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Childhood obesity risk factors by race and ethnicity

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Abstract

Objective: Childhood obesity is a public health concern that often worsens with age. While several risk factors at the child and maternal levels have been identified in cross-sectional studies, less is known about their long-term contribution to racial/ethnic disparities in childhood obesity. This study examines child and maternal-level factors associated with the growth trajectories of White, Black, and Latino children.

Methods: Group based trajectory models were used to identify BMI z-score trajectories from birth to 9 years of age among White, Black, and Latino children. The associations of child and maternal-level factors with the trajectory group identified as at-risk for obesity were examined using adjusted logistic regression analysis, stratified by race/ethnicity.

Results: Among White children, fast food consumption (Odds Ratio [OR], 1.66; 95% Confidence Interval [CI], 1.09–2.52) was associated with higher odds of following an at-risk trajectory. Among Black and Latino children, pre-pregnancy BMI was associated with following at-risk trajectory (OR, 1.05; 95% CI, 1.03–1.08 for Black, and OR, 1.12; 95% CI, 1.07–1.17 for Latino children) .

Conclusion: Findings showed racial/ethnic differences in the risk factors that influence the likelihood of obesity during childhood. Further research is needed to identify modifiable racial/ethnic specific risk factors to guide obesity prevention interventions.

Keywords

childhood obesity; obesity development; racial/ethnic disparities; risk factors; BMI z-scores; trajectories

Introduction

In the United States (US), more than one in five children have overweight or obese (1). Obesity disproportionately affects Black and Latino children with both having higher prevalence and incidence rates of overweight and obesity than their White counterparts

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(2–4). A national study found the prevalence of childhood overweight and obesity among Latino and Black children is higher (38.9% and 35.2%, respectively) than the prevalence of their White (28.5%) and Asian (19.5%) counterparts (5). Previous studies have shown that these racial/ethnic disparities start early in life (6, 7) and remain throughout the lifespan (4, 8, 9). While racial/ethnic disparities in overweight and obesity rates are widely documented, less is known about the race/ethnic-specific risk factors that contribute to the development of obesity during early childhood ages.

Several studies examined weight gain trajectories and factors associated with excessive weight gain during childhood ages (10). Findings from these studies identified factors associated with the development of childhood overweight and obesity beginning as early as pregnancy and infancy. For example, maternal body mass index (BMI), gestational weight gain, gestational diabetes, breastfeeding behaviors, and depression are associated with childhood obesity (11–15). Beyond these factors, behaviors throughout childhood such as sleep (16, 17), diet (18), physical activity (19, 20), and screen time (19, 20) have also been associated with overweight and obesity. Several of these factors differentially impact racial/ethnic groups (14, 21). Previous research has shown that due to disparities in neighborhood features attributed to structural racism and social inequities, Black and Latino children are more likely to be exposed to known obesity risk factors (e.g., they have limited access to opportunities to engage in physical activity and eat fresh fruits and vegetables) than their White counterparts (14, 21, 22). However, the direct contributions of child diet, screen time, and physical activity to race/ethnic specific longitudinal weight gain trajectories (7, 8) and race/ethnic specific obesity risks have not been examined among racially/ethnically diverse children (10).

The identification of racial/ethnic-specific early precursors of obesity during pregnancy, infancy, and early childhood can help guide efforts to prevent and reduce racial/ethnic disparities in childhood obesity. To support this, the goal of this study is to identify child-level (e.g., sleep, television viewing, outdoor play, dietary intake) and maternal-level (e.g., pre-pregnancy BMI, breastfeeding, depression) modifiable risk factors associated with the development of at-risk growth trajectories among White, Black, and Latino children.

Methods

This study used secondary data from Waves 1–5 of the Fragile Families and Child Wellbeing Study (FFCWS). FFCWS is a national prospective study of predominantly non-marital births in the United States. Participants were selected from several hospitals in 21 US cities (23). Unmarried and married mothers were invited to participate, but unmarried mothers were oversampled by a 3 to 1 ratio. At each hospital, the researchers obtained information regarding the percentage of non-marital births in the hospital's city during 1996 or 1997. Women who had given birth and were married or unmarried were invited to participate until reaching the identified quotas in each city. The present study used data collected when the children were born (wave 1), at one (wave 2), three (wave 3), five (wave 4), and nine (wave 5) years of age. The first wave of interviews was collected at the hospital, shortly after birth, from February 1998 to September 2000 from 4,898 mother-child dyads. Wave 2 was collected from 1999 to 2002, wave 3 from 2001 to 2003, wave 4 from 2003 to

2006, and wave 5 from 2007 to 2010. Study procedures have been published elsewhere (23) and additional information is available at: http://www.fragilefamilies.princeton.edu/documentation/general

Analytic Sample

The total number of participants in the study at baseline was 4,898 mother-child dyads. Children whose birth weight was less than 2,500 grams or who were premature (n = 558) were excluded from the analytical sample because they have different growth patterns. The analytic sample also excluded children whose BMI z-score was below −5 or above 5 (n = 5), since these values were deemed biologically implausible based on recommendations set by the World Health Organization (24). Children were also excluded from the sample if they lived with their mothers less than half of the time at ages 1 and 3 years (n = 835). In addition, a total of 139 participants were excluded from the analytic sample because their race/ethnicity was other than Non-Latino White, Non-Latino Black, or Latino, or their information on race/ethnicity was missing. The final analytic sample included information on 3361 mother-child dyads. Table 1 shows the child and mother's characteristics for the analytic sample stratified by race/ethnicity.

Due to the longitudinal nature of the study, the sample size for each wave was different. Contrary to what would be expected due to attrition, wave 5 had a larger sample size compared to waves 3 and 4. In waves 3 and 4, the in-home visits were not scheduled until after the phone interviews. This design was problematic and decreased participation. During wave 5, the participants were consented and scheduled for the in-home interview during the phone interview (i.e., no time elapsed between the phone interview and scheduling the home visit), which increased the number of in-home visits and overall sample size of wave 5.

Measures

Childhood Weight and Obesity Status—Child BMI z-scores are a standardized way to observe child growth over time (25, 26). BMI z-scores at birth (wave 1) were estimated from the child's weight and length measurements as stated on the child's medical record. BMI z-scores were then constructed using a macro in SAS 9.4 available from the World Health Organization (for more information, see: https://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas-who.htm). The WHO growth charts were used at wave 1 based upon the CDC recommendation that WHO growth charts be used for children under the age of 2 as they provide a more reliable estimate (CDC, 2010b). Height (in meters) and weight (in kilograms) were measured by trained interviewers when the children were 3 (wave 3), 5 (wave 4), and 9 (wave 5) years. Participants were instructed to remove their shoes prior to obtaining height and weight. The instruments used were: SECA 840 Bella Digital Scales to measure weight and SECA 214 Road Rod Stadiometer to measure height. Height and weight were used to estimate age and sex-adjusted BMI-Z scores using the CDC growth curve charts. The BMI z-score cut-off of +1.04 was used for overweight status and +1.64 for obesity status (26). These are equivalent to the 85^{th} and 95^{th} cutoff percentiles for overweight and obesity status (26). Prior empirical studies have validated and used these BMI z-score cut-offs (25, 27).

Child-level variables—Child-level variables were defined as behaviors that were carried out by the child during the first five years of life to understand early-life contributors to childhood obesity. All of these behaviors were reported by the mother. Table 2 outlines the variables that were collected at each wave.

Dietary intake—Dietary intake was assessed at age 5 years and encompassed 3 different variables. The overall aim of this construct was to quantify foods the child typically ate that were high in nutrition but low in calories (fruits and vegetables) and those that were low in nutrition but high in calories (soda and fast food). To assess dietary intake mothers were asked: "On a typical day, about how many servings of the following foods does your child eat?" for each of the following foods: soda, fresh fruits or vegetables, and frozen or canned fruits and vegetables. Responses were presented in a Likert scale from 0 to 5 with "0" meaning none and "5" meaning having five or more servings per day. Since there are two questions for fruit and vegetable consumption, these two questions were combined to yield servings/day. Information on fast food consumption was obtained by asking: "About how many times a week does your child eat a meal from a "fast food" restaurant (e.g., McDonald's, KFC, etc.)?" This question was asked per week rather than per day. The three dietary intake variables were used as continuous.

Outdoor play—Outdoor play was used as a proxy for physical activity since it is during this time that children are likely to be physically active without having to engage in structured activities (28). A study comparing three different measurements of physical activity: 1) accelerometers, 2) parental report using a checklist, and 3) parental recall of minutes playing outdoor daily found that the accelerometer measurement of physical activity was significantly correlated with parental report of time spent playing outdoors; indicating that outdoor play can be a strong surrogate measure of physical activity (29). For the present study, the mothers reported the number of hours on a typical weekday and weekend that their child played outside when the child was 3 and 5 years old. Weekday and weekend outdoor play were combined through a weighted average. This variable was analyzed as a continuous variable.

Television viewing—Mothers reported the typical number of hours their child watched television both on the weekends and during the week separately when the child was 3 and 5 years. Weekday and weekend television viewing were combined through a weighted average. Television viewing was dichotomized and categorized into children who watched less than two hours of television per day and children who watched two hours or more per day. Given that data were collected between 1998 and 2010, we used previous recommendations from the American Academy of Pediatrics that suggested children between the ages of 2–5 should not watch more than two hours of television per day (30).

Sleep—Mothers reported the number of hours the child slept, in whole numbers, when the child was 5 years old. This variable was dichotomized and categorized as children having less than 10 hours and those having 10 hours or more of daily sleep. This was based on the recommendation from the National Sleep Foundation where preschool-aged children should sleep between 10 and 13 hours (31).

Maternal-level variables: Four maternal modifiable factors were selected as maternal-level variables: maternal pre-pregnancy BMI, number of biological children, breastfeeding, and depression.

Pre-pregnancy BMI—Pre-pregnancy weight and height were collected from maternal medical records and pre-pregnancy BMI was calculated using weight (kg)/ height(m)^2. Pre-pregnancy maternal BMI was used as a continuous variable.

Number of biological children—Information about the number of biological children was reported by the mother when the child was born. Number of biological children was used as a continuous variable.

Breastfeeding—Breastfeeding was measured at wave 2 by asking: "How old was [child] when you stopped breastfeeding (him/her)?". This question was used to assess breastfeeding duration and was dichotomized into less than 6 months or 6 months or more to follow the American Academy of Pediatrics recommendations of breastfeeding exclusively for the first 6 months (34).

Maternal depression—Maternal depression was assessed at wave 2 using the Composite International Diagnostic Interview-Short Form (CIDI-SF). The CIDI-SF provides a categorical assessment of probable major depression (coded as 0, 1). Participants were asked whether they felt sad/depressed or had lost interest in activities they normally found pleasurable in the last year. Participants who had either of those feelings for at least half of the day, almost every day, for at least 2 weeks, were asked a set of follow-up questions about losing interest, feeling tired, change in weight (at least 10 pounds), trouble sleeping, trouble concentrating, feeling down, and having thoughts about death. These items were summed to create a score ranging from 0 to 8. Scores of 3 and above were coded as probable depression (32, 33). Participants taking antidepressant medication automatically received a positive score for depression.

Mother and Child Demographic Measures—Regression models were adjusted for factors previously associated with childhood overweight and obesity (35, 36). Child age and sex were considered in children's BMI z-scores estimates, and therefore, not duplicated in the regression models. Mother's demographic factors included: educational level (36) and relationship with baby's father (i.e., married or cohabiting status) (35). All variables were reported by the mother when the child was born. Maternal education was used as a categorical variable with two levels: women with high school or less and women with some college or more. Mother's relationship with baby's father was used as a categorical variable with three levels: married, cohabiting, and other type of relationship. Maternal race/ethnicity included White, Black, and Latino. Child race was not reported; therefore, following the National Center for Health Statistics, the race of the mother was used and assumed to be that of the child (37).

Statistical Analysis

Group based trajectory modeling (GBTM) was used to identify different growth trajectories, using child BMI z-scores from birth to 9 years of age (38, 39). Group-based trajectory modeling was designed to model developmental trajectories (38, 39). The main assumption of group-based trajectory modeling is that the population, in this case the children, have different growth patterns (38, 39). The main objective of this type of modeling is to identify specific and homogeneous clusters of trajectories for each racial/ethnic group, namely White, Black, and Latino (38, 39). SAS 9.4 was used for the analysis. Bayesian information criterion (BIC) and group membership probabilities were used to determine the optimal number of trajectories for each of the three racial/ethnic groups. Data were analyzed separately to identify whether children from different racial/ethnic backgrounds had different growth patterns. Next, group membership probabilities were checked to identify what proportion of the sample fell into each individual trajectory. Wald tests were then conducted to determine if the slopes of the trajectories were significantly different from one another. Further details on the growth trajectories are published elsewhere (6).

Once the best number of trajectories was identified for each racial/ethnic group, each child was assigned to a group depending on the growth trajectory he/she was most likely to follow. Because not all racial/ethnic groups had the same number of trajectories, the labels “at-risk” or “not-at-risk” trajectories were identified for each group. At-risk trajectories for each racial/ethnic group were defined as those crossing the overweight or obesity z-score threshold (+1.04 and +1.64, respectively), at waves 3, 4, or 5. Finally, logistic regression tests were used to investigate child-level and maternal-level factors associated with “at-risk” trajectory group membership. Two models were utilized for each racial/ethnic group. We ran a model including child-level factors, followed by a model that included both child and maternal-level factors.

Results

Sample description

Most mothers in the sample identified as Black (48.4%), followed by Latina (27.9%; Table 1). The average pre-pregnancy BMI was 26.5 (SD = 6.7). The average age of the mothers was 25 years (SD = 5.9). Most mothers were either married (25.2%) or cohabiting (26.5%) with the baby’s father. Among children, 52.1% were male. By age 3 years, 35.6% of children had overweight or obesity and by age 9, the prevalence increased to 42.9%. Racial/ethnic disparities were present at early ages. By age 3 years, 68.6% of White children had underweight or normal weight status, compared to only 53.3% of their similar-age Latino children counterparts. These racial/ethnic differences remained over time. By age 9, the rate of obesity among Latino children was 31.9%, almost double the rate of White children (16.2%). Chi-square tests demonstrated that these racial/ethnic differences were significantly different at all waves. Racial/ethnic differences in sleep patterns were also found. About 67.0% of White children slept at least 10 hours per night, compared to only 39.5% of Black and 50.2% of Latino children.

White children

Among White children, three-growth trajectories were identified (Figure 1, top): “stable”, “mid-rising”, and “high-rising” (6). About 13% of White children followed the high-rising growth trajectory that conveyed the highest risk of having overweight or obesity by age 9 (6). Table 3 shows the association of the child-level and maternal-level factors with the at-risk high-rising trajectory among White children. None of the child-level factors examined were associated with following the at-risk trajectory. Inclusion of maternal-level factors showed that fast food consumption was significantly associated with the at-risk trajectory. Each additional day per week that fast food was consumed was associated with a 45% increase in the odds of following an at-risk trajectory (Odds Ratio [OR], 1.45; 95% Confidence Interval [CI], 1.01– 2.07). Higher maternal pre-pregnancy BMI (OR, 1.03; 95% CI, 0.98 −1.09) and higher number of biological children (OR, 1.44; 95% CI, 0.99 – 2.10) were marginally associated with following the high-rising trajectory.

Black children

Among Black children, two-growth trajectories were identified (Figure 1, middle): a “slow-rising” group, which comprised 35.04% of the sample, and a “mid-rising” group, which included 64.96% of participants (6). The at-risk “mid-rising” trajectory indicated that most Black children were at an increased risk of having overweight, but not obesity (6). Findings of the association of child-level and maternal-level factors with the “mid-rising” trajectory are introduced in Table 4. None of the child-level factors were associated with the “mid-rising” trajectory among Black children. A one unit increase in maternal pre-pregnancy BMI was associated with a 5% increase in the odds of following a “mid-rising” growth trajectory (OR, 1.05; 95% CI, 1.03 – 1.08).

Latino children

Among Latino children, two-growth trajectories were identified (Fig. 1, bottom): a “slow-rising” group, which was made up of 35.2% of Latino children, and an at-risk “high-rising” group, which was made up of 64.8% of children (6). Close to 65% of the Latino children followed a growth pattern that placed them at a higher risk of developing overweight or obesity over time (6). None of the child level factors were significantly associated with the high-rising trajectory (Table 5). Maternal pre-pregnancy BMI and number of biological children were significantly associated with the high-rising trajectory. A one-unit increase in maternal pre-pregnancy BMI was associated with a 12% increase in the odds of following a high-rising trajectory (OR, 1.12; 95% CI, 1.07 −1.17). Fewer number of children birthed by the focal child’s mother was significantly associated with following a high-rising trajectory (OR, 0.79; 95% CI, 0.63–0.98).

Discussion

Our study revealed different predictors of at-risk growth trajectories for White, Black and Latino children. After testing the same demographic, child-level, and maternal-level factors for each racial/ethnic group separately, we found that there was not a common factor that was associated with developing at-risk growth trajectories across all racial/ethnic groups. Among White children, consumption of fast food was found to be the only significant factor for following an at-risk growth trajectory. Fast food consumption was not found to be a significant risk factor among Black or Latino children. This study contributes to the mixed findings on the association between fast food consumption and childhood obesity development. Most studies use proximity to fast food restaurants as a proxy for fast food consumption (40). Our study provides a measure of fast-food consumption reported by the parents, which might be more accurate than proximity to fast food outlets. It is also possible that an association between fast food intake and trajectory membership was not found in this study because this variable was only available at age 5 (wave 4). Measuring behaviors this late in time might mask the true effect that they have on the development of childhood obesity. Whenever available, future studies should focus on using behaviors measured close to the start of the trajectory or use behaviors that are measured over time.

Among Black and Latino children, higher maternal pre-pregnancy BMI was associated with an increased likelihood of developing an at-risk growth trajectory. These findings align with previous literature that suggests maternal obesity can impact the development of childhood obesity (13, 15, 21, 41). Children of mothers who have obesity before pregnancy or gain excessive weight during pregnancy are 1.4 to 4 times more likely to have obesity during childhood ages than children born to mothers with a healthy pre-pregnancy weight (15, 42). Studies have shown that when compared to White mothers, Black and Latino mothers are more likely to have overweight or obesity before pregnancy and are at higher risk for excessive weight gain during pregnancy (14). Current disparities in obesity among pre-pregnant women may exacerbate future racial/ethnic disparities in childhood obesity.

A surprising finding was that among White and Latino children, the number of biological children was a common factor that was associated with developing an at-risk trajectory. Among White children, a greater number of biological children increased the likelihood of following an at-risk trajectory. In contrast, among Latino children, fewer biological children placed them at an increased likelihood of following an at-risk trajectory. These findings suggest that more than investigating the effect that the number of biological children have for childhood obesity development, it is important to understand the household composition, and child ages, regardless of whether they are biological or not. The number of children in the household might be a better indicator of access to resources. Future studies should assess the number of children, biological or not, their ages, at different waves to better understand the effect that the number of children in the household has on the development of childhood overweight and obesity.

Despite investigating factors that have previously been found to be associated with childhood obesity (18, 20, 43–47), in this longitudinal study, no other child-level or maternal-level factors were associated with following an at-risk growth trajectory among White, Black and Latino children. This study showed that when a variety of risk factors are tested with longitudinal growth trajectories in different racial/ethnic groups, they do not place *all* children at a higher risk of developing obesity.

It is difficult to determine whether these associations were not significant because of a measurement or timing issue, or due to the demographic characteristics in our sample. Several risk factors have been identified in studies that used a cross-sectional design, thus, associations may not be longitudinal. It is also possible that specific risk factors explain prevalence of obesity at specific age periods, and may not become evident until later in life. Another potential reason for the lack of associations with traditional risk factors for childhood obesity might be driven by more systemic issues and social determinants. The sample in this study included women with low-income who were mostly unmarried. In contrast, previous longitudinal studies that examined risk factors associated with childhood obesity have relied on samples of predominantly White children with higher socioeconomic statuses (21, 47). For example, a previous longitudinal study conducted with children in the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) included children born to mothers who were 43% White, 56% had some college or more, and 79% were in a two-parent household (46). Future studies need to devote time and resources to recruit samples with racial/ethnic and socioeconomic diversity to enable the investigation of the social determinants of obesity that affect low-income and minority children. Our findings suggest interventions and policies that target risk factors identified on samples of predominantly White children may fail to address the obesity risks of Black and Latino children. As a result, these prevention efforts could inadvertently widen the current racial/ethnic disparities in childhood obesity rates by reducing obesity rates among White children, while obesity continues to increase in Black and Latino youth.

Overall, our findings demonstrate that the onset of racial/ethnic disparities in childhood overweight and obesity start early in life, even prior to conception. Yet, the majority of childhood obesity prevention interventions focus on implementing interventions among school age children, when obesity may have already developed (2, 9). Future interventions that aim to *prevent* childhood obesity and reduce disparities in childhood obesity rates need to start as early as possible and need to work with women and families before conception and birth. Efforts should prioritize promoting healthy weight before and during conception, particularly among Black and Latino women. Prenatal visits offer an opportunity for healthcare providers to discuss the importance of nutrition and appropriate weight gain during pregnancy with mothers-to-be to avoid complications for the mother and the offspring (11, 38).

Limitations

This study adds to the mixed results of important predictors of childhood overweight and obesity and is among the few studies to longitudinally examine child and maternal-level predictors of developing an at-risk growth trajectory among a diverse sample of children. There are, however, several limitations worth noting. Although innovative techniques such as GBTM provide a reliable and accurate way to analyze longitudinal data, identifying predictors of group membership can be cumbersome. One reason it is difficult to identify these predictors or factors that are associated with growth trajectories is that these factors must be measured as close to the start of the trajectory as possible or at the same time points as the outcome measure. When using longitudinal data, future studies should use datasets that recognize behavioral changes over time and collect recurrent measures of the independent variables that need to be analyzed. Second, outdoor play was used as a proxy for physical activity; however, there are activities that are conducted outdoors that may not entail moderate or vigorous physical activity. A third limitation is that dietary intake, outdoor play, television viewing and sleep were all reported by the caregiver and these reports could be misestimated. Fourth, the number of biological children was assessed when the focal child was born (i.e., wave 1); however, it is likely that more children were born during later waves, making the number of biological children less accurate. A final limitation is that breastfeeding duration was only assessed using one question; therefore, there was no information available on breastfeeding exclusivity, which might impact the development of childhood obesity more than breastfeeding duration alone (47).

Conclusion

This study examined the race/ethnic specific child and maternal-level risk factors associated with BMI z-score trajectories from birth to 9 years, a critical period for the development of obesity and racial/ethnic disparities. We found that maternal pre-pregnancy BMI was associated with the at-risk weight gain trajectory among Black and Latino children. Beyond this risk factor, we found that higher frequency of fast-food intake was directly associated with the at-risk weight gain trajectory among White children. Most of the previously recognized obesity risk factors were not significantly associated with changes in BMI-Z scores from birth to 9 years in this sample. Our findings suggest there are racial/ethnic differences in childhood obesity risk factors that need to be carefully evaluated before implementing ‘one size fits all’ childhood obesity prevention interventions and policies.

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What is already known about this subject?

- Childhood obesity disparities exist, and they start early in life

What are the new findings in your manuscript?

- Racial/ ethnic disparities start before birth
- More research is needed to identify the precursors of childhood obesity among low-income, minority populations

How might your results change the direction of research or the focus of clinical practice?

- Future studies need to include maternal pre-pregnancy BMI to be able to uncover modifiable childhood obesity precursors
- More attention needs to be devoted to identifying precursors of childhood obesity by racial/ethnic group
- Specific racial/ethnic amenable risk factors need to be identified and targeted through culturally grounded interventions

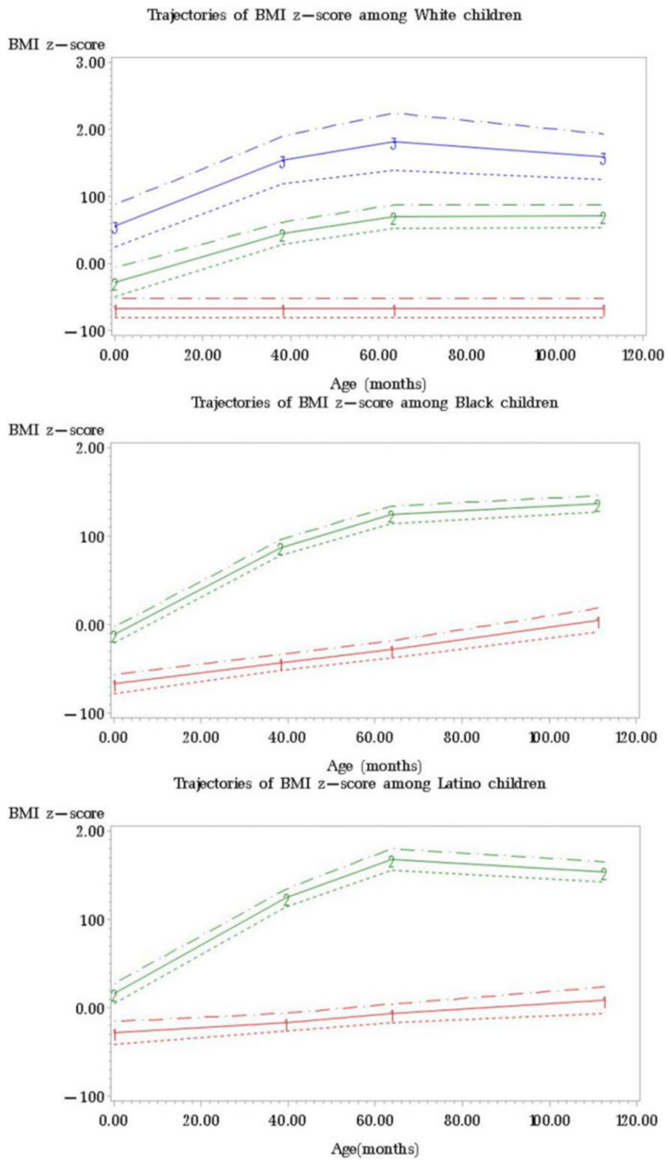

Figure 1:

BMI z-score trajectories by racial/ethnic group

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Table 1:

Sample characteristics stratified by race/ethnicity

Variables	Total n (%) N = 3361	White n (%) N = 797 (23.7)	Black n (%) N = 1626 (48.4)	Latino n (%) N = 938 (27.9)
Child-level factors				
Child sex				
Female	1611 (47.93)	384 (48.18)	781 (48.03)	446 (47.55)
Male	17.50 (52.07)	413 (51.82)	845 (51.97)	492 (52.45)
Child BMI z-score at W1, SD	−0.24 (1.09)	−0.24 (1.10)	−0.35 (1.09)	−0.05 (1.06)
Child BMI z-score W3, SD	0.59 (1.24)	0.48 (1.13)	0.49 (1.24	0.86 (1.26)
Child BMI z-score W4, SD	0.63 (1.13)	0.52 (1.07)	0.56 (1.14)	0.84 (1.11)
Child BMI z-score W5, SD	0.78 (1.10)	0.50 (1.10)	0.85 (1.08)	0.90 (1.11)
Child OW/OB status W3				
Normal and underweight	1259 (64.43)	284 (68.60)	694 (68.51)	281 (53.32)
Overweight	337 (17.25)	72 (17.39)	157 (15.50)	108 (20.49)
Obese	358 (18.32)	58 (14.01)	162 (15.99)	138 (26.19)
Child OW/OB status W4				
Normal and underweight	1105 (64.70)	254 (67.37)	596 (66.30)	255 (59.03)
Overweight	313 (18.33)	76 (20.16)	159 (17.69)	78 (18.06)
Obese	290 (16.98)	47 (12.47)	144 (16.02)	99 (22.92)
Child weight status at W5				
Normal and underweight	1448 (57.12)	392 (67.01)	703 (54.79)	353 (52.92)
Overweight	437 (17.24)	98 (16.75)	238 (18.55)	101 (15.14)
Obese	650 (25.64)	95 (16.24)	342 (26.66)	213 (31.93)
Sleep W4				
Less than 10 hours	1175 (51.35)	176 (32.96)	709 (60.55)	293 (49.83)
At least 10 hours	1113 (48.65)	358 (67.04)	460 (39.45)	295 (50.17)
Soda intake W4 (servings per day)	0.77 (1.15)	0.47 (0.91)	0.84 (1.21)	0.89 (1.19)
Fruit and vegetable (servings per day) W4	3.50 (1.35)	3.36 (1.35)	3.66 (1.30)	3.32 (1.42)
Fast food intake per week W4	1.23 (1.03)	1.04 (0.93)	1.25 (1.06)	1.35 (1.04)
Television viewing *				
Less than 2 hours per day	829 (28.39)	290 (42.34)	307 (21.39)	232 (29.00)
At least 2 hours per day	2091 (71.61)	395 (57.66)	1128 (78.61)	568 (71.00)
Outdoor play *	2.73 (1.73)	2.93 (1.58)	2.54 (1.74)	2.90 (1.79)
Maternal-level factors				
Maternal education				
High school or less	2135 (63.58)	325 (40.78)	1102 (67.82)	708 (75.64)
Some college or more	1223 (36.42)	472 (59.22)	523 (32.18)	228 (24.36)
Pre-pregnancy BMI (SD)	26.50 (6.65)	25.10 (6.22)	27.33 (7.16)	26.35 (5.92)
Maternal relationship with baby’s father				
Married	847 (25.20)	408 (51.19)	220 (13.53)	219 (23.35)
Cohabiting	1226 (26.48)	243 (30.49)	550 (33.83)	433 (46.16)

Variables	Total n (%) N = 3361	White n (%) N = 797 (23.7)	Black n (%) N = 1626 (48.4)	Latino n (%) N = 938 (27.9)
Other	1288 (38.32)	146 (18.32)	856 (52.64)	286 (30.49)
Number of biological children (SD)	1.10 (1.27)	0.87 (1.13)	1.24 (1.35)	1.04 (1.21)

Note. BMI: body mass index. W1: wave 1 (birth). W2: wave 2 (age 1). W3: wave 3 (age 3). W4: wave 4 (age 5). W5: wave 5 (age 9).

*Average hours reported in waves 3 and 4 were used to estimate hours of outdoor play and satisfaction of television viewing recommendations.

Table 2:

Variables included by waves

Variable of Interest	Wave 1 (birth)	Wave 2 (age 1)	Wave 3 (age 3)	Wave 4 (age 5)	Wave 5 (age 9)
Dependent Variable					
Child BMI z-score	x		x	x	x
Child-level variables					
Sex	x				
Age	x	x	x	x	x
Sleep				x	
Television viewing			x	x	
Outdoor play			x	x	
Dietary intake				x	
Maternal-level variables					
Maternal age	x				
Poverty level	x				
Education	x				
Race/ethnicity	x				
Number of biological children	x				
Pre-pregnancy BMI *	x				

Note. BMI: Body Mass Index.

* Pre-pregnancy BMI was obtained from medical records

Table 3:

Child-level Factors and their Association with High-Rising Growth Trajectory among White Children

	Model 1				Model 2			
Predictor	***B***	***SE***	***OR***	**95% CI**	***B***	***SE***	***OR***	**95% CI**
Child-level factors								
Sleeping 10 hours or more	−0.36	0.27	0.70	0.40 – 1.19	0.00	0.42	1.00	0.44 – 2.33
Viewing TV two hours or more	0.41	0.29	1.50	0.85 – 2.64	0.63	0.48	1.87	0.73 – 4.82
Outdoor play	0.01	0.08	1.01	0.86 – 1.19	0.19	0.13	1.21	0.94 – 1.57
Fast Food	0.14	0.14	1.15	0.87 – 1.52	0.51	0.22	1.66	1.09 – 2.52
Soda	0.05	0.14	1.05	0.81 – 1.37	0.00	0.19	0.99	0.67 – 1.45
Fruit and vegetable	0.10	0.10	1.10	0.90 – 1.35	0.05	0.15	1.01	0.78 – 1.42
Maternal-level factors								
Pre-pregnancy BMI					0.03	0.02	1.03	0.98 – 1.09
Number of biological children					0.36	0.19	1.44	0.99 – 2.10
Maternal depression					−0.67	0.59	0.51	0.16 – 1.63
Breastfeeding for at least 6 months					0.38	0.47	1.46	0.59 – 3.64
Education: some college or more					−0.20	0.46	0.82	0.33 – 2.00
Maternal relationship with baby’s father								
Cohabiting					−0.24	0.55	0.79	0.27 – 2.31
Other					0.48	0.53	1.62	0.57 – 4.70

Note: SE: Standard error. Model 1: unadjusted model. Model 2: fully adjusted model.

Table 4:

Child-level Factors and their Association with Mid-Rising Growth Trajectory among Black children

	Model 1				Model 2			
Predictor	***B***	***SE***	***OR***	**95% CI**	***B***	***SE***	***OR***	**95% CI**
Child-level factors								
Sleeping 10 hours or more	−0.06	0.12	0.94	0.74 – 1.20	−0.23	0.18	0.79	0.56 – 1.31
Viewing TV two hours or more	−0.15	0.15	0.86	0.64 – 1.16	−0.35	0.23	0.71	0.45 – 1.10
Outdoor play	0.01	0.04	1.01	0.94 – 1.09	−0.01	0.06	0.99	0.88 – 1.10
Fast Food	−0.03	0.06	0.97	0.87 – 1.09	−0.03	0.09	0.97	0.82 – 1.15
Soda	−0.01	0.05	0.99	0.89 – 1.10	0.01	0.08	1.01	0.86 – 1.18
Fruit and vegetable	0.01	0.05	1.01	0.92 – 1.11	0.08	0.07	1.09	0.95 – 1.25
Maternal-level factors								
Pre-pregnancy BMI					0.05	0.01	1.05	1.03 – 1.08
Number of biological children					0.07	0.07	1.10	0.94 – 1.24
Maternal depression					−0.14	0.25	0.87	0.54 – 1.40
Breastfeeding for at least 6 months					−0.36	0.26	0.70	0.42 – 1.16
Education: at least some college					0.31	0.21	1.36	0.90 – 2.05
Maternal relationship with baby's father								
Cohabiting					0.21	0.30	1.24	0.79 – 2.23
Other					−0.25	0.29	0.78	0.44 – 1.37

Note: SE: Standard error. Model 1: unadjusted model. Model 2: fully adjusted model.

Table 5:

Child-level Factors and their Association with High-Rising Growth Trajectory among Latino children

	Model 1				Model 2			
Predictor	***B***	***SE***	***OR***	**95% CI**	***B***	***SE***	***OR***	**95% CI**
Child-level factors								
Sleeping 10 hours or more	0.03	0.17	1.03	0.73 – 1.44	0.00	0.25	1.00	0.61 – 1.61
Viewing TV two hours or more	0.27	0.19	1.31	0.90 – 1.91	0.17	0.28	1.18	0.68 – 2.04
Outdoor play	−0.04	0.05	0.96	0.87 – 1.06	−0.04	0.07	0.97	0.84 −1.12
Fast Food	−0.05	0.09	0.95	0.81 – 1.13	0.05	0.13	1.05	0.82 – 1.35
Soda	−0.04	0.07	0.96	0.83 – 1.11	−0.01	0.11	0.99	0.80 – 1.23
Fruit and vegetable	−0.01	0.06	0.99	0.87 – 1.11	−0.01	0.09	1.00	0.83 – 1.17
Maternal-level factors								
Pre-pregnancy BMI					0.11	0.02	1.12	1.07 – 1.17
Number of biological children					−0.24	0.11	0.79	0.63 – 0.98
Maternal depression					−0.24	0.35	0.79	0.40 – 1.57
Breastfeeding for at least 6 months					0.05	0.30	1.05	0.58 – 1.91
Education: at least some college					−0.33	0.30	0.72	0.40 – 1.29
Maternal relationship with baby’s father								
Cohabiting					0.00	0.31	1.00	0.54 – 1.85
Other					0.38	0.35	1.46	0.74 – 2.88

Note: SE: Standard error. Model 1: unadjusted model. Model 2: fully adjusted model.