

Racial and Ethnic Disparities in Early Childhood Obesity

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abstract

OBJECTIVES: The prevalence of childhood obesity is significantly higher among racial and/or ethnic minority children in the United States. It is unclear to what extent well-established obesity risk factors in infancy and preschool explain these disparities. Our objective was to decompose racial and/or ethnic disparities in children's weight status according to contributing socioeconomic and behavioral risk factors.

METHODS: We used nationally representative data from ~10 700 children in the Early Childhood Longitudinal Study Birth Cohort who were followed from age 9 months through kindergarten entry. We assessed the contribution of socioeconomic factors and maternal, infancy, and early childhood obesity risk factors to racial and/or ethnic disparities in children's BMI z scores by using Blinder-Oaxaca decomposition analyses.

RESULTS: The prevalence of risk factors varied significantly by race and/or ethnicity. African American children had the highest prevalence of risk factors, whereas Asian children had the lowest prevalence. The major contributor to the BMI z score gap was the rate of infant weight gain during the first 9 months of life, which was a strong predictor of BMI z score at kindergarten entry. The rate of infant weight gain accounted for between 14.9% and 70.5% of explained disparities between white children and their racial and/or ethnic minority peers. Gaps in socioeconomic status were another important contributor that explained disparities, especially those between white and Hispanic children. Early childhood risk factors, such as fruit and vegetable consumption and television viewing, played less important roles in explaining racial and/or ethnic differences in children's BMI z scores.

CONCLUSIONS: Differences in rapid infant weight gain contribute substantially to racial and/or ethnic disparities in obesity during early childhood. Interventions implemented early in life to target this risk factor could help curb widening racial and/or ethnic disparities in early childhood obesity.



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WHAT'S KNOWN ON THIS SUBJECT: Childhood obesity is a significant public health challenge. Early childhood obesity prevalence is disproportionately higher among racial and/or ethnic minority children compared with their white peers. It is unclear which specific obesity risk factors underlie and explain these disparities.

WHAT THIS STUDY ADDS: Differences in rapid infant weight gain contribute substantially to racial and/or ethnic disparities in obesity during early childhood.

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The prevalence of childhood obesity is significantly higher among racial and/or ethnic minority children in the United States compared with white children.¹ Obesity is more prevalent among American Indian and/or Native Alaskan (31.2%), non-Hispanic black (20.8%), and Hispanic (22.0%) children compared with their white (15.9%) and Asian (12.8%) peers.¹ Obesity has been linked to genetic, epigenetic, biological, social, and environmental determinants and risk factors^{2,3} and is associated with multiple consequences.⁴

Childhood obesity is associated with various behavioral factors, including maternal smoking during pregnancy,⁵ breastfeeding,⁶ television viewing, and physical inactivity.⁷ Some of these risk factors vary by race and/or ethnicity and socioeconomic status (SES),^{8,9} leading some researchers to hypothesize that differences in the prevalence of these factors across racial and/or ethnic groups could explain observed disparities.¹⁰ Differences in socioeconomic measures across racial and/or ethnic groups could also contribute to the disparities. The relationship between SES and obesity has also been shown to vary by race and/or ethnicity and sex.¹¹ Researchers in that study documented an inverse relationship between SES and overweight and/or obesity among white, Asian, and Hispanic children but not among American Indian and African American children.¹¹ Reasons for these differences are not clear, partly because data on obesity risk factors remain sparse among certain racial and/or ethnic minority groups (eg, Asian and American Indian children).

Few researchers have explored the explanation of racial and/or ethnic differences in early childhood obesity rates.^{9,10,12} Existing studies found that some prenatal, perinatal, and early life and childhood risk factors (eg, maternal smoking during pregnancy, breastfeeding, child

care arrangements, sleep duration, television viewing, fast-food intake, and family meals) could explain a large part of BMI differences across racial and/or ethnic groups. However, some gaps in knowledge remain. Previous studies have not specified risk factors for different developmental time periods. There is a need for better understanding of the relative contribution of specific obesity risk factors to racial and/or ethnic disparities at different stages of the life course and to design effective, targeted interventions. For example, if early life factors are more influential in the development of racial and/or ethnic disparities in obesity prevalence than later risk factors, focusing mostly on risk factors from later childhood could limit efforts to eliminate disparities. Our goal in this study was to quantify the relative contribution of socioeconomic and behavioral risk factors to racial and/or ethnic disparities in early childhood weight status by using nationally representative data. We sought to provide a clearer picture of the factors underlying racial and/or ethnic disparities in early childhood obesity and highlight the modifiable risk factors that could be prioritized and targeted in interventions.

METHODS

Data were from ~10 700 US children born in 2001 and followed for 6 years in the Early Childhood Longitudinal Study Birth Cohort (ECLS-B), a stratified clustered survey designed and administered by the National Center for Education Statistics (NCES).¹³ A multistage, complex sampling strategy was used to draw the sample. American Indian and Native Alaskan children, Chinese, other Asian, and Pacific Islander children, twins, and low birth weight children were oversampled. Waves of data were collected when the children were aged ~9 months (wave 1),

2 years (wave 2), 4 years (wave 3, preschool interview), and between 5 and 6 years (wave 4, kindergarten entry interview). We used data from 4 waves for this analysis. The study was approved by the NCES and the Harvard T.H. Chan School of Public Health institutional review board. Per NCES ECLS-B data reporting requirements, all unweighted sample sizes were rounded to the nearest 50.

Outcome Variable

We used BMI z scores from wave 4 (kindergarten entry) as our main dependent variable. A child's length or height and weight were measured by using a measure mat, stadiometer, and a digital bathroom scale, respectively. We calculated BMI z scores using the Centers for Disease Control and Prevention's sex-specific BMI-for-age growth charts.¹⁴

Exposure Variables

Parents reported their children's race and/or ethnicity by choosing 1 or more options displayed on a card. On the basis of parent responses, the ECLS-B assigned children to the following racial and/or ethnic categories: Asian, Pacific Islander, American Indian, non-Hispanic white, non-Hispanic black, Hispanic, and multiracial. For this study, we assigned children to 1 of 5 racial and/or ethnic categories: any child who had at least 1 race and/or ethnicity group reported by the parent as American Indian was categorized as American Indian. In a similar, prioritized manner, we then categorized children to African American, Hispanic, Asian, and white categories, in that order. Because of limited sample sizes and distributions, we restricted our analytic sample to the following categories: white (reference group), African American, American Indian, Hispanic, and Asian (Pacific Islander children were not included in our analyses).

Model Covariates

Obesity Risk Factors

Obesity behavioral risk factors were collected at wave 1 or wave 3 and were grouped into 3 types: (1) maternal risk factors from wave 1, (2) infancy risk factors from wave 1; and (3) early childhood risk factors from wave 3. We chose variables from waves 1 and 3 to ensure that risk factor measurement preceded the outcome: BMI z score at wave 4. Supplemental Table 4 displays all variables, their measurement, and categories.

Maternal Risk Factors (Wave 1)

Maternal risk factors included (1) mother's weight (kg) and (2) maternal history of smoking during pregnancy (yes or no).

Infancy Risk Factors (Wave 1)

Infancy risk factors included (1) history of breastfeeding (ever breastfed versus never breastfed), (2) age at introduction of solid foods (≤ 4 months versus > 4 months), and (3) infant weight gain based on the 9-month rate of infant weight gain (calculated as the difference in weight at the time of data collection and birth weight [kg] divided by age in months at the time of data collection).

Early Childhood Risk Factors (Wave 3)

Early childhood risk factors included (1) television-viewing (≥ 2 hours per day of television and/or DVD viewing on weekdays and weekends versus less), (2) sugar-sweetened beverage (SSB) consumption (regular SSB drinkers [ie, drank ≥ 1 serving of SSB per day] versus infrequent and nondrinkers [< 1 drink per day]), (3) fruit and vegetable consumption (adequate consumption [≥ 1 times per day] versus inadequate consumption [< 1 time per day]), (4) physical activity (child went outside to walk or play at least once per day versus less than once per day), (5) family meals (regular family meals

[≥ 4 meals together per week] or not), (6) and child care arrangement (parental versus nonparental). The ECLS-B provides a composite variable to indicate the primary, nonparental child care arrangement based on where the child spent the most hours per week.

Socioeconomic Factors (Wave 1)

Socioeconomic factors included (1) household SES (a composite variable developed by the ECLS-B for children's SES at baseline data collection), and the variable was categorized into quintiles and comprised information on the mother's and father's educational attainment, occupational category and prestige score, and household income; (2) household food insecurity, which was assessed by using a series of questions obtained from the Household Food Security Scale (if parents had ≥ 3 affirmative responses to questions, the household was categorized as food insecure [versus food secure]); and (3) neighborhood safety (unsafe versus safe on the basis of parents' perceptions of their neighborhood safety).

Statistical Analysis

We created our overall study sample by examining children's weight and height trajectories at each wave and excluding children who had implausible height values ($n = 100$), were born with low or very low birth weight (ie, birth weight < 2500 g; $n = 3000$), had height and weight values missing for all waves ($n = 150$), and had extreme BMI values (z score > 3 SD or ≤ -3 SD; $n = 100$). For the decomposition analyses, we excluded observations with missing values on any of the independent variables, leaving us with a sample size of ~ 4400 . We examined differences in the distribution of all variables by race and/or ethnicity by using χ^2 and t tests (2-sided $P < .05$ was considered significant). To first examine the relationship between

obesity risk factors (at 1 time point) and BMI z scores at kindergarten entry within each racial and/or ethnic group, we used multivariable ordinary least squares (OLS) regression models. Subsequently, to quantify the degree to which risk factors explained racial and/or ethnic disparities in children's BMI z scores, we employed the Blinder-Oaxaca decomposition technique,^{15,16} which is commonly used to examine wage differentials,^{15,16} health disparities,^{17,18} and in recent years, obesity research.^{19–23} Briefly, the method involves estimating the regression coefficients by fitting the OLS regression for the reference category and then predicting the outcomes for the other groups by using their covariate distributions. The difference between the observed and predicted averages for the comparative group is the proportion of the disparity that is not explained by the covariates in the model. For clarification purposes, in the data supplement section, we describe the steps employed for a decomposition analysis by using an example based on OLS models comparing white and African American boys. For a more comprehensive explanation of the Blinder-Oaxaca technique, we recommend articles by Jann²⁴ and Sen.^{19,20} We performed our decomposition analyses by using the "Oaxaca" command in the Stata statistical package (StataCorp, College Station, TX) with the "svy" routine to account for the ECLS-B survey weights. Sex-stratified, pairwise comparisons between white children and each racial and/or ethnic minority group were conducted. Because white children had the largest sample size, they were used as the reference category to compare with children of other races and/or ethnicities. We first categorized model covariates into 4 groups (sociodemographic, maternal, infancy, and early childhood factors), followed by detailed analyses for individual covariates

within each risk category. Finally, by using the regression results, we computed the percent explained (PE%), which represents the contribution to explained disparities from each covariate.¹⁹ The total PE% indicates how much of the mean difference in BMI z scores is accounted for by group differences in the distributions of all model covariates. All models were adjusted for child age and accounted for the complex ECLS-B design. Given the documented differences in BMI by sex,²⁵ analyses were stratified by sex. As recommended, we estimated coefficients from a pooled regression over both comparison groups and included a group indicator as an additional covariate.²⁴ We also conducted sensitivity analyses by fitting models that used coefficients from white children as the reference group, and the results did not differ substantively. All analyses were conducted by using statistical software (SAS version 9.3 [SAS Institute, Inc, Cary, NC] and Stata 12).

RESULTS

Overall, 51.3% of the sample were boys, 54.6% were white, 23.3% were Hispanic, 15.8% were African American, 2.9% were American Indian, and 3.5% were Asian (Table 1). At baseline (age ~2 years), on average, Asian children had the lowest BMI z scores (0.29 [0.08 SD]), whereas American Indian children had the highest BMI z scores (0.67 [0.15 SD]). At kindergarten entry, BMI z scores were also lowest among Asian children (0.41 [0.07 SD]) and highest among American Indian children (0.98 [0.08 SD]). BMI z scores by race and/or ethnicity and sex are displayed in Table 1.

In terms of socioeconomic factors, Hispanic, African American and American Indian children were more disadvantaged compared with their Asian and white peers. For example, a higher proportion

of African American (56.7%), Hispanic (51.3%), and American Indian (50.1%) children belonged to households earning <\$25 000 per year compared with white (19.8%) and Asian children (17.7%). A higher percentage of African American and Hispanic children lived in households that were food insecure or in unsafe neighborhoods compared with their white and Asian peers. In addition, the obesity risk factor profile among Hispanic, African American, and American Indian children was less favorable than those of white and Asian children. African American children had the highest and Asian children the lowest prevalence of risk factors of all racial and/or ethnic groups. A higher proportion of Asian children were breastfed, watched ≤ 2 hours of television, consumed less SSBs, and ate more fruits and vegetables compared with their peers of other racial and/or ethnic groups. Asian mothers also had the lowest prevalence of maternal smoking during pregnancy. Because the lower prevalence of obesity risk factors among Asian and white children could reflect, at least in part, their more advantaged SES compared with their peers, we also estimated the prevalence of risk factors accounting for SES, neighborhood safety, and food insecurity. In these models, African American children still had the highest prevalence of obesity risk factors, whereas the prevalence among Hispanic children was similar to those of Asian children (data available on request).

Results of multivariable regression analyses indicated that associations between BMI z score and individual risk factors were generally modest and varied by sex and race and/or ethnicity (Table 2). For example, an early introduction of solid foods had a significant, positive association with BMI z scores among African American and American Indian boys, whereas it was significantly associated only among American

Indian girls. Eating meals as a family was positively associated with BMI z scores among Hispanic girls but negatively associated among African American girls. The magnitude of most of these associations was small. Rapid infant weight gain was the only variable that had a consistently strong, positive association with BMI z score at kindergarten entry across all racial and/or ethnic groups and by sex (except among American Indian boys). The average contribution of risk factors to the explained portion of the gaps in BMI z scores between white and other racial and/or ethnic boys and girls are displayed in Table 3. Among African American boys, the combined differences in risk factors explained -0.11 U of the -0.18 U gap in mean predicted BMI z scores, which is ~64%. By contrast, the sociodemographic, maternal, infant, and early childhood risk factors included in the model collectively accounted for only ~25% of racial differences between Asian and white girls. Indeed, for some racial and/or ethnic groups, a large portion of the difference in BMI z scores remained unexplained. Of all the risk factor groups, infancy risk factors had the most substantial contribution to the explained portion of the model. In this group, the rate of infant weight gain played the most influential role, although this varied by race and/or ethnicity and sex. For example, differences in infant weight gain between white and African American boys accounted for 70.5% (-0.080 of -0.113) of the explained gap in BMI z scores between the 2 groups, whereas between white and Asian girls, it accounted for only 14.9% of the explained gap (Supplemental Table 6).

Gaps in socioeconomic factors were another important contributor to explained disparities. Within this category, household SES was the individual covariate with the highest PE%, with values ranging from 3.4% among white versus African

TABLE 1 Child and Parent Socioeconomic Characteristics, Obesity Risk Factors, and BMI z Scores by Child Race and/or Ethnicity: ECLS-B

Characteristic	Overall	African American	Hispanic	Asian	American Indian	White
Distribution of race, %		15.8	23.3	3.5	2.9	54.6
Boys, %	51.3	53.6	51.8	53.2	50.4	50.3
Household income, \$ (%) ^a						
<25 000	33.5	56.7	51.3	17.7	50.1	19.8
25 000–50 000	29.7	25.7	32.5	25.2	31.6	29.8
>50 000	36.8	17.7	16.2	57.1	18.3	50.5
Parent education, % ^a						
Less than high school	45.8	60.3	68.2	23.9	55.5	33.2
Some college	29.2	30.2	23	19.9	36.7	31.8
Less than college	25.0	9.5	8.8	56.3	7.8	35.0
Food insecurity, % ^a	11.8	16.9	17.7	6.5	15.1	8.1
Neighborhood safety, % ^a	8.0	15.6	12.5	3.4	9.2	4.2
Maternal risk factors						
Wt, kg, mean (SE) ^a	72.2 (0.44)	78.76 (1.15)	71.10 (0.85)	60.46 (0.63)	76.02 (2.2)	71.30 (0.55)
Smoking during pregnancy, % ^a	9.1	6.7	4.4	0.7	19.4	13.0
Infant risk factors						
Never breastfed, % ^a	29.2	46.6	23.8	16.3	28.4	27.3
Early introduction of solid foods, % ^a	23.7	29.8	21.2	7.5	28.6	23.9
Wt gain, mean (SE) ^{a,b}	0.57 (0.01)	0.61 (0.01)	0.59 (0.01)	0.56 (0.01)	0.64 (0.02)	0.57 (0.01)
Early childhood risk factors ^c						
Television viewing >2 h per d, % ^a	35.6	50.6	44.8	29.4	41.6	27.5
Physical inactivity, % ^a	56.1	60.4	56.8	67.8	50.8	54.1
SSB consumption, % ^a	30.1	41.4	35.7	21.7	33.5	25.0
Fruit and vegetable consumption <1 per d, %	18.5	20.3	16.8	16.5	19.8	19.0
Family meals <4 per wk (%) ^a	16.1	24.6	20.2	16.9	16.8	11.9
Nonparental child care, % ^a	80.2	84.0	73.2	84.8	79.3	82.0
BMI z score, mean (SE)						
Boys						
2 y (2003–2004) ^a	0.52 (0.05)	0.58 (0.12)	0.66 (0.11)	0.28 (0.12)	0.73 (0.25)	0.44 (0.07)
Preschool (2005–2006) ^a	0.67 (0.03)	0.65 (0.09)	0.86 (0.07)	0.44 (0.10)	1.04 (0.15)	0.59 (0.04)
Kindergarten (2006) ^a	0.69 (0.03)	0.75 (0.07)	0.93 (0.07)	0.48 (0.11)	0.93 (0.09)	0.58 (0.04)
Girls						
2 y (2003–2004)	0.34 (0.06)	0.30 (0.15)	0.43 (0.16)	0.30 (0.11)	0.62 (0.15)	0.30 (0.08)
Preschool (2005–06) ^a	0.66 (0.03)	0.70 (0.07)	0.79 (0.06)	0.38 (0.09)	1.00 (0.11)	0.60 (0.04)
Kindergarten (2006) ^a	0.68 (0.03)	0.76 (0.07)	0.78 (0.06)	0.34 (0.10)	1.04 (0.11)	0.61 (0.04)
Overweight and/or obesity, %						
Boys						
2 y (2003–2004)	17.5	17.3	20.1	12.2	27.3	16.3
Preschool (2005–2006) ^a	33.6	37.2	39.9	24.5	47.0	29.7
Kindergarten (2006) ^a	34.8	41.0	43.7	29.4	42.8	29.0
Girls						
2 y (2003–2004)	16.7	16.4	17.0	14.0	22.2	16.5
Preschool (2005–2006) ^a	34.8	36.8	42.6	28.7	47.1	30.9
Kindergarten (2006) ^a	35.1	39.9	39.9	29.6	49.2	31.5

^a P value for the difference across races is <.01.

^b Nine-mo rate of infant wt gain (kg) is wt at 9 mo birth wt over age in mo at the first wave of data collection (~9 mo).

^c Measured at wave 3 of data collection.

American boys to 104% among white versus Hispanic girls (Supplemental Materials). A contribution of >100% means that Hispanic girls would be even better off than white girls if their SES could be adjusted to levels found among white girls.

Maternal and early childhood risk factors played negligible roles in explaining racial and/or ethnic

disparities in BMI z scores. For example, maternal risk factors accounted for <20% of the explained gaps between white children and children of other racial and/or ethnic groups, except between white and Asian children, in which they played a more substantial role. On the other hand, the contribution of early childhood risk factors was more

evident between white and Hispanic girls.

DISCUSSION

We examined the distributions of early childhood obesity risk factors by race and/or ethnicity and the extent to which they explained disparities in BMI z scores at

TABLE 2 Adjusted Estimates of Associations Between Sociodemographic and/or Obesity Risk Factors and BMI z Scores at Kindergarten Entry by Child Race and/or Ethnicity, Boys and Girls: ECLS-B

Characteristic	Boys					Girls				
	African American, β (SE) ^a	Hispanic, β (SE)	Asian, β (SE)	American Indian, β (SE)	White, β (SE)	African American, β (SE) ^a	Hispanic, β (SE)	Asian, β (SE)	American Indian, β (SE)	White, β (SE)
Age, mo	.09 (0.03) ^b	.07 (0.03) ^b	.01 (0.03)	.00 (0.06)	.07 (0.02) ^c	.03 (0.03)	.02 (0.03)	.14 (0.03) ^c	.03 (0.05)	.03 (0.02)
Household SES, quintile										
First	-.27 (0.25)	.37 (0.27)	.52 (0.26) ^b	-.10 (0.43)	.14 (0.17)	.17 (0.22)	.34 (0.25)	.30 (0.29)	-.45 (0.35)	-.04 (0.17)
Second	-.19 (0.24)	.17 (0.27)	.78 (0.23) ^c	-.144 (0.39) ^c	-.03 (0.13)	.17 (0.22)	.08 (0.25)	-.68 (0.21) ^c	.09 (0.36)	.17 (0.12)
Third	-.20 (0.24)	-.03 (0.28)	.11 (0.18)	-.75 (0.40)	.28 (0.11) ^b	-.05 (0.21)	.14 (0.26)	-.04 (0.22)	-1.00 (0.36)	.11 (0.10)
Fourth	-.08 (0.26)	.19 (0.29)	.06 (0.16)	.08 (0.44)	.05 (0.10)	.28 (0.23)	.59 (0.27) ^b	.07 (0.15)	-.08 (0.35)	-.15 (0.09)
Fifth	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Household food insecurity	.05 (0.16)	-.27 (0.15)	-.40 (0.22)	.15 (0.32)	.04 (0.14)	-.30 (0.16)	.07 (0.18)	.58 (0.25) ^b	.07 (0.17)	.23 (0.13)
Neighborhood safety	.09 (0.14)	.20 (0.16)	.66 (0.36)	.71 (0.46)	-.01 (0.21)	-.05 (0.17)	.02 (0.21)	.09 (0.27)	-.22 (0.39)	.43 (0.17) ^b
Maternal risk factors										
Wt, kg (SE)	.01 (0.00) ^c	.02 (0.00) ^c	.01 (0.00) ^b	.00 (0.01)	.01 (0.00) ^c	.01 (0.00) ^c	.01 (0.00) ^d	.00 (0.00)	.01 (0.00) ^c	.01 (0.00) ^c
Smoking during pregnancy	.03 (0.27)	-.03 (0.27)	.38 (0.67)	-.12 (0.30)	-.01 (0.12)	.06 (0.22)	.51 (0.39)	.37 (0.70)	-.44 (0.23) ^b	.01 (0.11)
Early life risk factors										
Never breastfed	.04 (0.12)	-.04 (0.13)	-.46 (0.16) ^b	-.28 (0.25)	.11 (0.09)	-.04 (0.12)	.26 (0.14)	-.14 (0.18)	.35 (0.18) ^b	.17 (0.08) ^b
Early introduction of solid foods	.37 (0.13) ^c	.19 (0.14)	.38 (0.22)	.47 (0.21) ^b	.11 (0.09)	.12 (0.13)	-.11 (0.18)	-.07 (0.25)	.54 (0.20) ^b	.10 (0.09)
Wt gain	2.70 (0.43) ^c	2.11 (0.40) ^c	1.31 (0.46) ^c	.61 (0.86)	2.11 (0.29) ^c	2.13 (0.38) ^c	1.73 (0.43) ^c	2.44 (0.47) ^c	2.28 (0.73) ^c	1.23 (0.20) ^c
Early childhood risk factors ^d										
Television viewing >2 h per d	.00 (0.13)	.19 (0.12)	-.12 (0.13)	.64 (0.25) ^b	-.03 (0.08)	-.08 (0.12)	-.06 (0.12)	-.12 (0.14)	.28 (0.19)	-.11 (0.08)
Physical inactivity	.10 (0.12)	-.22 (0.12)	-.13 (0.17)	-.21 (0.18)	-.10 (0.07)	.17 (0.12)	-.13 (0.12)	.01 (0.13)	-.13 (0.15)	-.11 (0.07)
SSB consumption	.01 (0.12)	.02 (0.12)	.16 (0.15)	-.52 (0.24) ^b	.08 (0.09)	.18 (0.12)	.02 (0.13)	.09 (0.17)	-.45 (0.17) ^b	-.12 (0.08)
Nonparental child care	.26 (0.13)	.01 (0.14)	.13 (0.17)	-.08 (0.30)	.03 (0.10)	.33 (0.17) ^b	.24 (0.13)	-.16 (0.19)	.21 (0.23)	.11 (0.09)
Fruit and vegetable consumption	.05 (0.13)	-.10 (0.14)	.11 (0.16)	.19 (0.23)	-.09 (0.09)	.02 (0.16)	-.34 (0.16)	.14 (0.15)	-.48 (0.24) ^b	-.20 (0.09) ^b
Family meals <4 per wk	-.03 (0.13)	.01 (0.14)	.70 (0.17) ^c	.40 (0.39)	-.01 (0.11)	-.27 (0.13) ^b	.37 (0.16) ^b	-.19 (0.17)	.00 (0.20)	.02 (0.11)

^a SE.^b Significant at $P \leq .05$.^c Significant at $P \leq .01$.^d Measured at wave 3 of data collection (approximately age 36 mo).

TABLE 3 Decomposition Results From Blinder-Oaxaca Decomposition BMI z Score Difference Between White and Other Racial and/or Ethnic Groups for Individual Risk Factors, Boys and Girls: ECLS-B

Factor	Boys						Girls									
	African American		Hispanic		Asian		American Indian		African American		Hispanic		Asian		American Indian	
	B ^a (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI
Age	0.012 (0.01)	-0.008 0.032	-0.007 (0.01)	-0.027 0.012	0.005 (0.01)	-0.016 0.025	-0.018 (0.02)	-0.050 0.015	0.006 (0.01)	-0.008 0.021	0.021 (0.01)	-0.010 0.014	-0.001 (0.01)	-0.017 0.014	0.001 (0.01)	-0.017 0.019
Socioeconomic factors																
SES	-0.004 (0.03)	-0.070 0.063	-0.00296 (0.01)	-0.150 0.002	0.016 (0.01)	-0.010 0.043	-0.037 (0.04)	-0.116 0.043	-0.053 (0.04)	-0.123 0.017	0.017 (0.04)	-0.130 0.019	0.016 (0.01)	-0.012 0.044	-0.060 (0.04)	-0.143 0.022
Household food insecurity	-0.001 (0.01)	-0.019 0.018	0.016 (0.01)	-0.014 0.045	0.000 (0.00)	-0.002 0.002	0.001 (0.01)	-0.021 0.023	-0.008 (0.01)	-0.029 0.012	0.012 (0.01)	-0.023 0.005	0.004 (0.01)	-0.009 0.018	-0.028 (0.02)	-0.070 0.013
Neighborhood safety	-0.006 (0.02)	-0.043 0.032	-0.021 (0.02)	-0.056 0.014	0.000 (0.00)	-0.004 0.004	0.000 (0.00)	-0.001 0.001	-0.016 (0.01)	-0.039 0.008	0.008 (0.01)	-0.023 0.012	-0.004 (0.01)	-0.016 0.009	-0.003 (0.00)	-0.013 0.006
Maternal risk factors																
Wt, kg (SE)	-0.016 (0.01)	-0.035 0.004	0.002 (0.01)	-0.008 0.013	0.022 (0.01)	-0.005 0.049	0.012 (0.01)	-0.015 0.038	-0.015 (0.01)	-0.034 0.004	0.004 (0.00)	-0.006 0.012	0.018 (0.01)	-0.008 0.045	-0.008 (0.01)	-0.029 0.014
Smoking during pregnancy	0.008 (0.01)	-0.013 0.030	-0.001 (0.01)	-0.023 0.022	0.003 (0.02)	-0.050 0.037	-0.002 (0.01)	-0.013 0.010	0.001 (0.01)	-0.016 0.018	0.018 (0.02)	-0.021 0.038	0.002 (0.02)	-0.032 0.037	0.000 (0.00)	-0.005 0.005
Early life risk factors																
Never breastfed	-0.017 (0.01)	-0.044 0.010	0.002 (0.00)	-0.005 0.009	0.006 (0.01)	-0.013 0.024	-0.006 (0.01)	-0.023 0.011	-0.011 (0.02)	-0.045 0.023	0.023 (0.01)	-0.006 0.019	0.009 (0.01)	-0.011 0.028	-0.001 (0.01)	-0.014 0.011
Early introduction of solid foods	0.000 (0.01)	-0.010 0.010	0.007 (0.01)	-0.006 0.02	0.024 (0.02)	-0.014 0.063	-0.006 (0.01)	-0.025 0.013	-0.008 (0.01)	-0.026 0.009	0.009 (0.00)	-0.004 0.006	0.010 (0.01)	-0.014 0.035	-0.004 (0.01)	-0.017 0.010
Wt gain	-0.079*** (0.03)	-0.131 -0.028	-0.030 (0.02)	-0.074 0.014	0.011 (0.02)	-0.031 0.054	-0.026 (0.04)	-0.098 0.045	-0.060*** (0.02)	-0.106 -0.015	-0.0003 -0.075	0.001 (0.02)	-0.024 0.044	-0.096*** (0.03)	-0.163 -0.028	
Early childhood risk factors																
TV viewing >2 h per d	0.003 (0.02)	-0.032 0.038	-0.007 (0.01)	-0.029 0.015	0.001 (0.01)	-0.010 0.011	0.000 (0.01)	-0.013 0.014	0.002 (0.02)	-0.035 0.039	0.039 (0.01)	-0.022 0.033	0.000 (0.00)	-0.003 0.003	-0.001 (0.02)	-0.043 0.041
Physical inactivity	-0.002 (0.01)	-0.013 0.009	0.000 (0.00)	-0.006 0.007	0.004 (0.01)	-0.009 0.018	-0.003 (0.01)	-0.019 0.013	0.002 (0.00)	-0.005 0.010	0.010 (0.01)	-0.005 0.017	0.014 (0.01)	-0.014 0.042	0.001 (0.01)	-0.010 0.011
SSB consumption	-0.012 (0.01)	-0.038 0.013	-0.007 (0.01)	-0.024 0.009	-0.002 (0.01)	-0.012 0.009	0.002 (0.00)	-0.006 0.011	0.011 (0.01)	-0.014 0.035	0.035 (0.01)	-0.008 0.024	-0.008 (0.01)	-0.024 0.009	0.024 (0.02)	-0.011 0.059
Nonparental child care	0.001 (0.00)	-0.004 0.006	0.002 (0.01)	-0.009 0.013	0.000 (0.00)	-0.003 0.003	-0.001 (0.00)	-0.005 0.004	-0.009 (0.01)	-0.022 0.005	0.005* (0.01)	0.000 0.046	-0.005 (0.01)	-0.018 0.008	0.007 (0.01)	-0.015 0.029
Fruit and vegetable consumption	0.002 (0.00)	-0.005 0.010	-0.003 (0.00)	-0.011 0.005	-0.004 (0.01)	-0.015 0.007	0.002 (0.01)	-0.008 0.013	-0.001 (0.00)	-0.009 0.006	0.006 (0.01)	-0.013 0.008	-0.001 (0.01)	-0.01 0.008	-0.009 (0.01)	-0.025 0.008
Family meals <4 per wk	-0.004 (0.01)	-0.029 0.021	-0.008 (0.01)	-0.028 0.011	-0.014 (0.01)	-0.040 0.013	-0.003 (0.01)	-0.016 0.010	0.014 (0.01)	-0.010 0.038	0.038 (0.01)	-0.022 0.007	0.002 (0.00)	-0.007 0.01	0.001 (0.01)	-0.011 0.013
Total explained gap	-0.113** (0.06)	-0.225 -0.000	-0.129 (0.05)	-0.234 -0.025	0.073* (0.04)	-0.010 0.157	-0.085 (0.05)	-0.191 0.022	-0.146*** (0.05)	-0.235 -0.057	-0.057 -0.145	0.038 (0.05)	-0.145 0.038	0.067* -0.007	0.14 -0.176***	-0.288 -0.064 (0.06)

TABLE 3 Continued

Factor	Boys						Girls											
	African American		Hispanic		Asian		American Indian		African American		Hispanic		Asian		American Indian			
	B ^a (SE)	95% CI	95% CI	B (SE)	95% CI	95% CI	B (SE)	95% CI	95% CI	B (SE)	95% CI	95% CI	B (SE)	95% CI	95% CI	B (SE)	95% CI	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Total unexplained gap	-0.063 (0.09)	-0.238 (0.112)	0.112 (-0.231)**	-0.406 (0.09)	-0.054 (-0.105)	0.060 (0.105)	-0.137 (0.119)	-0.371 (0.119)	0.097 (0.119)	0.011 (0.086)	-0.0869 (0.08)	-0.245 (0.08)	0.071 (0.09)	0.204** (0.09)	0.030 (0.09)	0.379 (0.11)	-0.231** (-0.449)	-0.012 (-0.187)
Total predicted gap	-0.176** (0.08)	-0.330 (-0.021)	-0.350** (-0.514)	-0.206 (0.08)	-0.206 (-0.11)	0.133 (0.11)	-0.222* (-0.121)	-0.459 (0.121)	0.016 (0.121)	-0.135* (-0.078)	-0.140* (-0.078)	-0.289 (0.08)	0.009 (0.08)	0.271*** (0.09)	0.094 (0.09)	0.448 (0.11)	-0.407** (-0.627)	-0.187 (-0.11)

The average contribution of risk factors to the explained portion of the gaps in BMI z scores between white and other race and/or ethnicity boys and girls. For example, differences in infant weight gain between white and African American boys accounted for 70.5% (-0.079 of -0.113) of the explained gap in BMI z scores between the 2 groups. CI, confidence interval.

^a Contribution to explained gap.
 *** $P < .01$; ** $P < .05$; * $P < .10$.

kindergarten entry. We found that other than among Hispanic children, the rate of infant weight gain in the first 9 months of life had the most substantial contribution to explained racial and/or ethnic disparities in early childhood obesity. This finding reflects the fact that infant weight gain was the strongest predictor of children’s BMI z scores at kindergarten entry and also varied significantly by race and/or ethnicity. Rapid infant weight gain has been previously shown to be associated with childhood obesity^{26,27} and is thought to be 1 of the primary determinants in the first year of life of later-onset obesity.²⁸ Infant weight gain is also known to differ by race and/or ethnicity.⁸ Racial and/or ethnic differences in feeding and child-rearing practices²⁹ could contribute to observed differences. For example, Ejlerskov et al²⁷ reported that the impact of infant weight gain on later obesity is attenuated by longer breastfeeding duration. This could mean that racial and/or ethnic groups with historically lower rates of breastfeeding^{8,30} might not benefit from its protective effect against obesity.

Besides infant weight gain, socioeconomic factors (predominantly SES) were also significant contributors to explained disparities, particularly among Hispanic children. Hispanic children were noted to have a high prevalence of obesity risk factors, but in models that adjusted for socioeconomic factors, their risk factor profile was 1 of the best of all racial and/or ethnic groups and as favorable as that of Asian children. There are well-documented racial and/or ethnic differences in SES,³¹ and household SES is known to be associated with childhood obesity.³² However, because patterns of association between SES and obesity are complex and vary by race and/or ethnicity, age, sex, and over time,³³ researchers

have suggested that interventions should not focus solely on eliminating income disparities but also address other contributory factors.³³ Neighborhood SES and certain features of the built environment are some potential contributory contextual factors³⁴ that could be considered, along with important individual-level factors.

An unexpected finding in this study was that some known behavioral obesity risk factors (eg, fruit and vegetable consumption and television viewing) played a relatively minor role in explaining racial and/or ethnic differences in children’s BMI z scores after accounting for other factors. In our study, these risk factors were not significant predictors of BMI z scores at kindergarten entry except among white girls and American Indian children. Guerrero et al¹² also documented that television viewing and fruit and vegetable consumption were not predictive of BMI growth for any racial and/or ethnic group. In previous studies, maternal, infancy, and early childhood risk factors collectively fully explained racial and/or ethnic differences in preschool-aged children’s weight status.^{9,10,12} There were no African American–white differences in US preschool-aged children’s weight status after adjusting for prenatal, perinatal, and early life risk and protective factors.⁹ Taber et al²¹ assessed the sources of disparities in adolescent obesity prevalence and found that measured behavioral and environmental factors only accounted for 46.8% of the racial prevalence disparities. Important factors contributing to differences between African American and white girls were more screen time, less fruit and vegetable access at home, less sports participation, and greater probability of obtaining school lunch versus lunch from home. In our study, we found that for most racial and/or ethnic groups, maternal and early childhood risk factors played a

less important role compared with factors in early infancy. In addition, covariates that contributed to explained disparities differed by race and/or ethnicity. For example, the same factors that accounted for 64% of the explained disparities between white and African American boys only accounted for 36% of explained disparities between white and Hispanic boys.

Our study has some limitations. Although the decomposition technique can explore potential mechanisms in more detailed ways than can traditional regression methods, we cannot conclusively attribute causality to the obesity risk factors examined in this study. Although we accounted for a wide array of confounders and risk factors, there is still potential for residual confounding or model misspecification. In addition, the measurement of behavioral risk factors was based on parents' reports, and therefore could have been subject to misreporting or measurement error. This could have resulted in biased estimates that may not fully represent the degree to which these risk factors contribute to explained gaps. Results may also vary depending on how SES is measured. For this reason, it has been recommended that researchers should assess the robustness of their findings by using multiple SES measures.³⁵ To minimize this limitation, we used a composite variable for our SES measure that comprised information on both parents' educational attainment, occupation, and household income. Our study sample excluded children who were born with low birth weight because their growth trajectories are typically different from normal birth weight children. We also limited our

analytic sample to children of only 5 racial and/or ethnic groups. As part of the decomposition analysis, we relied on a complete case analysis to ensure that each decomposition model included the same sample of children. This resulted in children with missing values on any independent variable being excluded. The degree of missing data could impact the generalizability of our findings and result in biased estimates or a failure to detect a significant effect. The ECLS-B study was conducted on US children born in 2001 and followed for 6 years (through 2007), and therefore, our findings need to be replicated with more recent data. In spite of these limitations, we believe our findings make an important contribution to the field by highlighting the extent to which infancy weight gain contributes to racial and/or ethnic disparities in early childhood obesity. The study provides a more nuanced picture of the role that various groups of obesity risk factors play in explaining racial and/or ethnic disparities in US preschool-aged children's weight status.

Our study has 3 important public health implications. First, if the association between infant weight gain and obesity is causal, then interventions that target determinants of rapid infant weight gain could lead to substantial reductions in observed racial and/or ethnic disparities in childhood obesity. Short breastfeeding duration, formula feeding, and feeding to schedule are some modifiable exposures that have been linked to rapid infant weight gain^{36,37} and can be effective policy or intervention targets. Tailored interventions implemented at birth or in early infancy, such

as home visits, group visits, or in-home-based interventions that educate parents on responsive parenting and optimal infant feeding practices, are promising prevention approaches.³⁸⁻⁴⁰ Second, given that the relative importance of risk factors differed across groups, efforts should be tailored to address the unique contributory risk factors for specific racial and/or ethnic groups. Finally, our findings indicate that policies and programs that target household socioeconomic disadvantage in addition to key contributory factors might be beneficial in preventing early childhood obesity, particularly among Hispanic children. Interventions implemented early in the life course that target these important contributory risk factors may help reduce the magnitude of racial and/or ethnic disparities in early childhood obesity.

CONCLUSIONS

Differences in rapid infant weight gain contribute substantially to racial and/or ethnic disparities in obesity during early childhood. Interventions implemented early in life to target this risk factor could help curb widening racial and/or ethnic disparities in early childhood obesity.

ABBREVIATIONS

ECLS-B: Early Childhood Longitudinal Study Birth Cohort
NCES: National Center for Education Statistics
OLS: ordinary least squares
PE%: percent explained
SES: socioeconomic status
SSB: sugar-sweetened beverage

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