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Mexican American Birthweight and Child Overweight: Unraveling a Possible Early Life Course Health Transition

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Abstract

Mexican American children have a weight distribution that categorizes them as relatively healthy at birth but relatively unhealthy by age 3. This early life course transition in health based on weight raises the question of whether Mexican American children "outgrow" the epidemiologic paradox of favorable birth outcomes despite social disadvantage or whether their birthweight distribution places them on trajectory for overweight in childhood. We address this question using newly available 9-year follow-up data from the Fragile Families and Child Wellbeing birth cohort study linked to pre-natal medical records. We systematically investigate the roles of birthweight, pre-natal factors, and childhood factors in explaining racial/ethnic differences in childhood overweight. Our main finding is that Mexican American children do outgrow the paradox: Their rates of childhood overweight are higher than expected given their birthweight distribution. Observed pre-natal and childhood factors do not explain the elevated rates of overweight among Mexican American children.

Keywords

birthweight, childhood health, epidemiologic paradox, Mexican American, overweight, race/ethnicity

In the United States, Mexican American children are more likely than non-Hispanic black and non-Hispanic white children to be overweight. Recent data indicate that 23 percent of Mexican American 6- to 11-year-olds have weight-for-height above the 95th percentile, compared to 22 percent of black children and 17 percent of white children (Ogden et al. 2006). These high rates of overweight, particularly among Mexican American and black children, are concerning because overweight in childhood is a risk factor for a variety of serious child health conditions (Dietz 1998). Overweight children are more likely than their non-overweight peers to be overweight in adulthood (Magarey et al. 2003), and adult health risks associated with overweight are exacerbated when overweight begins in childhood (Daniels 2006).

The search for causes of the elevated rates of overweight among Hispanic children has generally focused on childhood and has paid less attention to health endowments at birth. This may be because

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Hispanic infants are relatively healthy. Hispanic infants in the United States have rates of low birthweight and infant mortality on par with those of non-Hispanic whites. The surprisingly favorable birth outcomes among Hispanics, given their socioeconomic disadvantages relative to whites, have puzzled researchers and are often referred to as an epidemiologic paradox (Markides and Coreil 1986). The situation looks different a few years out, however. When childhood weight is used as a marker of health, Hispanics lose their health advantage as early as age 3 (Kimbro, Brooks-Gunn, and McLanahan 2007). This disadvantage continues throughout childhood (Ogden et al. 2002) and into adulthood (Ogden et al. 2006). Thus, there appears to be an early life course transition in the health of Hispanic children based on weight from an advantage at birth to a disadvantage a few years later, mirroring what others have suggested is a "disappearance" of the epidemiologic paradox as Hispanic children grow and develop (Guendelman, English, and Chavez 1995).

It is usually taken as a given that the birthweight distribution among Hispanics is unambiguously favorable in terms of infant health. However, observed associations between birthweight and later weight call this assumption into question. Birthweight is positively associated with later body weight, meaning that heavy infants tend to be heavy in childhood (Oken and Gillman 2002). Moreover, certain pre-natal factors that are associated with a reduced risk of low birthweight, such as maternal obesity, are also associated with child overweight (Reichman et al. 2008; Whitaker 2004). It is therefore possible that the seemingly favorable birthweight distribution of Hispanic infants obscures a health disadvantage (i.e., risk of overweight) that does not become apparent until a few years later.

In this study, we systematically explore factors that may contribute to the relatively high rates of childhood overweight among Mexican Americans, the largest Hispanic sub-group in the United States. We focus primarily on the role of birthweight and other factors established at birth but also consider the role of childhood factors such as diet and activity. We use newly available 9-year follow-up data from the Fragile Families and Child Wellbeing birth cohort study linked to pre-natal medical records and several waves of survey data to explore the transition from healthy birthweight to high rates of child overweight for Mexican Americans as compared to other racial/ethnic groups. First, we present a conceptual model of potential pathways to overweight in the early life course. Then we review the relevant empirical literature, describe our data and methods, and present the results of our analyses. We conclude with a discussion of our findings and suggestions for further research.

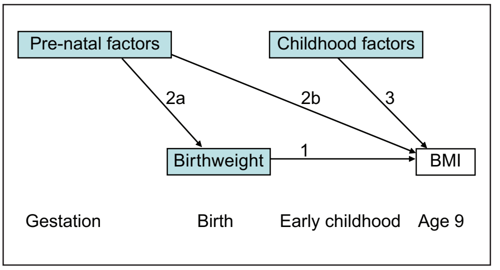

Figure 1. Conceptual Model of the Early Life Course Pathways to Child Weight

BACKGROUND

Early Life Course Pathways to Child Overweight

The life course perspective considers the long-term and cumulative influences of conditions and events across an individual's life by focusing on processes that unfold over time and intergenerationally within families (Elder 1994). The conceptual model in Figure 1 illustrates the intergenerational and early life course processes that guide our analyses of the apparent transition from relative health advantage of Mexican American children based on birthweight to a relative disadvantage based on subsequent overweight.

We begin by assessing weight "at the starting gate" (birth), which can be understood as a reflection of gestation process and the intergenerational transmission of health via the mother. As illustrated by arrow 1 in Figure 1, birthweight may directly translate to child weight. Second, pre-natal factors may affect child weight indirectly through birthweight (arrow 2a) or directly (arrow 2b). Third, childhood exposures, particularly those related to diet and activity, also affect child weight (arrow 3). Below we discuss and review the relevant literature on each of these pathways; we then structure our analytic models accordingly.

Birthweight and Child Weight

Birthweight is a key indicator of infant health. Low birthweight (<2,500 grams) is highly associated with infant mortality as well as with health and development problems in childhood and beyond (e.g., Reichman 2005). In the United States in 2006, 6.6 percent of births to Mexican origin women were low birthweight, compared to 7.3 percent of births to white mothers and 14 percent of births to black mothers (Martin et al. 2009). This pattern of racial and ethnic differences—specifically, the Mexican American rate of low birthweight that is similar to whites and substantially lower than blacks—is the defining characteristic of the epidemiological paradox. The paradox has generated a great deal of research attention because it defies common sociological understandings of the relationship between minority status and health (e.g., see Hummer 1996) and therefore presents an important opportunity to investigate factors that protect health in the face of socioeconomic disadvantage.

The paradox also calls the classic assimilation story—of immigrant disadvantages disappearing over time—into question, as a handful of studies suggest that the health advantage at birth may not persist into childhood or across generations (Guendelman et al. 1995; Padilla, Hamilton, and Hummer 2009). Notably, the elevated risk of overweight among Hispanic children compared to those in other groups is apparent by age 3 (Kimbro et al. 2007). This shift from an ostensibly favorable weight distribution at birth to a relatively unfavorable weight distribution in early childhood has led scholars to question whether Hispanic children "outgrow" the epidemiologic paradox (e.g., Fuentes-Afflick 2006).

What has not been considered in this literature is the fact that birthweight is linearly and positively associated with later weight (Oken and Gillman 2003). In other words, heavy infants tend to be heavy in childhood and beyond, suggesting a weight trajectory that is established at birth. More than two dozen studies show that, on average, 1,000 grams of birthweight is associated with an increase of between .5 and .7 in later body mass index (Oken and Gillman 2003).

Since birthweight is positively related to weight in childhood, it is possible that the favorable birthweight distribution of Mexican American infants puts them on trajectory for overweight in childhood. In other words, there could be a translation of a weight distribution defined as good at birth to one defined as problematic a few years later rather than a transition in early life course health, which would suggest that the Mexican American health advantage at birth is a mixed blessing as opposed to an unambiguously good outcome after which health compromising events begin to occur. However, while Mexican American children have a lower rate of low birthweight than non-Hispanic white children, the average Mexican American infant is not heavier at birth than the average non-Hispanic white infant (Buekens et al. 2000), suggesting that it is important to consider the entire birthweight distribution rather than focus on specific cutoffs.

Some studies of racial/ethnic differences in child overweight, all of which have considered Hispanics as a broad group, have controlled for birthweight measured continuously and found that it does not explain observed racial/ethnic differences (Balistreri and Van Hook 2010; Salsberry and Reagan 2005; Van Hook and Baker 2010). However, these studies did not examine the relationship between birthweight and child weight without controls for childhood factors, and none considered the possibility that birthweight may not have the same associations with subsequent weight for all racial/ethnic groups. Rooth (1980) and Wilcox and Russell (1990) have argued that different population standards for birthweight may be warranted given observed differences across world regions in associations between birthweight and perinatal mortality. In other words, birthweight may not be a uniform index of subsequent morbidity across all racial/ethnic groups. If that is the case, simply controlling for birthweight would not adequately account for the infant's standing on the relevant birthweight distribution. The incomplete research on this topic calls for an investigation of how patterns in child weight across the birthweight spectrum may vary by race/ethnicity, in particular for Mexican American children.

Pre-Natal Factors and Child Weight

The relationship between birthweight and later weight may reflect maternal pre-natal health behaviors and health status. Maternal pre-pregnancy weight, pregnancy malnutrition, pregnancy weight gain, pre-natal smoking, and gestational diabetes are all associated with both birthweight (Reichman 2005) and increased risk of childhood overweight (Huang, Lee, and Lu 2007).

Maternal pre-natal health behaviors and health status may also affect child weight through channels other than birthweight. In particular, they may affect the development of fetal organs associated with metabolism in a process referred to as *fetal programming* (Lucas 1994; Barker 1992). Studies indicating that there are racial/ethnic differences in many relevant pre-natal factors, and that some of these factors are associated with child weight net of birthweight, support the fetal programming theory as a potential explanation for racial/ethnic differences in child weight. In particular, non-Hispanic black and Hispanic mothers are more likely than non-Hispanic white mothers to weigh more than 200 pounds before pregnancy, gain more than 40 pounds during pregnancy, and have gestational diabetes (Rosenberg et al. 2005), and maternal obesity and gestational diabetes both lower the risk of low birthweight and increase the risk of child overweight net of the mediating influence of birthweight (Reichman et al. 2008; Salsberry and Reagan 2005; Whitaker 2004).

Childhood Factors and Child Weight

A growing volume of research has focused on childhood behavioral and environmental influences on child overweight. The factors most explored are related to food and soft drink consumption and activity level, and some of what is known to date about their associations with child obesity is summarized below. In general, research in this area has produced inconclusive results; that is, for studies showing significant associations there are others showing no associations, and this may largely be due to inherent difficulties in summarizing child diet and activity in survey data. Thus, much remains to be learned about the effects of food and activity-related factors on child obesity.

Past research has shown that breastfeeding is negatively associated with child overweight (Metzger and McDade 2010) and that that putting children to bed with a bottle is a risk factor for child overweight (Kimbro et al. 2007). Both fast food and soft drink consumption have been linked to dietary imbalances among children (Bowman et al. 2004) and obesity among adolescents (Taveras et al. 2005). Food insecurity is associated with overweight in childhood, perhaps because in a context of constrained resources, food becomes a source of shared family intimacy (Dubois et al. 2006; Kaufman and Karpati 2007). Supermarkets tend to offer more healthful foods at lower prices than neighborhood grocery and convenience stores (Galvez et al. 2008), and living in neighborhoods with lower fruit and vegetable prices is associated with lower child weight (Powell and Bao 2009). It is well-known that feeding behaviors, material hardships, and residential location vary considerably by race/ethnicity.

Recent studies have confirmed that physical activity helps keep children lean and that television viewing is associated with child overweight (e.g., Dennison, Erb, and Jenkins 2002). Computer and video game use has received less attention even though those activities are prevalent in children as young as age 5 (Rideout, Vandewater, and Wartella 2003). A recent study found that Mexican American children in certain age/gender groups are at elevated risk for low levels of active play and high levels of screen time compared to their counterparts in other racial/ethnic groups (Anderson, Economos, and Must 2008).

Racial/Ethnic Differences in Child Overweight

A number of recent studies on child overweight have examined race/ethnicity and various pre-natal and childhood factors. All of these studies focused on Hispanics overall rather than Mexican Americans in particular. Most were unable to account for the elevated rate of overweight of Hispanic children relative to white children, regardless of the measure of overweight used (Baker, Balistreri, and Van Hook 2009; Balistreri and Van Hook 2010; Kimbro et al. 2007; Salsberry and Reagan 2005; Van Hook and Baker 2010; Van Hook and Balistreri 2007; Whitaker 2004; Whitaker and Orzol 2006). One exception is the study by Li et al. (2007), which used data from children born to parents sampled in the 1979 National Longitudinal Survey of Youth (NLSY) and found no statistically significant differences in overweight between Hispanics and non-Hispanic whites. Because the sample used in that study was quite specific, the findings may not be generalizable. Another exception, which used the Early Childhood Longitudinal Survey birth cohort data, was able to account for the elevated odds of overweight at nine months controlling for a large number of pre-natal and post-natal factors (Li et al. 2011). Studies examining growth in overweight disparities, either by controlling for earlier weight gain or using growth curve modeling, have not found significant differences between Hispanic and non-Hispanic white children, suggesting that disparities are established in the first few years of childhood, likely between ages 1 and 3 (Li et al. 2011; Salsberry and Reagan 2005; Van Hook and Baker 2010; Van Hook and Balistreri 2007).

Only two studies used series of models to examine the differential impacts of risk factors on racial/ethnic differences in child weight. Both studied 3-year-old children. Whitaker and Orzol (2006) found that the high prevalence of obesity among Hispanics was not explained by racial/ethnic differences in maternal education, household income, or a standard measure of food security. Kimbro et al. (2007) found that none of a wide range of measures of feeding and nutrition, physical activity, and child care attenuated observed racial/ethnic differences in obesity.

We build on this emerging literature by distinguishing and systematically testing three different pathways to child overweight at age 9 as delineated in our conceptual model. The first, corresponding to arrow 1 in Figure 1, is that birthweight itself sets Mexican Americans on a trajectory toward heavier weight in childhood. The second is that pre-natal factors that are associated with both race/ethnicity and child weight (but not necessarily birthweight) increase the likelihood that Mexican American children become overweight (arrows 2a and 2b). The third is that health inputs introduced during childhood lead to the relatively higher weight of Mexican American children (arrow 3).

METHODS

Data and Sample

We used data from the Fragile Families and Child Wellbeing Study (FFCWS), a national birth cohort study of children born between 1998 and 2000 to predominantly unmarried mothers in large U.S. cities (see Reichman et al. 2001). The primary advantage of the FFCWS data is that they link anthropometric measures at age 9 to clinical measures of pre-natal and birth characteristics taken from medical records from the birth hospitalization, as well as to three waves of survey data collected during childhood (at ages 1, 3, and 5). These data uniquely allow us to investigate the roles of birthweight and pre-natal factors using clinical measures, observe child weight at a much later age (9 years) than most previous studies using prospective data, and incorporate factors introduced during childhood.

The FFCWS study drew a stratified random sample of all 77 U.S. cities with populations of 200,000 or more. In 18 cities, all hospitals with maternity wards were included; in the two largest cities, hospitals with maternity wards were randomly sampled. Within hospitals, births were randomly sampled, with oversamples of births to unmarried parents. A total of 4,898 mothers (3,712 unmarried; 1,186 married) were interviewed after they gave birth. Additional information about the pregnancy and birth was abstracted from the mothers' and infants' medical records (from the birth hospitalization). The availability of medical record data depended on administrative processes of hospitals rather than decisions on the part of survey respondents to make their medical records available. Mothers were re-interviewed at 1, 3, 5, and 9 years following the birth. At the 3-, 5-, and 9-year follow-ups, trained interviewers administered in-home assessments that included weight and height measurements of the children.

The analytic sample for this study includes all singleton births to white, black, Mexican origin, and other Hispanic mothers who participated in the 9-year in-home interview ($N = 2{,}977$). Plural births were excluded because the growth and development of multiples differ distinctly from those of singletons, and births to mothers of other race/ethnicities were excluded because they represent a very heterogeneous group. All missing information, including that due to medical records not being abstracted for 1,124 child–mother dyads, was imputed using Stata's multiple imputation method. Results based on the sample with complete information ($N = 1{,}335$) did not substantively or substantially differ from those based on the multiple imputation sample.

Between the baseline and the 9-year follow-up interviews, the FFCWS had a 35 percent attrition rate, which is similar to that of other national, longitudinal child health studies (see Balistreri and Van Hook 2010). Mexican American children of immigrants (i.e., whose mothers were Mexican-born) and other Hispanic children (i.e., whose mothers were Hispanic other than Mexican, not distinguishing between foreign and U.S. born) were more likely than other children to be lost to follow-up (47 percent and 44 percent, compared to 35 percent). We explored whether selective attrition is likely to bias our estimates by comparing the mean birthweight, percent low birthweight, and percent pre-pregnancy overweight (defined later) between mothers who completed 9-year in-home interviews and those who were lost to follow-up, separately by race/ethnicity. For all groups, low(er) birthweight infants were more likely to be lost to follow-up. However, the only statistically significant differences between leavers and stayers in low or mean birthweight were for non-Hispanic whites, and there were no significant differences (and no consistent pattern) between leavers and stayers in maternal pre-pregnancy overweight for any racial/ethnic group. These results (not shown) give us confidence that the racial/ethnic differences we observe in overweight at year 9 are not an artifact of selective attrition by birthweight or mother's weight.

Measures

Overweight. Child weight and height were measured during the 3-, 5-, and 9-year in-home assessments by trained interviewers following U.S. Centers for Disease Control (CDC) guidelines. Weight and height were used to calculate child body mass index (BMI), which is equal to weight in kilograms divided by height in meters squared. The CDC considers children above the 95th percentile BMI for age and sex to be overweight and children above the 85th percentile to be at risk of overweight. We used 95th percentile cutoff in all analyses presented in the paper but assessed the sensitivity of our findings to the use of the 85th percentile cutoff.

Race/ethnicity. The child's race/ethnicity is based on mothers' self-reports as Mexican origin, non-Hispanic white, non-Hispanic black, and other Hispanic. Given literature on the epidemiologic paradox indicating that health behaviors and outcomes of Mexican origin individuals vary considerably by immigrant generation (see Padilla et al. 2009), we further distinguish between foreign-born and U.S.-born mothers of Mexican origin based on mothers' reports of their place of birth. Mexican American children are therefore categorized as either second-generation (i.e., children of Mexican-born mothers) or third-plus-generation Mexican American (i.e., children of U.S.-born mothers of Mexican origin). Other Hispanic sub-groups were too small to analyze separately.

Pre-natal factors and birthweight. Mother's pre-pregnancy weight was coded as normal or underweight (BMI < 25), overweight (25 ≤ BMI < 30), or obese (BMI ≥ 30) based on pre-pregnancy weight and height data obtained from the mother's pre-natal medical record. Separate analyses that included a separate category for underweight (BMI < 18.5, N = 82) showed no difference in child overweight between underweight and normal weight mothers. Pregnancy weight gain, also obtained from the medical records, was measured in kilograms. We used dichotomous indicators for gestational diabetes (ascertained from the medical records) and pre-natal cigarette smoking. Following best practices for ascertaining pre-natal substance use, we coded mothers as having smoked during the pregnancy on the basis of information either in the medical records or in postpartum self-reports (Arendt et al. 1999). The timing of pre-natal care (second trimester, third trimester, or no care, versus first trimester) was also included. Although causal links between timing of pre-natal care and child health have not been firmly established (Reichman et al. 2009), the two are highly associated and vary by race/ethnicity (Padilla et al. 2009; Reichman et al. 2008). No pre-natal care and third trimester pre-natal care were grouped together because of the small number of mothers who did not receive any pre-natal care (N = 34). Pre-natal care information was taken from the medical records when it was available and from the mother's postpartum interview otherwise. Birthweight (in grams) was obtained from the medical records or, when not available from that source, from mothers' reports in the postpartum survey (the correlation between the two sources was .95). In regression models, birthweight is measured in kilograms.

Childhood factors. We included dichotomous indicators for whether the child was breastfed for at least six months and whether the child regularly took a bottle to bed, as reported in the 1-year follow-up interview. We used four indicators of diet constructed from maternal reports at 5 years: fast food consumption (2+ fast food servings per week), soft drink consumption (1+ sodas per day), snack food consumption (2+ servings per day), and fruit and vegetable consumption (5+ servings per day), all following U.S. Department of Health and Human Services recommendations for a healthy diet. As a measure of food insecurity, we included a dichotomous indicator for whether the mother reported at the 3-, 5-, or 9-year interview that she could not afford to feed her child(ren) a balanced meal or had to rely on low-cost food to feed her child(ren). We included whether the mother reported at 5 years that she regularly buys food at a supermarket as opposed to a smaller store or other outlet. We considered average weekday and weekend hours the child spent watching television, at a computer or playing video games, and playing outdoors, which were reported by mothers at 5 years. For both active (outdoor play) and inactive (television viewing and computer or video game) playing time, we multiplied the mother's weekday reports by five and weekend reports by two, summed the products, and divided by seven to obtain a daily estimate. Average daily hours watching television and at a computer or playing video games were then summed to obtain a single measure of "non-active" daily time.

We created the diet and activity measures from the year-5 survey rather than the year-9 survey to preserve the temporal ordering of events and to minimize the possibility of reverse causality (children's diet and activities may reflect their weight status at earlier ages). In analyses not shown, we used corresponding measures of diet and activity from the 9-year survey and found that the associations between those factors and overweight were very similar to those between the 5-year factors and overweight and that the 9-year factors explained no more or less of the differences in overweight between Mexican American and white children.

Sociodemographic controls. We controlled for the child's age (in months) at the time of the 9-year interview, the child's gender (female), the mother's age when she gave birth to the child (<20 years and 35+ years, vs. 20–34 years), marital status at the time of the birth (married versus unmarried), and parity (first birth, vs. second- or higher-order birth). We included two measures of socioeconomic status at the time of the birth: mother's education (<high school, high school or equivalent, and some college, vs. college +) and household poverty (<100 percent and 100–300 percent, vs. >300 percent of the federal poverty line).

Statistical Analyses

First, we present percent distributions and means of the birthweight and child weight measures at four time points (birth and ages 3, 5, and 9) by race/ethnicity. These figures are based on complete data (i.e., with no imputations) for the sample that appears in each follow-up wave. Then we present percent distributions and means of all analysis variables by race/ethnicity for the sample with non-missing child height and weight data in the 9-year follow-up, based on the multiple imputation data set ($N = 2{,}977$).

Next, we examine bivariate relationships between birthweight and child BMI at age 9 with graphs of average BMI by bands of birthweight (<2500, 2500–2799, 2800–2999, 3000–3199, 3200–3399, 3400–3599, 3600–3799, 3800–3999, and >4000) by race/ethnicity and regressing BMI on birthweight for each racial/ethnic group, again using the multiple imputation dataset. We also estimated logistic regressions for overweight that controlled for birthweight and included interactions between race/ethnicity and birthweight in order to test whether the association between birthweight and overweight varies significantly by group.

Finally, using the multiple imputation data set, we estimated multivariate logistic regression models that controlled for birthweight, sociodemographic characteristics, pre-natal factors, and childhood factors in a series of models that allowed for each set of factors to be assessed separately, for prenatal factors to be assessed with and without birthweight, and for the full set of factors to be included together. Stata/SE version 11 software was used to conduct all statistical analyses.

Table 1. Weight Distributions at Birth and Ages 3, 5, and 9 by Mother's Race/Ethnicity/Nativity

	U.S.-Born Mexican	Foreign-Born Mexican	Non-Hispanic White	Non-Hispanic Black	Other Hispanic	All
Percent low birthweight (<2,500 grams)	5.0	3.9	8.0	13.1	8.0	9.9
Mean birthweight (grams)	3,319.7	3,424.0	3,354.0	3,114.6	3,288.6	3,230.0
Percent overweight						
Age 3	19.6	22.6	14.9	16.4	32.7	18.6
Age 5	23.7	18.8	13.3	16.3	26.4	17.6
Age 9	31.2	34.4	16.6	26.1	30.9	25.6
Mean body mass index percentile						
Age 3	70.7	71.3	63.6	61.2	70.5	64.3
Age 5	72.6	71.4	64.3	64.7	70.4	66.3
Age 9	72.3	76.8	63.3	71.2	73.4	70.1
Sample sizes						
Birth	378	355	992	2,250	574	4,549
Age 3	189	168	457	1,242	257	2,313
Age 5	169	117	421	1,116	239	2,062
Age 9	250	189	644	1,570	324	2,977

Source: Fragile Families and Child Wellbeing Study.

RESULTS

Weight and Race/Ethnicity in the Early Life course

Table 1 presents, for each racial/ethnic/nativity group, four measures of weight in the early life course: mean birthweight and percent low birthweight, which were assessed at birth, and percent overweight (>95 percent BMI) and mean BMI percentile, which were assessed at ages 3, 5, and 9. Differences in rates of low birthweight across groups are consistent with the epidemiologic paradox of more favorable birth outcomes of Mexican Americans as compared to non-Hispanic whites and blacks. Race/ethnic differences in mean birthweight are less pronounced. Consistent with findings discussed earlier by Buekens et al. (2000), infants of U.S.-born women of Mexican origin are lighter at birth than non-Hispanic white infants on average.

Consistent with past studies, we find that the difference in overweight between Mexican American and non-Hispanic white children appears by age 3 (Kimbro et al. 2007). Whereas the percentage of non-Hispanic white children who are overweight increases only slightly from age 3 to age 9 (from 15 to 16.6), it increases by 50 percent for Mexican American children, resulting in a nearly 2:1 (Mexican American to white) difference in rates of overweight by age 9. Growth in this disparity largely occurs between age 5 and age 9. With only one exception (at age 5), the difference in overweight is greater between Mexican American children of foreign-born mothers and non-Hispanic white children than it is between Mexican American children of U.S.-born mothers and white children. The difference between Mexican American and non-Hispanic white children is smaller when considering mean BMI percentile. Consistent with Van Hook and Baker (2010), we find very little growth in the mean BMI percentile difference over time.

Sample Characteristics

Means and cross tabulations for the remaining study variables by mother's race/ethnicity/nativity are presented in Table 2. Three patterns are consistent with a shift from good health at birth to poor subsequent health within a context of socioeconomic disadvantage. First, the data reveal that Mexican origin mothers, especially the foreign born, are disproportionately socioeconomically disadvantaged. Foreign-born Mexican origin mothers are far less likely than other mothers to have a high school education or more, and they are far more likely than other mothers to live in households that fall below 300 percent of poverty. Second, Mexican origin mothers look favorable in terms of pre-natal smoking but unfavorable in terms of other pre-natal factors, in particular initiation of pre-natal care and pre-pregnancy weight (compared to non-Hispanic whites). Third, postnatal factors thought to influence child overweight suggest an elevated risk of overweight for children of U.S.-born Mexican origin mothers. This group was the least likely to have been breastfed for six months and the most likely to regularly consume fast food and sodas.

Birthweight and Child Weight at Age 9

Figure 2 shows, for each group, average child BMI at age 9 graphed by birthweight in 200-gram bands, with the linear regression coefficient for BMI regressed on birthweight for each group superimposed on the bands.

A positive relationship between birthweight and BMI at age 9 is apparent for all groups. For the entire sample, the coefficient is .84, meaning that 1,000 grams of birthweight is associated with an average increase of .84 in BMI; this figure is just above the range of estimates—between .5 and .7—in the literature on birthweight and later weight (Oken and Gillman 2003). Although the group-specific coefficients range from 0.36 for other Hispanics to 1.16 for non-Hispanic blacks, the differences in these coefficients across groups are not statistically significant. Models testing interactions between birthweight and race/ethnicity (not shown) indicate that the relationship between birthweight and age 9 overweight does not differ significantly by group. This result was replicated using OLS regressions of BMI at age 9. Further analysis using the Margins command in Stata confirmed that the differences in the odds of overweight between groups are positive and stable across the birthweight distribution. Thus, it is clear that the relationship between birthweight and child BMI is similar (positive and linear) for all groups and that Mexican American children are heavier than non-Hispanic white children across the entire birthweight distribution. That is, the primary difference is not one of slope (association between birthweight and BMI) but one of intercept (average weight of each group net of birthweight). These results indicate that Mexican American overweight is not a direct consequence of their birthweight distribution but instead reflects a health transition from infancy to childhood.

Pre-Natal and Childhood Determinants of Child Overweight

Having ruled out the possibility that the Mexican American birthweight distribution accounts for Mexican Americans' increased risk of overweight in childhood, and ascertaining that there really is a health transition among Mexican American children from birth to early childhood, we now turn to our analysis of the roles of prenatal and childhood factors in explaining the transition. Table 3 shows results from multivariate logistic regression models of the associations between race/ethnicity and age-9 overweight across seven models. The similarity in the odds ratios for Mexican origin with and without controlling for birthweight (Model 1 compared to Model 2) is consistent with our earlier finding that Mexican American overweight is not a direct consequence of their birthweight distribution. Changes in the odds ratios for race/ethnicity from Model 2 to Model 3 indicate that a small portion (about 10 percent) of the elevated odds of overweight among children of Mexican origin, non-Hispanic black, and other Hispanic women are due to their relative sociodemographic disadvantages as measured here. We find a robust, protective effect of marriage on child overweight; children whose mothers were married at the time of their birth have on average 45 percent lower odds of overweight at age 9, net of other measured factors. Children whose household incomes were below poverty at the time of their birth have lower odds of overweight than those with higher household incomes, all else equal. This seemingly perverse finding has been documented in other studies using the FFCWS data (Whitaker and Orzol 2006) and may result from the study over-representing nonmarital births and therefore minorities, for whom the association between socioeconomic status and

Table 2. Percent Distributions and Means by Mother's Race/Ethnicity/Nativity

	U.S.-Born Mexican	Foreign-Born Mexican	Non-Hispanic White	Non-Hispanic Black	Other Hispanic	All
Child characteristics						
Female (percent)	52.0	48.7	47.2	47.5	44.4	47.5
Age (mean, months)	111.8	113.4	110.7	111.1	111.5	111.2
Maternal characteristics						
Age at birth (percent)						
<20 years	21.6	11.6	13.8	20.3	23.1	18.8
20–34 years	74.8	78.4	71.1	73.2	68.3	72.6
≥35 years	3.6	10.0	15.1	6.5	8.6	8.6
Married (percent)	16.8	30.7	47.5	11.5	19.2	21.8
First birth (percent)	43.2	35.4	45.5	33.1	40.7	37.6
Education (percent)						
Some high school or less	40.4	75.1	19.1	31.7	40.3	33.4
High school or GED	30.0	16.0	26.1	37.5	30.7	32.2
Some college	26.4	8.0	27.6	26.1	23.2	25.0
College or higher	3.2	0.9	27.2	4.7	5.8	9.4
Income-to-poverty ratio (percent)						
<100 percent	36.8	38.6	13.8	38.5	34.0	32.5
100–300 percent	33.2	47.1	33.1	35.5	38.3	35.8
>300 percent	30.0	14.3	53.1	26.0	27.7	31.7
Pre-natal factors						
Pre-pregnancy weight (percent)						
Normal or underweight	42.7	47.9	56.2	42.4	50.1	46.7
Overweight	32.0	28.5	25.6	25.9	26.0	26.4
Obese	25.3	23.6	18.2	31.7	23.9	26.8
Pregnancy weight gain (mean, pounds)	14.9	13.1	15.5	13.3	14.0	14.0
Gestational diabetes (percent)	3.8	6.2	3.5	3.6	5.6	4.0
Smoked during pregnancy (percent)	17.3	4.8	42.7	29.1	20.7	28.6
Trimester pre-natal care begun (percent)						
First	53.1	54.7	74.1	57.7	58.2	60.7
Second	36.9	38.9	20.8	34.8	36.2	32.4
Third or none	10.0	6.4	5.1	7.5	5.6	6.9
Childhood factors						
Bottle to bed (percent)	4.2	11.2	4.2	3.2	20.2	5.9
Breastfed six months or more (percent)	9.2	37.0	19.5	12.4	15.4	15.5
Regular fast food (percent)	44.4	24.0	24.5	34.2	34.8	32.4
Regular sodas (percent)	51.8	46.5	31.7	47.4	49.3	44.7
Regular snack foods (percent)	46.8	30.0	37.7	53.4	41.8	46.6
Regular fruits and vegetables (percent)	41.8	21.7	29.1	38.2	28.6	34.3
Food insecurity (percent)	29.2	28.7	16.4	27.1	25.4	24.8
Shops at a supermarket (percent)	96.5	91.3	96.8	97.3	97.9	96.8
Television/computer time (mean, hours)	3.9	2.8	2.7	4.1	3.8	3.7
Outdoor play time (mean, hours)	2.9	2.8	2.7	2.2	2.2	2.4
N	250	189	644	1,570	324	2,977

Source: Fragile Families and Child Wellbeing Study.

overweight is not as clear as it is among non-Hispanic whites (Zhang and Wang 2004).

Model 4 in Table 3 incorporates pre-natal factors in addition to the sociodemographic controls. Mother's pre-pregnancy weight status is highly associated with child overweight. Mothers who were obese prior to pregnancy have nearly five times greater odds, and mothers who were overweight have nearly two times greater odds, of having an overweight child compared to mothers who were neither overweight nor

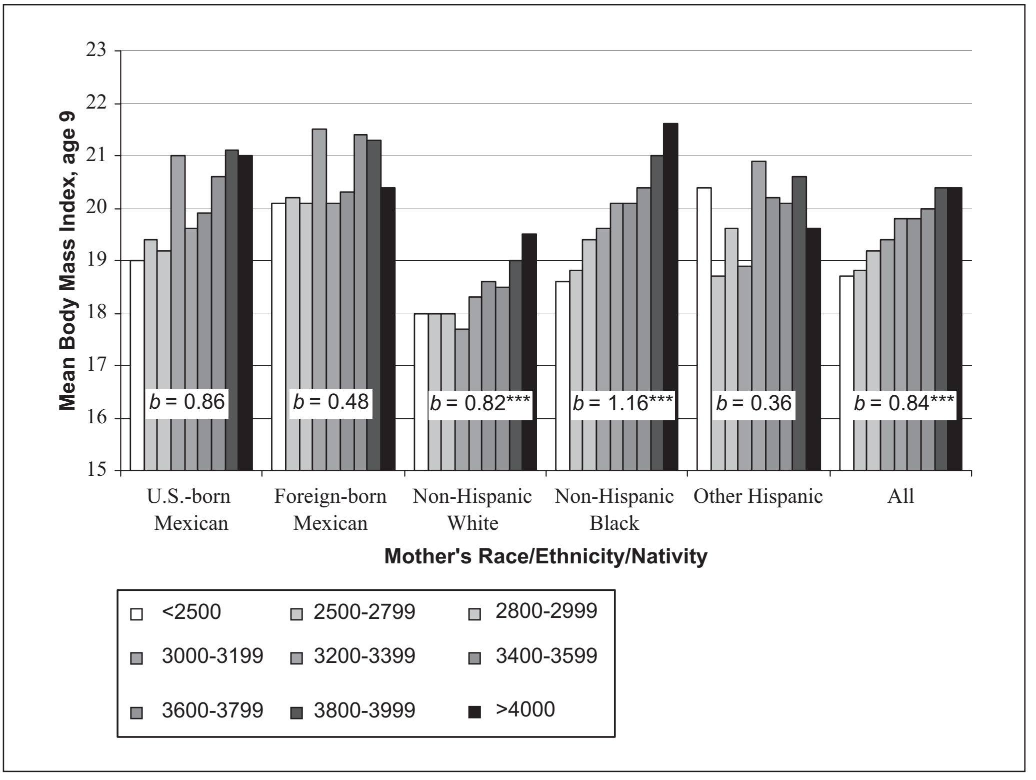

Figure 2. Average Child Body Mass Index at Age 9 by Birthweight (in Bands), by Mother's Race/Ethnicity/Nativity
Note: The linear regression coefficient (b) for body mass index regressed on birthweight for each group is superimposed on the respective set of bars.

obese. Pregnancy weight gain is also positively and independently associated with childhood overweight; each kilogram is associated with a 4 percent increase in the odds of child overweight.

Model 5 considers the associations of pre-natal factors net of birthweight. While the odds ratios for the pre-natal factors are unchanged from Model 4 to Model 5, the odds ratio for birthweight is reduced in half (from that in Model 3). In other words, the association between birthweight and later weight is in large part explained by pre-natal factors. However, those factors appear to influence child's later weight through pathways other than birthweight. These results support the fetal programming hypothesis wherein pre-natal factors affect the development of metabolism in utero.

Controlling for pre-natal factors accounts, to a small extent, for the elevated odds of overweight among Mexican American children of U.S.-born mothers and non-Hispanic black children. However, the odds ratios for Mexican American children of foreign-born mothers and other Hispanic children increase with controls for pre-natal factors, and for all groups there are strong associations between race/ethnicity and child overweight even when pre-natal factors are controlled.

Model 6 incorporates factors introduced during childhood. The only significant associations are for breastfeeding and regular consumption of soda. Children breastfed for six months or longer have 35 percent lower odds of being overweight at age 9 compared to those who were not breastfed for six months or longer, which is consistent with a recent study indicating that breastfed babies are, on average, 14 pounds lighter in adolescence than their formula-fed siblings (Metzger and McDade 2010). Daily consumption of soda at age 5 increases the odds of overweight at age 9 by 24 percent. We do not observe significant associations between child overweight and regular fast food consumption, regular snack food consumption, regular fruit and vegetable consumption, food insecurity, supermarket shopping, daily television/computer time, or daily outdoor play time.

Table 3. Odds Ratios from Logistic Regression Models Predicting Child Overweight (Body Mass Index > 95 Percent) at Age 9

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Mother's race/ethnicity (ref = white)							
U.S.-born Mexican	2.28***	2.35***	2.13***	1.95**	2.00***	2.02***	1.91**
Foreign-born Mexican	2.63***	2.62***	2.39***	2.69***	2.70***	2.59***	2.86***
Non-Hispanic Black	1.78***	1.97***	1.75***	1.46**	1.55**	1.72***	1.52**
Other Hispanic	2.24***	2.32***	2.12***	2.15***	2.20***	2.04***	2.06**
Sociodemographic characteristics							
Child female			1.17	1.13	1.16	1.18	1.17
Child age			1.01	1.01	1.01	1.01	1.01
Mother's age at birth (ref = 20–35)							
<20 years			.72**	.95	.95	.71**	.94
>35 years			1.11	1.02	1.03	1.10	1.01
Married at birth			.55***	.59***	.58***	.58***	.59***
First birth			1.05	1.04	1.07	1.05	1.05
Mother's education at birth (ref = college graduate)							
Less than high school			1.05	.94	.95	.94	.89
High school or GED			1.03	.95	.97	.93	.90
Some college			1.00	.91	.92	.94	.88
Household poverty status at birth (ref = >300 percent)							
<100 percent of poverty line			.80*	.73**	.73**	.78*	0.73**
100–300 percent of poverty line			1.16	1.04	1.04	1.16	1.04
Pre-natal factors							
Pre-pregnancy weight (ref = normal)							
Overweight				1.93***	1.89***		1.90***
Obese				4.84***	4.64***		4.69***
Pregnancy weight gain				1.04***	1.03***		1.03***
Gestational diabetes				1.11	1.08		1.09
Pre-natal smoking				1.12	1.17		1.15
Pre-natal health care began (ref = first trimester)							
Second trimester				1.09	1.08		1.09
Third trimester or none				.84	.83		.84
Postnatal factors							
Bottle to bed						1.10	1.21
Breastfed six months or more						.65**	.69*
Regular fast food						1.02	1.08
Regular sodas						1.24*	1.23
Regular snack foods						.90	.86
Regular fruits and vegetables						.99	.97
Food insecurity						1.02	.92
Shops at a supermarket						.90	1.07
Television/computer time						1.02	1.01
Outdoor play time						.99	.99
Birthweight		1.45***	1.51***		1.26*	1.54***	1.27*
N	2,977	2,977	2,977	2,977	2,977	2,977	2,977

* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed tests).

As with pre-natal factors, accounting for childhood factors does not appreciably reduce the associations between race/ethnicity and overweight; the odds ratios for both groups of Mexican American children, as well as those for non-Hispanic black and other Hispanic children, remain highly significant. When both pre-natal and childhood factors are included (Model 7), the odds ratios for U.S.-born Mexican American, non-Hispanic black, and other Hispanic are smaller than those in the model controlling only for demographic factors but are still large and statistically significant. The odds of overweight for children born to foreign-born Mexican American mothers actually increase, suggesting that their children would have even higher rates of overweight if observed childhood factors were similar to those of whites.

We ran many supplementary models to assess the sensitivity of our findings to variable construction, choice of covariates, and sample composition. Our primary findings vis-à-vis racial/ethnic differences in child overweight are robust to using an 85 percentile BMI cutoff for overweight, measuring BMI continuously, limiting the sample to cases with complete data, including city fixed effects, controlling for neighborhood racial/ethnic composition, measuring activity time continuously, using different cutoffs for activity time, measuring activity time only using weekday reports, using different cutoffs for the dietary consumption measures, including father's height and weight in the models, limiting to cases in which the parents are the same race/ethnicity, controlling for gestational age, and incorporating alternative measures of socioeconomic status (insurance coverage for the birth and neighborhood poverty). Finally, we also estimated a series of models of child overweight at ages 3 and 5 using childhood factors measured at ages 1 and 3, respectively, and of child overweight at ages 3, 5, and 9 using contemporaneously measured childhood factors. We found the effects of all pre-natal factors, childhood factors, and birthweight to be remarkably robust.

CONCLUSION

Mexican American children have a healthy weight distribution at birth but an unhealthy weight distribution only a few years later. Using rich, longitudinal birth cohort data with newly available anthropometric measures at age 9 linked to pre-natal medical records and five waves of survey data, we systematically investigated this crossover by exploring the extent to which the elevated rates of overweight among Mexican American children relative to non-Hispanic white children can be explained by three potential early life course pathways: birthweight, pre-natal factors, and childhood factors.

We found that Mexican American children are heavier than non-Hispanic white children regardless of their birthweight—that is, they are heavier across the birthweight distribution. We observed essentially the same positive, linear relationship between birthweight and later BMI for Mexican American children as has been observed in the general population. Moreover, controlling for birthweight does not account for the elevated risk of overweight at age 9 among Mexican American children. These results clearly show that their birthweight distribution does not place Mexican American children on trajectory to overweight in childhood.

By ruling out the role of birthweight, our results clarify that there is indeed a transition in the early life course health of Mexican American children from a relative health advantage at birth (low rates of low birthweight) to a relative health disadvantage a few short years later (high rates of overweight). This finding is consistent with a growing body of research indicating that the epidemiologic paradox at birth does not extend to childhood, and suggests that protective mechanisms in place during gestation are less operative in early childhood (Fuentes-Afflick 2006).

Having clearly confirmed that Mexican American children are not heavier because of their birthweight distribution, we investigated two other early life course pathways to overweight—pre-natal and childhood factors. We found limited support for these mechanisms. The pre-natal factors we examined—including pre-pregnancy weight, gestational diabetes, and health behaviors—capture the key pre-natal determinants of children's weight. However, controlling for those factors barely accounts for the higher odds of overweight among Mexican American children. One exception is that—to the extent it is not captured by pre-pregnancy weight and pregnancy weight gain—we do not have measures of pre-natal nutrition, which may be key in the fetal programming of metabolism (Barker 1992). The childhood factors we examined included a wide range of health behaviors related to diet and activity in early childhood. But consistent with most past work on this topic, we fail to account for the Mexican American child overweight disadvantage.

The data we used, while very rich, are exclusively urban and overrepresent children born to unmarried parents, who tend to be disadvantaged. As such, our findings are not necessarily generalizable to all children. That said, there are advantages to looking at a relatively homogenous group in terms of socioeconomic status and residential location in that it may eliminate potential confounding effects of unobserved socioeconomic factors. The disadvantaged nature of our sample makes the disparities observed in our data all the more striking.

Why were we able to explain so little of the Mexican American child weight disadvantage? The fact that only one of the measures of childhood food consumption and physical activity—soda consumption—is associated with BMI in the regression models suggests that survey measures are not sufficiently sensitive to characterize diet or physical activity. It is possible that our measures of childhood diet and activity levels (mother-reported, weekly averaged) do not capture the real day-to-day experience of eating, watching television, sitting at the computer, and playing. This kind of variation may be better elicited using journal entries by respondents over several weeks.

Based on our findings and the strengths and weaknesses of the various measures we used, we believe that the most fruitful directions for future research on causes of excess rates of overweight among Mexican Americans children are maternal pre-natal nutrition and factors introduced during childhood. Both of these may be influenced by culture. Sociological models of black-white differences in health emphasize structural disadvantage and discrimination, which in turn affect proximate determinants of health such as health behaviors (Hummer 1996). The rapid growth of Hispanic and Asian groups in the United States since 1965 complicates this model, as the health of recent immigrant groups cannot be explained without reference to the role of home country culture and assimilation to U.S. cultural norms—factors that also affect health behaviors and other proximate determinants of health.

Racial/ethnic differences in cultural attitudes regarding the acceptability and desirability of child overweight, as well as in food and diet patterns, may be important. There is some empirical support for this. A recent study found that different ideas about health may lead some Hispanic parents to view child weight as a sign of health and to encourage food consumption (Evans et al. 2009). And an ethnographic study of Latino families in Brooklyn found that food plays an important role for notions of gratification and parental satisfaction, particularly given the material constraints of low-income families and communities (Kaufman and Karpati 2007). Studies such as ours are unable to capture either the cultural beliefs of this kind or the specific health behaviors they may promote.

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