Dreby’s (2010) ethnography also documents how remittances increase migrant-sending households’ incomes, thus improving caregivers’ ability to feed children.

Immigrant Vulnerability is another explanation for the high overweight prevalence among children of Mexican immigrants. Their parents’ migration status and cultural orientation may pose risks for obesity upon U.S. arrival. Returning to our “canary” metaphor, being lowered down the mineshaft or adjusting to new conditions in the mine make the birds more vulnerable than if they had always lived there.

Previous research supports this line of thinking. Immigrant parents may be unconcerned with childhood obesity because it is less common and not viewed as problematic in their native country. Mexican-American parents are unlikely to link child obesity to poor health (Bayles, 2010; Crawford et al., 2004; Gomel and Zamora, 2007; Sosa, 2011). Some research reports that Mexican mothers see childhood fatness as a sign of good health (Guendelman et al., 2010; Rosas et al., 2010), and thinness as a sign of illness (Sosa, 2011). This is particularly true for mothers living Mexico (vs. Mexican-Americans) (Guendelman et al., 2010; Rosas et al., 2010). These values may be rooted in the precarious nutritional resources

available to Mexican children (Rosas et al. 2010), but may fade as U.S. immigrants become aware of the prevalence and health risks of obesity in the U.S. (Sussner et al., 2008). Thus, newly-arrived immigrant parents may do less to safeguard their children from obesity, making their children more vulnerable to obesity than native peers.

Children of Mexican immigrants may also be vulnerable to obesity if their parents are overwhelmed with more immediate concerns like finding work, status documentation, and coping with poverty and segregation within disadvantaged neighborhoods (Sosa, 2011; Viruell-Fuentes, 2007). A few qualitative studies suggest that Mexican-American parents' nutritional values are generally aligned with U.S. Centers for Disease Control and Prevention (CDC) recommendations (i.e., children should eat more fresh fruits and vegetables and less soda and junk food) (Gallagher, 2010; Garro, 2010). However, these studies also note discrepancies between parents' beliefs and their children's diets because parents do not have enough money to purchase fresh foods (Gallagher, 2010), are too busy to cook (Gallagher, 2010; Sussner et al., 2008), and they want to preserve family harmony and child happiness by providing favorite foods (Garro, 2010). In sum, migration-related constraints may make good nutrition impractical or a low priority.

Approach and Hypotheses

Our goal is to assess whether the counterintuitive, high prevalence of overweight among Hispanic children of immigrants holds for Mexicans, and further, to evaluate whether selective migration or immigrant vulnerability explains any observed pattern. The ideal study design would track changes in Mexican children's weight as they move to the U.S. Because such longitudinal data do not exist, we use Mexican and U.S. cross sectional data to infer the effects of immigration and U.S. residence on children's weight. We use propensity score methodology to identify the children living in Mexico with different propensities of emigration. By comparing children living in Mexico with low versus high propensities to emigrate, we can evaluate whether heavier children are selected into immigrant streams. By comparing Mexican-American children with Mexican children who are similar in many ways except for country of residence (i.e., Mexican children with a high propensity to emigrate), we can assess how U.S. residence is associated with weight. Few studies on immigrant health (and none on overweight or obesity) have used a multi-country comparison (see Buttenheim et al., 2010; Crimmins et al., 2005; Landale et al., 1999; Wong et al. 2008 for exceptions) and none to our knowledge have used propensity scores to refine binational comparisons.

After confirming that Mexican children of immigrants weigh more than children of natives, we test three hypotheses depicted in Figure 1:

H_{o1}: Selective migration explains children of Mexican immigrants' high overweight prevalence.

If parents with heavy children are selected into immigration streams, then Mexican children whose parents have a high emigration propensity will be heavier than other Mexican children and as likely to be overweight as first generation Mexican-Americans (depicted in Panel A of Figure 1).

H_{o2}: Exposure to the U.S. environment explains children of Mexican immigrants' high overweight prevalence. This hypothesis predicts that Mexican-American children in the United States weigh more than comparable Mexican-resident children (those with a high propensity to have immigrant parents), and this difference increases with time and generations spent in the United States. It is depicted in Panel B of Figure 1.

H_{o3}: Immigrant vulnerability explains children of Mexican immigrants' high overweight prevalence. If children of immigrants (particularly first generation children)

are more likely to be overweight than comparable Mexican children and children of native U.S. residents, then this hypothesis, depicted in Panel C of Figure 1, is supported.

We evaluate these hypotheses for school-aged children. They have more independent exposure to the obesogenic U.S. environment (i.e., through schools and peer interactions) than younger children.

Methods

Data

Approval to conduct the research was obtained from the human subjects review board at the Pennsylvania State University. We analyze nationally-representative surveys from Mexico and the United States. Mexican data come from wave one of the Mexican Family Life Survey (MxFLS), collected in 2002. It surveyed 8,440 households and 35,677 individuals in 150 Mexican communities, including an oversample of rural communities. These data include information on individual, household, and community characteristics and U.S. migration between waves 1 and 2 (2005). Unfortunately, no post-migration data on children's weight and height are available, so we cannot directly assess how immigration affects children's weight after immigration. We limit the sample to children aged 6–19 in 2002 with valid height and weight measurements. We exclude pregnant youth and 23 children with BMI percentile outliers, or biologically implausible values (z-score on height or weight is less than –5 or greater than 5). Their exclusion does not change the results. We also exclude children with missing values on independent variables (N = 966), leaving a final sample of 7,998 children.

To examine Mexicans in the United States, we use data from the National Health and Nutrition Examination Survey (NHANES), a cross-sectional U.S. survey conducted every two years. We pool the 2001/02, 2003/04, and 2005/06 samples to obtain a sufficiently large Mexican-origin child sample. (We checked whether pooling data across years influences study findings in supplementary analyses that include survey year as an analytic variable. It does not). It is restricted to 6–19 year-olds with valid height and weight measurements who reported Mexican ethnicity, living with a Mexican-born householder, or being born in Mexico (N = 3,177). We exclude pregnant youth and 26 children with BMI percentile outliers. Their exclusion does not alter the results. We also exclude 526 children with missing values on independent variables, leaving a final sample of 2,612 children.

We pool the MxFLS and NHANES samples into a single file representing Mexican-origin children ages 6–19 with Mexico or U.S. residence in the early 2000s (N = 10,610). The Mexican and U.S. samples are highly comparable. Both include representative household-based samples of their respective populations from the early 2000s; both measured children's height and weight and other indicators of adiposity (e.g., hip-waist measurements); and both collected comparable socioeconomic and demographic data. The binational data permits us to compare the weight of native Mexican children (with varying propensities of migrating) and Mexican-American children (with varying durations of U.S. residence and generational statuses).

Measures

Percentile BMI and Overweight—We estimate percentile BMI and a dichotomous indicator of overweight (= 1) using measured height and weight data from the MxFLS and NHANES. We use CDC guidelines (Kuczmarski et al., 2002), recommended by the World Health Organization, to assign children age- and sex-specific BMI percentiles and to use these percentiles to classify children as overweight (= 1 if BMI percentile ≥ 85th). Among Mexican children, estimates of overweight do not differ when using CDC and International

Task Force on Obesity guidelines (del Rio-Navarro et al., 2004). We do not predict obesity because few children in our sample, especially those in Mexico, have a BMI percentile 95th.

Children's Migrant Status—For U.S. children, this is determined by *generational status* and *duration of U.S. residence*. We distinguish between the 38.0% of children of natives, the 39.5% of 2nd generation children, and the 22.4% of 1st generation children, who we also subdivide into two equal-sized U.S. residential duration categories: less than 5 years and 5 or more years. Unfortunately, parents and children cannot be linked in NHANES, so we use householder's nativity as a proxy for parents' nativity.

For Mexican children, migrant status is determined by *their propensity of having a parent emigrate* between 2002 and 2005, which we estimate using a logistic regression model (see Appendix A [INSERT LINK TO ONLINE FILES]). The model fit is modest (pseudo R-square = .12), leading us to perform sensitivity tests and to compare the model predictions against prior literature on Mexican migration (described further below). We use this model to derive each adult's propensity to emigrate regardless of whether they actually emigrated. We then linked mothers' estimated propensity scores to our child file because children are more likely to emigrate with mothers than fathers when parents emigrate separately (Dreby, 2010). For the 151 children without these data, we linked father's propensity to emigrate. We also assigned 35 children with parents already living in the U.S. at baseline to our highest propensity category (described below) because these parents were not original MxFLS respondents and could not be included in models predicting their propensity to emigrate. Excluding these two groups of children from analysis does not change study results.

Mexican children were assigned into five equal-sized groups with low to high propensities of having an immigrant parent. For simplicity, we refer to Mexican children with a very high propensity to have a migrant parent as "very high propensity children" and so forth. Among children in these five groups, the propensity of having an immigrant parent among those with and without actual immigrant parents is not significantly different (e.g. our propensity score is balanced).

We conducted extensive supplementary analyses to ensure the robustness of our estimated propensity scores. We tested alternative prediction models using more covariates and interaction terms. We also assessed whether results varied if we linked children to father's rather than mother's propensity score, the highest propensity score of the two parents, or the average propensity score of parents. We additionally trimmed data to exclude children whose propensity of having an immigrant parent fell in the top and bottom 10% of the propensity score distribution since extreme cases can bias study results at the high and low end of the propensity score distribution (Becker and Ichino, 2002).

Controls—We control for important covariates common to the NHANES and MxFLS; each are harmonized for comparability across surveys. They include household income quartile (determined separately for Mexico and the U.S. to capture the countries' distinct income differences and access to resources), householders' educational attainment, family structure, the child's age in months, child's gender, the number of household residents, and an indicator of stunting (<-2 height-for-age and sex z-score, based on CDC growth charts) that we include for two reasons. BMI cut-off points may not adequately capture fatness if children are stunted (Lobstein et al., 2004). Stunting is also associated with an increased risk of overweight and central adiposity (Florencio et al., 2001). Table 1 presents descriptive statistics for all study variables.

Analyses

All analyses are weighted to account for each survey's clustered and stratified sampling design and missing MxFLS height and weight data. We use the person weight for the MxFLS sample and the examination weight for the NHANES sample. Unweighted and weighted analyses yielded substantively similar results.

We first evaluate the validity of our propensity score categories representing children's likelihood of having an immigrant parent by comparing the characteristics of these groups to each other (Table 2) and to characteristics of Mexican labor migrants and non-migrants. We then use logistic and OLS regression models to predict overweight and BMI percentile among children in 9 migrant status groups: children in Mexico with very low, low, average, high, and very high propensities to migrate; 1st generation children with less than 5 and 5 or more years of U.S. residence; 2nd generation children; and children of natives. Table 3 shows weight comparisons of these 9 groups using models with and without control variables to show whether confounders account for any statistically significant observed group differences, which we test for using appropriate post-estimation tests. We are most interested in three key weight comparisons: (1) Mexico-resident children with very high versus lower propensities to have an immigrant parent, which evaluates H_{01} ; (2) Mexico-resident children with parents most likely to migrate (very high propensity) and U.S.-resident children, which evaluates H_{02} ; (3) children of immigrants, especially those of the most recently arrived, and Mexican-American children of natives, which evaluates H_{03} .

We conducted extensive analyses to test the performance of our statistical models and the robustness of study findings. OLS regression models were tested for normality, heteroskedasticity, and multicollinearity. We also used adjusted p-values (using the false discovery rate method) to account for the large number of multiple group comparisons (11 pairwise comparisons) to decrease the likelihood of false positives in our significant tests (Benjamini and Hochberg 1995). Supplementary models also estimated weight comparisons of our migrant status groups using different propensity score groups in the Mexico-resident sample. We used fewer (as low as 3) and larger numbers (as high as 10) of propensity score groups in analysis. We also used the 5 propensity score blocks automatically generated by the STATA 11.0 "pscore" procedure. These analyses all produced results remarkably similar to those shown here (available upon request). Finally, we assessed whether the patterns were similar for children ages 6–11 and 12–19 by including interactions between our 9 migrant status groups and a dummy variable indicating these age categories. None of the interaction terms were statistically significant and their inclusion reduced model fit. These findings were replicated in models interacting our 9 migrant status groups with a continuous age variable. Thus, we only show models for all children ages 6–19.

Results

Table 2 shows how children's characteristics vary by their propensities of having an immigrant parent. Only 0.1% of children in the lowest propensity category had an immigrant parent. Eighty-six times as many children in the highest propensity category had an immigrant parent (8.6%). The 8.6% figure, implies an annual emigration rate of 2.9% ($(1 - (1 - .086)^{33}) = .029$). At this rate, about one-quarter of children in the highest propensity group would have a parent emigrate over the course of a decade. This is consistent with estimates of U.S.-bound emigration from traditional sending communities in Mexico (e.g., Arias, 2004), suggesting that our model estimating emigration propensity works well. Other group differences are also consistent with characterizations of Mexican emigrants and non-emigrants. Emigrants have limited education and capital access, tend to know other international immigrants (e.g., Massey et al., 2003), and originate mostly from rural, less developed regions in Western and Central Mexico. These are also the characteristics of

children in our study with parents having very high migration propensities; 5.7% of their parents have a high school education or beyond compared to 14.7% of very low propensity children. Household income is lowest among very high propensity children (2,578 pesos per month) and highest among very low propensity children (5,444 pesos per month). Very high propensity children are the most likely to have a U.S.-resident family member, to live in rural areas, and to live in Western Mexico. They also live in states with lower GDP's than their counterparts in the two groups with parents with low migration propensities

Having established the quality of our propensity score groups, we now make weight comparisons of children in our 9 migrant status groups. Our discussion of results will largely focus on the comparisons that are relevant to evaluating study hypothesis.

First, we confirm that Mexicans follow the same pattern as all Hispanic children. Mexican children of immigrants weigh significantly more than Mexican children of natives; 41.6% are overweight compared to 36.7 of children of natives ($p < .05$) (result not shown).

Next, to assess whether heavy children are selected into immigrant streams (H_01), we make weight comparisons between Mexican children with the lowest and highest propensity of having immigrant parents. Estimates in Models 1 and 3 (Table 3) suggest that children in the highest propensity group (the reference category) are leaner than those in lower propensity groups. This pattern holds after we account for confounders (Models 2 and 4).

This runs counter to H_01 . Heavier children are not selected into migration streams; those with the highest propensity of having immigrant parents are *leaner* than other Mexican children. Table 2 also indicates that *parents'* BMI is lowest among the highest propensity score group, further rejecting the notion that heavy Mexicans are selected into U.S. migration streams. If anything, migration selection operates in a way that supports the epidemiological paradox and a "healthy migrant" effect.

To evaluate whether exposure to the U.S. environment increases weight (H_02), we compare children in Mexico with the highest propensity to have immigrant parents (the reference category) with Mexican American children. They are leaner than all Mexican-origin children in the U.S., regardless of whether statistical models include confounders. These findings support H_02 . Note that if we had compared Mexican children with lower propensities of having an immigrant parent and Mexican-origin U.S. children, we would have seen less pronounced differences.

Finally, we evaluate whether immigrant vulnerability (H_03) explains weight differences of different migrant status groups by comparing results in Table 3 for the most recently-arrived Mexican immigrants and the other Mexican-American groups. Second generation children are heavier than every other migrant status group we study. The "a" superscript denotes that they are the only U.S. group with significantly higher percentile BMI and odds of overweight than children with less than 5 years of U.S. residence. Children of natives do not differ significantly from the most recently-arrived immigrants. Additional tests show that the odds of overweight for 1st generation children with 5 or more years of U.S. residence is 30 percent greater than children of natives ($2.13/1.64 = 1.30$), but this difference is marginally significant ($p = .08$). This provides modest support for H_03 . Children of immigrants appear more vulnerable to the risk of overweight than children of natives. But unexpectedly these harmful effects do not appear for newly-arrived 1st generation children, but rather appear among those who have lived in the United States at least five years, and are most apparent for the second generation.

Discussion

This study evaluates explanations for the high risk of overweight among Hispanic-origin children of immigrants relative to children of natives found by prior research (Van Hook and Baker 2010; Balistreri and Van Hook 2009). This pattern does not fit the epidemiological paradox. We show that this counterintuitive pattern also emerges among a more homogenous group of Hispanic immigrants children, those with parents who emigrated from Mexico. Further, we use a unique binational study design that utilizes comparable height and weight data from children in Mexico and the U.S. to evaluate whether selection, exposure to the U.S. environment, or immigrant vulnerability explain differences in the weight of children in 9 migrant status groups.

Results provide evidence that selective migration does not explain children of immigrants' high prevalence of overweight. Their Mexican counterparts with very high propensities of having immigrant parents are much *leaner* than Mexican peers with a lower propensity to migrate, suggesting that families with heavy children are less, not more, likely to be selected into migration streams. This finding actually supports the epidemiological paradox and points to the need for more studies that utilize binational study designs, which permit children of U.S. immigrants and natives be compared with an appropriate comparison group, their non-migrant counterparts living outside the U.S.

Instead of selection, exposure to the U.S. environment better explains weight comparisons among school-age children from different Mexican-origin migration status groups. In other words, the “canary in a coalmine” metaphor is applicable. Mexicans who are most likely to emigrate are much less likely to be overweight than their Mexican-American counterparts living in the United States, even those with less than 5 years of U.S. residence. This implies that weight gain begins soon after children of Mexicans immigrate to the U.S., possibly because exposure to the U.S. obesogenic environment is a major “health shock”. Because no representative, longitudinal data are currently available to track children’s weight as they emigrate, our binational approach provides the best evidence to date that this phenomenon is real and not attributable to selective migration. Our propensity score methodology, which refines binational comparisons, further shows that these effects are large. If we had compared all Mexican with Mexican-American children and did not distinguish Mexican children by propensity to emigrate, we would have understated the harmful effects of exposure to the U.S. environment on immigrant children’s weight.

Simple exposure to U.S. society is not the only problem. Otherwise, Mexican-American children of natives—presumably the most acculturated group—would weigh more than children of immigrants and would not be leaner than the second generation. The immigrant vulnerability hypothesis explains this finding. First proposed by Van Hook and Baker (2010), it is backed by multiple qualitative studies. They argue that children of immigrants have *lower resistance* (i.e., greater vulnerability) to obesity upon entry to the U.S. Immigrant parents may be unfamiliar with U.S. foods and the opportunities for physical activity (Van Hook et al., 2009), and unaccustomed to protecting their children from overeating because they originate from a country where food insecurity and under-nutrition are more salient health risks than obesity (Popkin and Doak, 1998; Van Hook and Balistreri, 2007; Wang et al., 2002). They also face challenging circumstances as they work to gain a foothold in the American economy and society, often in less than ideal circumstances (e.g., socioeconomic disadvantage, language barriers).

Of note, we had hypothesized that the most recently-arrived group would weigh the most. This pattern was observed in prior research for Hispanic children (e.g., Van Hook and Baker, 2009), but we did not observe it for Mexican-American children. Rather, we see a

non-linear relationship between time and generations in the U.S. and weight. Second generation children and (to a lesser extent) 1st generation children with 5 or more years of U.S. residence weigh more than recently-arrived immigrants and children of natives. This nonlinear pattern may emerge from a combination of all three processes: migration selection of leaner children, exposure to the U.S. obesogenic environment, and immigrant vulnerability. Given that leaner children are selected into migration streams and that exposure to the U.S. is associated with overweight, it may take a number of years of living in the U.S. before children of immigrants “catch up” with their native counterparts, even if they are particularly vulnerable to the risk of overweight.

Future research can build on our findings by analyzing direct measures of vulnerability and exposure to the obesogenic environment (e.g., parental weight concerns, feeding practices, detailed measures of the built environment, etc.) Additionally, we did not explore how the patterns we observe vary by gender or birth order. Boys may be particularly susceptible to weight gain following migration (Brewis, 2003; Van Hook and Baker, 2010). The same may be true of younger siblings born in the U.S. (compared to older siblings born in Mexico). Future research should also assess whether similar patterns emerge among other immigrant groups because selection into U.S. migration streams is not uniform. Refugees, labor migrants, foreign students, and high-tech foreign workers come to the U.S. for different reasons, have different skills, and are treated differently upon arrival. Children of immigrants from richer countries with a lower prevalence of food insecurity may also be less vulnerable to weight gain in the U.S. than those from poorer countries (Van Hook and Balistreri, 2007).

Our study’s contributions should be considered within its limitations. Measuring selection and exposure to the U.S. environment is challenging given that no perfect data exist for this purpose. Thus, our analysis provides indirect support for hypotheses regarding exposure and vulnerability. Analyses also estimate body fatness using BMI percentiles, which are relatively reliable and correlated with other body fatness assessments (e.g., dual energy x-ray absorptiometry) (Center for Disease Control and Prevention, 2003), but certainly have limitations (Daniels, 2009). We helped ensure that findings were not biased by confirming study results with supplementary analyses (available upon request) predicting different body fatness indicators (e.g. waist-to-height ratio and waist circumference).

Despite limitations, results reinforce the role that U.S. exposure plays in the weight of children of Mexican immigrants. Second generation children are particularly vulnerable, which does not bode well for the future. Child obesity has far-reaching negative consequences for adult health, mortality, and status attainment, and will likely hinder immigrants’ future social and economic incorporation. Changing these trends most likely will involve wholesale changes in children’s environments that would benefit all children. Yet any childhood obesity prevention strategy should include interventions specifically targeting the children of Mexican immigrant families given the size and rapid growth of the Mexican-origin population.

Research highlights

- We explore US and Mexico Hispanic immigrant children’s high overweight risk, a pattern counter to the epidemiological paradox
- Binational comparisons of Mexican-American and Mexican children help explain this anomaly
- Supporting the epidemiological paradox, Mexican children with a high likelihood of immigrating are *quite lean*

- Upon recent arrival to the U.S., these children appear to be particularly vulnerable to weight gain

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was supported by grants from the National Institutes of Health (1 P01 HD062498-01 and 2R24HD041025-11). We thank Molly Martin and Frank D. Bean for their helpful comments on earlier drafts.

References

- Abraído-Lanza AF, Armbrister AN, Flórez KR, Aguirre AN. Toward a theory-driven model of acculturation in public health research. *American Journal of Public Health*. 2006; 96(8):1342–1346. [PubMed: 16809597]
- Akresh IR. Dietary Assimilation and Health among Hispanic Immigrants to the United States. *Journal of Health and Social Behavior*. 2007; 48(4):404–417. [PubMed: 18198687]
- Akresh IR, Frank R. Health Selection Among New Immigrants. *American Journal of Public Health*. 2008; 48(4):404–417.
- Alba, R.; Nee, V. *Remaking the American Mainstream*. Cambridge, MA: Harvard University Press; 2003.
- Antecol H, Bedard K. Unhealthy Assimilation: Do Immigrants Converge to American Health Status Levels? *Demography*. 2006; 43:337–360. [PubMed: 16889132]
- Arias, P. Old Paradigms and New Scenarios in a Migratory Tradition: U.S. Migration from Guanajuato. In: Durand, J.; Massey, DS., editors. *Crossing the Border: Research from the Mexican Migration Project*. New York: Russell Sage Foundation; 2004. p. 171-183.
- Arredondo EM, Elder JP, Avala GX, Campbell N, Baquero B, Duerksen S. Is parenting style related to children's healthy eating and physical activity in Latino families? *Health Education Research*. 2006; 21:862–871. [PubMed: 17032706]
- Ayala GX, Baquero B, Klinger S. A systematic review of the relationship between acculturation and diet among Latinos in the United States: implications for future research. *Journal of the American Dietetic Association*. 2008; 108(8):1330–1344. [PubMed: 18656573]
- Baker, E.; Altman, CE.; Van Hook, J. Working Paper No. 10-01. State College, PA: Population Research Institute; 2010. *International Migration and Child Obesity in Mexican Sending Communities*.
- Baker E, Balistreri KS, Van Hook J. Maternal Employment and Overweight among Hispanic Children of Immigrants and Children of Natives. *Journal of Immigrant and Minority Health*. 2008; 11(3): 158–167. [PubMed: 17963041]
- Balistreri KS, Van Hook J. Socioeconomic Status and Body Mass Index Among Hispanic Children of Immigrants and Children of Natives. *American Journal of Public Health*. 2009; 99(12):2238–2246. [PubMed: 19846690]
- Bayles B. Perceptions of childhood obesity on the Texas-Mexico border. *Public Health Nursing*. 2010; 27:320–328. [PubMed: 20626832]
- Bean, FD.; Tienda, M. *The Hispanic Population of the United States*. New York: Russell Sage Foundation; 1987.
- Becker S, Ichino A. Estimation of average treatment effects based on propensity scores. *STATA Journal*. 2002; 22:358–377.
- Benjamini Y, Hochberg Y. Controlling the False Discovery rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society*. 1995; 57(1):289–300.
- Bogin B, Loucky J. Plasticity, Political Economy, and Physical Growth Status of Guatemala Maya Children Living in the United States. *American Journal of Physical Anthropology*. 1997; 102:17–32. [PubMed: 9034036]

- Brewis A. Biocultural aspects of obesity in young Mexican schoolchildren. *American Journal of Human Biology*. 2003; 15(3):446–460. [PubMed: 12704721]
- Buttenheim A, Goldman N, Pebley AR, Wong R, Chung C. Do Mexican immigrants “import” social gradients in health to the US? *Social Science & Medicine*. 2010; 71(7):1268–1276. [PubMed: 20692753]
- Center for Disease Control and Prevention. BMI-for-Age. Division of Nutrition and Physical Activity. 2003.
- Cho Y, Frisbie WP, Hummer RA, Rogers RG. Nativity, Duration of Residence, and the Health of Hispanic Adults in the United States. *International Migration Review*. 2004; 38:1841–1821.
- Crawford PB, Gosliner W, Anderson C, Strode P, Becerra-Jones Y, Samuels S, Carroll AM, Ritchie LD. Counseling Latina mothers of preschool children about weight issues: Suggestions for a new framework. *Journal of the American Dietetic Association*. 2004; 104(3):387–394. [PubMed: 14993861]
- Creighton M, Goldman N, Teruel G, Rubalcava L. Migrant Networks and Pathways to Child Obesity in Mexico. *Social Science & Medicine*. 2011; 72:683–693.
- Crimmins EM, Soldo BJ, Kim JK, Alley DE. Using Anthropometric Indicators for Mexicans in the United States and Mexico to Understand Selection of Migrants and the “Hispanic Paradox. *Social Biology*. 2005; 52:164–177. [PubMed: 17619609]
- Daniels SR. The Consequences of Childhood Overweight and Obesity. *The Future of Children*. 2006; 16.1:47–67. [PubMed: 16532658]
- Daniels SR. The use of BMI in the clinical setting. *Pediatrics*. 2009; 124(Suppl 1):535–541.
- del Rio-Navarro BE, Velazquez-Monroy O, Sanchez-Castillo CP, Lara-Esqueda A, Berber A, Fanghanel G, Violante R, Tapia-Conyer R, James WP. Encuesta Nacional de Salud 2000 Working Group, National Health Survey 2000. The High Prevalence of Overweight and Obesity in Mexican Children. *Obesity Research*. 2004; 12(2):215–223. [PubMed: 14981213]
- Dreby, J. *Divided by Borders: Mexican Migrants and their Children*. Berkeley: University of California Press; 2010.
- Florencio TT, Ferreira HS, Franca APT, Cavalcante JC, Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceio, Northeastern Brazil. *Brazilian Journal of Nutrition*. 2001; 86:277–283.
- Franzini L, Ribble JC, Keddie AM. “Understanding the Hispanic paradox”. *Ethnicity and Disease*. 2001; 11(3):496–518. [PubMed: 11572416]
- Gallagher MR. Maternal perspectives on lifestyle habits that put children of Mexican descent at risk for obesity. *Journal for Specialists in Pediatric Nursing*. 2010; 15:16–25. [PubMed: 20074110]
- Garro LC. Beyond the Reproduction of Official Accounts. *Medical Anthropology*. 2010; 24:472–499.
- Gomel JN, Zamora A. English- and Spanish-speaking Latina mothers’ beliefs about food, health, and mothering. *Journal of immigrant and minority health*. 2007; 9:359–367. [PubMed: 17347890]
- Gordon-Larsen P, Harris KM, Ward DS, Popkin BM. Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health. *Social Science & Medicine*. 2003; 57:2023–2034. [PubMed: 14512234]
- Guendelman S, Fernald LCH, Neufeld LM, Fuentes-Afflick E. Maternal perceptions of early childhood ideal body weight differ among Mexican-origin mothers residing in Mexico compared to California. *Journal of the American Dietetic Association*. 2010; 110:222–229. <http://www.ncbi.nlm.nih.gov/pubmed/20102849>. [PubMed: 20102849]
- Hernandez B, Cuevas-Nasu L, Shamah-Levy T, Monterrubio E, Ramirez-Silva C, Garcia-Feregrino R, Rivera J, Supulveda-Amor J. Factors associated with overweight and obesity in Mexican school-age children: Results from the National Nutrition Survey 1999. *Salud pública de México*. 2003; 45:S551–S557. [PubMed: 14746049]
- Hummer RA, Rogers RG, Nam CB, LeClere FB. Race/ethnicity, nativity, and U.S. adult mortality. *Social Science Quarterly*. 1999; 80:136–153.
- Hunt LM, Schneider S, Comer B. Should “acculturation” be a variable in health research? A critical review of research on U.S. Hispanics. *Social Science & Medicine*. 2004; 59:973–986. [PubMed: 15186898]

- Jasso, G.; Massey, DS.; Rosenzweig, MR.; Smith, JP. Immigrant Health: Selectivity and Acculturation. In: Anderson, NB.; Bulatao, RA.; Cohen, B., editors. *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life*. Washington, D.C.: National Academies Press; 2004. p. 227-266.
- Kandel W, Massey DS. The Culture of Mexican Migration: A Theoretical and Empirical Analysis. *Social Forces*. 2002; 80(3):981-1004.
- Kuczmariski, RJ.; Ogden, CL.; Guo, SS. *Vital Health Statistics 1(246)*. Hyattsville, MD: National Center for Health Statistics; 2002. 2000 CDC Growth Charts for the United States: Methods and Development.
- Landale, NS.; Oropesa, RS.; Gorman, BK. Immigration and Infant Health: Birth Outcomes of Immigrant and Native-Born Women. In: Hernandez, DJ., editor. *Children of Immigrants: Health, Adjustment, and Public Assistance*. Washington, D.C.: National Academy Press; 1999. p. 244-287.
- Landale NS, Thomas K, Van Hook J. The living arrangements of the children of immigrants. *The Future of Children*. 2011; 21:43-70. [PubMed: 21465855]
- Lobstein T, Baur L, Uauy R. Obesity in children and young people: A crisis in public health. *Obesity Reviews*. 2004; 5:4-85. [PubMed: 15096099]
- Massey, DS.; Alacron, R.; Durand, J.; Gonzalez, H. *Return to Aztlan: The Social Process of International Migration from Western Mexico*. Berkeley, CA: University of California Press; 1987.
- Massey, DS.; Durand, J.; Malone, NJ. *Beyond Smoke and Mirrors: Mexican Immigration in an Era of Economic Integration*. New York: Russell Sage Foundation; 2003.
- Monteiro CA, Conde WL, Lu B, Popkin BM. Obesity and Inequities in health in the developing world. *International Journal of Obesity*. 2004a; 28:1181-1186. [PubMed: 15211362]
- Nestle, M. *Food politics: how the food industry influences nutrition and health*. Berkeley, CA: University of California Press; 2007.
- Office of Immigration Statistics. 2010 Yearbook of Immigration Statistics. Washington, DC: Department of Homeland Security; 2011. <http://www.dhs.gov/files/statistics/publications/yearbook.shtm>
- Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and Trends in Overweight Among U.S. Children and Adolescents, 1999-2000. *The Journal of the American Medical Association*. 2002; 288(14):1728-1732.
- Park J, Myers D, Kao D, Min S. Immigrant obesity and unhealthy assimilation: Alternative estimates of convergence or divergence, 1995-2005. *Social Science & Medicine*. 2009; 69(11):1625-1633. [PubMed: 19811864]
- Popkin BM, Doak CM. The obesity epidemic is a worldwide phenomenon. *Nutrition Reviews*. 1998; 56:106-114. [PubMed: 9584495]
- Popkin BM, Gordon-Larsen P. The nutrition transition: Worldwide obesity dynamics and their determinants. *International Journal of Obesity*. 2004; 28:S2-S9. [PubMed: 15543214]
- Rosas LG, Harley KG, Guendelman S, Fernald LCH, Mejia F, Eskenazi B. Maternal Perception of Child Weight Among Mexicans in California and Mexico. *Maternal & Child Health Journal*. 2010; 14(6):886-894. [PubMed: 19911262]
- Roshania R, Venkat Narayan KM, Oza-Frank R. Age at Arrival and Risk of Obesity Among U.S. Immigrants. *Obesity*. 2008; 16(12):2669-2675. [PubMed: 18846044]
- Rubalcava LN, Teruel GM, Thomas D, Goldman N. The Healthy Migrant Effect: New Findings From the Mexican Family Life Survey. *American Journal of Public Health*. 2008; 98:78-84. [PubMed: 18048791]
- Ruggles, S.; Alexander, JT.; Genadek, K.; Goeken, R.; Schroeder, MB.; Sobek, M. *Integrated Public Use Microdata Series: Version 5.0*. Minneapolis: University of Minnesota; 2010. [Machine-readable database].
- Satia-Abouta J, Patterson RE, Neuhouser ML, Elder J. Dietary Acculturation: Applications to nutrition research and dietetics. *Journal of the American Dietetic Association*. 2002; 102:1105-1118. [PubMed: 12171455]

- Singh GK, Yu SM, Siahpush M, Kogan MD. High Levels of Physical Inactivity and Sedentary Behaviors Among U.S. Immigrant Children and Adolescents. *Archives of Pediatric and Adolescent Medicine*. 2008; 162:756–763.
- Sosa ET. Mexican American Mothers' Perceptions of Childhood Obesity: A Theory-Guided Systematic Literature Review. *Health Education & Behavior*. 2011; 38(3)
- Sussner KM, Lindsay AC, Greaney ML, Peterson KE. The influence of immigrant status and acculturation on the development of overweight in Latino families: a qualitative study. *Journal of Immigrant & Minority Health*. 2008; 10(6):497–505. [PubMed: 18373200]
- Van Hook J, Baker E. Big Boys and Little Girls: Gender, Acculturation, and Weight among Young Children of Immigrants. *Journal of Health and Social Behavior*. 2010; 51(2):200–214. [PubMed: 20617759]
- Van Hook J, Balistreri KS. Immigrant generation, socioeconomic status, and economic development of countries of origin: A longitudinal study of body mass index among children. *Social Science & Medicine*. 2007; 65:976–989. [PubMed: 17570571]
- Van Hook, J.; Baker, E.; Altman, CE. Does it begin at school or home? The institutional origins of overweight among young children of immigrants. In: Grigorenko, EL.; Takanishi, R., editors. *Immigration, Diversity, and Education*. New York: Routledge/Taylor and Francis Group; 2009. p. 205-224.
- Viruell-Fuentes EA. Beyond acculturation: Immigration, discrimination, and health research among Mexicans in the United States. *Social Science & Medicine*. 2007; 65(7):1524–1535. [PubMed: 17602812]
- Wang Y, Monterio C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *American Journal of Clinical Nutrition*. 2002; 75:971–977. [PubMed: 12036801]
- Wong R, Ofstedal MB, Yount K, Agree EM. Unhealthy Lifestyles among Older Adults: exploring transitions in Mexico and the U.S. *European Journal of Ageing*. 2008; 5:311–326.

A. Selection

B. Exposure

C. Immigrant Vulnerability

Figure 1. Hypothesized relationships of weight with Mexico versus U.S. residence, propensity to emigrate, and generation and duration of U.S. residence

Table 1

Descriptive Statistics (weighted means/percentages) for key Dependent and independent Variables

	Mexican Sample	U.S. Sample	Pooled Mexican-U.S. Samples	Unweighted N (categorical vars)
Dependent Variables (Child's weight status)				
Overweight (%)	26.8	40.3	30.1	3,102
Percentile BMI (mean)	61.9 (27.6)	67.0 (29.9)	63.1 (28.3)	---
Migrant Status Groups				
<i>Mexico Residence by Propensity to have Immigrant Parents</i>				
Very Low Propensity	20.6	---	15.6	1,600
Low Propensity	19.6	---	14.8	1,595
Medium Propensity	22.4	---	16.9	1,592
High Propensity	20.7	---	15.6	1,587
Very High Propensity	16.7	---	12.6	1,624
<i>U.S. Residence by Generation and Duration</i>				
1st Generation				
<5 Years of U.S. residence	---	11.2	2.8	305
5+ Years of U.S. residence	---	11.2	2.8	337
2nd Generation				
Children of natives	---	38.0	9.4	926
Control Variables				
<i>Household Income Quartiles</i>				
First Quartile	24.1	25.1	24.3	2,664
Second Quartile	25.7	39.2	29.1	3,201
Third Quartile	24.2	21.0	23.4	2,402
Fourth Quartile	26.0	14.8	23.2	2,343
<i>Education Level of Household Head</i>				
Less than High School	83.3	53.4	75.9	8,220
High School	8.1	22.9	11.8	1,222
College+	8.7	23.8	12.4	1,168
<i>Marital Status of Household Head</i>				
Married	76.2	74.1	75.7	7,948
Single	2.1	6.4	3.2	328
Other	21.8	19.5	21.8	2,334
Household Size				
	5.8 (2.0)	5.0 (1.4)	5.6 (1.9)	---
Child's Age (months)				
	148.7 (46.0)	148.9 (47.2)	148.7 (46.3)	---
Child's sex (Male)				
	47.8	50.7	48.5	5,193
Child's stunting status				
	15.5	2.9	10.7	1,134

Data and Analytic Sample: Pooled 2002 Mexican Family Life Survey and 2001/02, 2003/04, and 2005/06 NHANES, Mexican-origin children ages 6–19 (see text for details); N = 10,610.

Standard Deviations for continuous variables are in parentheses under the means

Table 2
 Characteristics of Mexico-resident Children by propensity to have an immigrant parent (2002 Characteristics, weighted)

	Very Low Propensity	Low Propensity	Average Propensity	High Propensity	Very High Propensity
Propensity Score (mean)	0.00 ***	0.00 ***	0.01 ***	0.02 ***	0.04
Mother or Father migration to the United States by 2005 (%)	0.1 ***	1.0 ***	0.6 ***	3.6 ***	8.6
Parents's Characteristics					
Parent's Age (mean)	43.4 ***	39.1 ***	37.4 ***	36.3 ***	35.2
Male (%)	0.8 ***	0.9 ***	1.3 *	2.0 *	3.7
Parent's Educational Attainment (%)					
No Education	9.0 **	8.5 **	13.6	9.0 **	12.9
Elementary	54.2	56.3	45.8 ***	45.8 ***	56.3
Middle School	22.1	23.0	28.6	31.2 **	25.1
High School or more	14.7 ***	12.2 ***	12.0 ***	13.9 ***	5.7
Employed (%)	34.8 **	39.1	33.8 ***	38.3	41.3
Parent's Marital Status (%)					
Married	83.9 ***	74.4 ***	75.0 ***	76.6 ***	66.4
Cohabiting	9.6 †	15.1	13.9	11.4	12.3
Other Marital Status	5.6 ***	7.9 ***	7.8 ***	7.8 ***	13.5
Never Married	0.9 ***	2.6 **	3.3 ***	4.1 **	7.8
Parent's BMI (mean)	29.3 ***	29.2 ***	28.4 ***	28.1 **	27.4
Missing BMI (%)	0.9 ***	1.3 ***	2.6 ***	2.5 ***	7.8
Parent has a relative living in the United States (%)	14.6 ***	27.1 ***	48.1 ***	77.3 ***	86.4
Household Characteristics					
<i>Number and Age of Household Members (mean)</i>					
Age 0 to 5	0.6 **	0.6	0.7	0.7	0.7
Age 5–12	1.0 ***	1.4 ***	1.7 ***	1.6 ***	1.9
Age 13–20	1.6 *	1.3 *	1.4 †	1.2 ***	1.5

	Very Low Propensity	Low Propensity	Average Propensity	High Propensity	Very High Propensity
Age 20–64	2.4***	2.1***	2.1***	2.1***	1.8
Age 65+	0.1***	0.1***	0.1***	0.1***	0.2
Household Income (mean)	5.444	5.203***	4.388***	4.248***	2.578
Household Wealth Index (mean)	7.6***	7.3*	7.1	7.6***	7.1
Home Ownership (%)	82.3**	77.8	78.6	72.6 [†]	76.9
Community Characteristics					
Region (%)					
Northeast	19.4***	11.8***	10.4*	11.3**	8.1
South-Southwest	36.0***	27.1***	30.6***	14.6	14.2
West	4.8***	12.0***	20.8***	37.5***	50.4
Central	23.0	39.4***	32.6**	33.0**	25.9
Northwest	16.8***	9.7***	5.6***	3.6***	1.4
Migration rate of state (mean)	0.04***	0.05***	0.07***	0.09***	0.11
Rural Residence (%)	16.4***	22.1***	27.5***	24.4***	54.8
Community has a health supplier (%)	79.8***	80.7***	73.8**	83.7***	68.3
Rich infrastructure (%)	44.1***	22.2***	27.1***	14.7***	5.9
State GDP (mean)	98,927***	91,868**	85,087	83,567	82,836
N	1,600	1,595	1,592	1,587	1,590

Data and Analytic Sample: 2002 Mexican Family Life Survey, children ages 6–19

Significance tests between the highest quintile of migration and the other quintiles

[†] p<0. 10,

* p<0.05,

** p<0.01,

*** p<0.001

Table 3

Models Predicting Children's Percentile BMI and Overweight Status by Country of Residence, Migration, and Generation Status

	OLS Models Predicting Percentile BMI (Regression Coefficients)		Logistic Regression Models Predicting Overweight (Odds Ratios)	
	Model 1	Model 2	Model 3	Model 4
Migrant Status Groups				
<i>Mexico Residence by Propensity to Emigrate</i>				
Very Low Propensity	3.93 *	3.46 **	1.35 **	1.27 *
Low Propensity	5.02 ***	4.14 **	1.50 ***	1.38 **
Medium Propensity	2.04 ***	2.00	1.28 *	1.24 *
High Propensity	1.02	0.25	1.37 **	1.26 *
Very High Propensity (Ref)	---	---	---	---
<i>U.S. Residence by Child's Generation and Duration</i>				
1st Generation				
<5 years of U.S. residence	4.97 *	4.54 †	1.82 ***	1.70 ***
5+ years of U.S. residence	5.76 **	5.04 *	2.30 ***	2.13 ***
2nd Generation				
Children of Natives	10.50 *** ^a	9.27 *** ^a	3.05 *** ^a	2.62 *** ^a
	5.82 ***	4.51 **	2.09 ***	1.64 ***
Control Variables				
<i>Household Income Quartiles (Ref=First Quartile)</i>				
Second Quartile		1.39		1.09
Third Quartile		1.84 †		1.13
Fourth Quartile		2.66 *		1.29 **
<i>Education Level of Household Head (Ref = Less than HS)</i>				
High School		-2.05		0.98
College+		-3.49 *		1.00
<i>Marital Status of Household Head (Ref = Married)</i>				
Single		0.21		1.05
Other		0.15		0.91
Household Size		-1.34 ***		0.09 ***
Child's Age (months)		0.00		1.00
Child's sex (Male)		-1.72 *		1.07
Child's Stunting Status		-4.94 ***		0.58 ***
Constant	59.40 ***	68.47 ***		
R-Squared/Pseudo R-Squared	0.011	0.024	0.017	0.030
Sample Size	10,610	10,610	10,610	10,610

Data and Analytic Sample: Pooled 2002 Mexican Family Life Survey and 2001/02, 2003/04, and 2005/06 NHANES, Mexican-origin children ages 6–19 (see text for details); N = 10,610. models are weighted.

† p<0. 10,

*
p<0.05,

**
p<0.01,

p<0.001

^aSignificantly different from 1st Generation children with <5 years of U.S. residence (p<.05); comparisons made among U.S. migrant status groups only.