Prenatal, Perinatal, Early Life, and Sociodemographic Factors Underlying Racial Differences in the Likelihood of High Body Mass Index in Early Childhood

Margaret M. Weden, PhD, MHS, Peter Brownell, PhD, and Michael S. Rendall, PhD

Objectives. We investigated early childhood disparities in high body mass index (BMI) between Black and White US children.

Methods. We compared differences in Black and White children's prevalence of sociodemographic, prenatal, perinatal, and early life risk and protective factors; fit logistic regression models predicting high BMI (≥95th percentile) at age 4 to 5 years to 2 nationally representative samples followed from birth; and performed separate and pooled-survey estimations of these models.

Results. After adjustment for sample design–related variables, models predicting high BMI in the 2 samples were statistically indistinguishable. In the pooled-survey models, Black children's odds of high BMI were 59% higher than White children's (odds ratio [OR] = 1.59; 95% confidence interval [CI]= 1.32, 1.92). Sociodemographic predictors reduced the racial disparity to 46% (OR = 1.46; 95% CI = 1.17, 1.81). Prenatal, perinatal, and early life predictors reduced the disparity to nonsignificance (OR = 1.18; 95% CI = 0.93, 1.49). Maternal prepregnancy obesity and short-duration or no breastfeeding were among predictors for which racial differences in children's exposures most disadvantaged Black children.

Conclusions. Racial disparities in early childhood high BMI were largely explained by potentially modifiable risk and protective factors. (*Am J Public Health.* 2012;102:2057–2067. doi:10.2105/AJPH.2012.300686)

Over recent decades, as the prevalence of high body mass index (BMI; defined as at or above the Centers for Disease Control and Prevention 95th percentile[1]) has increased dramatically among all children,[2,3] racial disparities have been documented in nationally representative samples of children at very young ages.[4–7] Reviews and prevalence studies highlight the need for a better understanding of the predictors of these disparities in BMI and other indicators of childhood obesity,[8,9] especially in early childhood.[7]

Previous research on high BMI in early childhood with racially and ethnically diverse samples has identified risk and protective factors at multiple developmental stages. In the prenatal and perinatal period, risks include higher birth weight,[10–13] maternal prepregnancy BMI,[14] and maternal smoking during pregnancy.[14,15] In infancy and early life, risks include maternal employment,[11] especially among highly educated women,[12,16] nonparent child care,[13,17,18] and television viewing hours.[12,19–21] Protective factors include breastfeeding[10,12,14] and family meals.[12,21,22]

Studies have shown that young racial/ethnic minority children are exposed to more of these risks and fewer of these protections.[23,24] Nevertheless, in analyses of nationally representative samples, high BMI remains more common among Black than White children even after adjusting for sociodemographic characteristics and risk and protective factors.[6,11,12,14,16] We suspect that the persistence of racial disparities in these studies might be attributable to omitted predictors or less detailed measurement of the age and duration of children's exposures. This type of comprehensive assessment is methodologically challenging because of the number of variables and observations required to draw statistically valid inferences.

We employed a novel 2-survey methodological design to overcome these challenges. We used data from 2 nationally representative samples of US children followed from birth to age 4 to 5 years in separate and pooled-survey analyses to identify prenatal, perinatal, early life, and sociodemographic factors that may explain Black–White disparities in early childhood high BMI. The separate analyses in 2 surveys that cover a historical period of more than 10 years increased the robustness of our findings to differences in sample design, measurement protocols, and period variability in unobserved confounders. The pooled-survey analyses enhanced the statistical power of our study and thereby strengthened our conclusions about which factors explain Black–White disparities in early childhood high BMI.

METHODS

Data came from the Early Childhood Longitudinal Study 2001 birth cohort (ECLS-B) and the Children and Young Adults of the National Longitudinal Survey of Youth 1979 cohort (NLSY79-CYA). The ECLS-B was directed by the National Center for Education Statistics to assess US children's early learning environments, health, and development. It followed a nationally representative cohort of children born in the United States in 2001 in waves at 9 months, 2 years, 4 years, and upon entry into kindergarten (fall 2006 or 2007).[25] The ECLS-B conducted computer-assisted, in-home interviews with mothers (or for ~5% of children, fathers or other guardians) and assessments of children.

NLSY79-CYA children are offspring of the NLSY79, which is a nationally representative probability sample of youths aged 14 to 21 years in 1979, which oversampled racial/ethnic minorities and economically disadvantaged youths.[26] Participants in the NLSY79 were followed annually through 1994 and biennially thereafter. Biennial follow-up of children of NLSY79 women began in 1986 and is ongoing.[27] The NLSY79-CYA conducted in-home interviews with mothers and assessments of children. Since 1992, the

NLSY79-CYA has included all variables required for our study.

Measures

Early childhood high BMI (BMI defined as weight in kilograms divided by the square of height in meters), our study's outcome variable, was defined as BMI at or above the Centers for Disease Control and Prevention's 95th percentile.[1] We determined BMI percentiles and biologically implausible values with Centers for Disease Control and Prevention growth charts and guidelines.[28] All ECLS-B sample counts were rounded to the nearest 50 to comply with National Center for Education Statistics confidentiality requirements. In the ECLS-B, we employed height and weight measured in the fall of kindergarten. In the NLSY79-CYA, height and weight came from the wave when the child was either 4 or 5 years old. If NLSY79-CYA children were observed in 2 waves in the age range 4 to 5 years, we randomly selected one of these waves. The NLSY79-CYA measured 70% of the sample's height and weight. Among the remaining 30%, mothers self-selected into reporting either height or weight or both. To maximize NLSY79-CYA sample size and avoid any biases from selection into the sample of children with measured height and weight, we included children from both groups. In analyses not reported here, we found no substantive differences in our findings when we restricted the sample to children with measured data.

We constructed 5 sets of predictor variables (Table 1). The first set consisted exclusively of race, according to census categories for non-Hispanic Black and non-Hispanic White.[30] The second set comprised survey sample control variables to account for differences in the sampling designs of the ECLS-B and NLSY79-CYA: year of child's BMI assessment, mother's age at child's birth, and child's birth order. The latter 2 variables addressed our need to exclude NLSY79-CYA children aged 4 to 5 years prior to 1992 when all study variables first became available. Excluded children had younger mothers and lower birth orders. The third set comprised sociodemographic variables: mother's education (at child's birth), family or household income (at age 4 years), mother's marital status history (at child's age 0, 2, and 4 years), and gender. The fourth set comprised prenatal and perinatal variables, all of which are risk factors: mother's prepregnancy overweight and obesity, mother's cigarette smoking during pregnancy, and high birth weight. We also controlled for confounding associated with low birth weight and preterm birth. The fifth set comprised early life environment variables. Protective factors were breastfeeding duration and family meals or dinner (at age 2 and 4 years). Risk factors were television viewing hours (at age 4 years), and both maternal employment and nonparent child care settings (in the child's first year). Appendix 1 (available as a supplement to the online version of this article at http://www.ajph.org) describes how we achieved comparable operational definitions in each survey and provides the prevalence of item nonresponse.

Analytical Samples

We conducted complete case analyses[31] of Black and White non-Hispanic children from the ECLS-B and NLSY79-CYA observed at all survey waves prior to and including age 4 to 5 years. These samples were designed to be representative, respectively, of the 2001 US birth cohort and of children born between 1986 and 2001 to US women aged 14 to 21 years in 1979.

The ECLS-B completion rate for the first survey wave (at 9 months) was 77%.[25] Among White and Black children who completed this wave and whom the National Center for Education Statistics considered eligible for assessment in kindergarten (n = 4450), 93% were observed at all study waves (n = 4150). We excluded from this sample 20% who had missing data on at least 1 study variable; missing data frequency was less than 10% for all variables except television viewing (15%). After also excluding respondents with biologically implausible values (n = 50), our final analytical sample comprised 3300 children.

Retention rates for NLSY79 mothers remained above 90% through 1994, and in subsequent biennial waves were between 80% and 90%.[26] Completion rates for children of the NLSY79 mothers varied from a low of 90% in 1998 to a high of 99% in 2006.[27] Among the White and Black NLSY79-CYA children who reached age 4 or 5 years in or after 1992 (n = 3106), 89% were observed at age 4 or 5 years and all previous waves (n = 2779). We excluded from this sample 43% who had missing data on at least 1 study variable; missing data frequency was above 10% for family income (14%), birth weight (12%), preterm birth (11%), and breastfeeding (11%). After also excluding respondents with biologically implausible values (n = 58), our final analytical sample comprised 1515 children.

The relatively large sample loss was similar to that in a previous study of NLSY79-CYA data.[14] To assess any biases that could result, we tested (with Pearson χ^2 statistics) for differences in the outcome and predictor variables between the excluded sample (n = 1591) and included (study) sample (n = 1515). We also conducted sensitivity analyses in which we included in the regression samples children with biologically implausible values in the NLSY79-CYA sample. A smaller proportion of children in the study sample than in the excluded sample were Black (an unweighted 30% of study sample vs 36% of excluded children). Because the excluded children had biologically implausible values or missing values on any predictor variables, the study sample had a smaller proportion of children who had high BMI than did the excluded sample (an unweighted 14% of the study sample vs 18% of excluded children). Including observations with biologically implausible values in the NLSY79-CYA regressions resulted in the Black coefficient becoming a statistically significant predictor of high BMI in models 1 through 4, but still nonsignificant in our final model (model 5), which incorporated all predictors.

Data Analysis

We first calculated the weighted distributions of high BMI and the predictor variables for White and Black children in the ECLS-B and NSLY79-CYA, with sample weights supplied by the data producers. We tested for Black–White differences in these distributions with Pearson χ^2 statistics, adjusting for the clustering of children in families. We then estimated a series of 5 unweighted logistic regression models in which the 5 sets of predictor variables were added sequentially in models 1 through 5. We estimated regression models with a generalized estimating equation estimators to adjust for clustering of children in

TABLE 1—Exposure to Risk and Protective Factors for High Body Mass Index in Early Childhood Among Non-Hispanic Whites and Black Children Observed From Birth to Age 4 or 5 Years: Early Childhood Longitudinal Study 2001 and Children and Young Adults of the National Longitudinal Survey of Youth 1979 Cohort, United States

	ECLS-B				NLSY79-CYA			
Variable	White (n = 2400), % or Mean	Black (n = 900), % or Mean	Total (n = 3300), % or Mean	P[a]	White (n = 1068), % or Mean	Black (n = 447), % or Mean	Total (n = 1515), % or Mean	P[a]
Outcome variable								
High BMI at age 4–5 y				<.001				.053
Yes	12.1	19.0	13.4		12.9	16.9	13.4	
No	87.9	81.0	86.6		87.1	83.1	86.6	
Survey sample control variables								
Year of observation	2006.3	2006.3	2006.3	.246	1996.3	1995.8	1996.3	.029
Birth order (mean)	1.9	2.2	2.0	<.001	2.0	2.6	2.1	<.001
Mother's age at child's birth, y				<.001				<.001
≤ 24	29.9	51.0	34.0		5.6	10.5	6.2	
25–29	27.7	23.1	26.8		41.4	48.8	42.2	
30–34	28.2	16.4	25.9		38.5	27.0	37.1	
≥ 35	14.2	9.5	13.3		14.5	13.7	14.4	
Sociodemographic variables								
Mother's education at child's birth, y				<.001				<.001
< 12	9.5	25.0	12.5		4.4	14.3	5.6	
12	29.5	42.1	32.0		37.1	37.7	37.1	
13–15	24.9	20.8	24.1		23.6	35.1	24.9	
≥ 16	36.1	12.1	31.4		35.0	12.9	32.4	
Family/household income when child was aged 4 y,[b] $				<.001				<.001
< 25 000	23.5	61.2	30.9		12.6	46.6	16.6	
25 000–49 999	21.5	19.8	21.1		26.0	25.7	26.0	
50 000–74 999	18.2	8.1	16.2		29.8	14.0	27.9	
≥ 75 000	36.8	11.0	31.7		31.6	13.8	29.5	
Mother's marital status				<.001				<.001
Unmarried when child was aged 0, 2, or 4 y	27.5	75.6	36.9		16.7	62.3	22.1	
Married when child was aged 0, 2, and 4 y	72.5	24.4	63.1		83.3	37.7	77.9	
Gender of child				.686				.553
Male	49.2	50.2	49.4		51.6	53.6	51.9	
Female	50.8	49.8	50.6		48.4	46.4	48.1	
Prenatal and perinatal variables								
Mother's cigarette smoking during pregnancy, packs/d				.784				.83
None or < 1	98.4	98.6	98.5		93.4	93.8	93.5	
≥ 1	1.6	1.4	1.5		6.6	6.2	6.5	
Mother's prepregnancy BMI				<.001				<.001
Normal (< 25 kg/m^2)	62.2	53.2	60.4		70.1	54.5	68.2	
Overweight (25–29.9 kg/m^2)	24.7	22.7	24.4		17.4	28.6	18.7	
Obese (≥ 30 kg/m^2)	13.1	24.1	15.2		12.5	16.8	13.0	
Birth weight, g				<.001				.001
Low (< 2500)	6.4	12.6	7.6		7.2	13.8	8.0	
Normal (2500–4000)	82.2	83.2	82.4		77.7	76.1	77.5	
High (> 4000)	11.3	4.1	9.9		15.1	10.1	14.5	

Continued

TABLE 1—*Continued*

Preterm birth, wk gestation				<.001				.096
≥ 37	90.2	84.1	89.0		87.2	83.6	86.8	
< 37	9.8	15.9	11.0		12.8	16.4	13.2	
Early life environment variables								
Breastfeeding duration, mo				<.001				<.001
None or < 1	28.2	52.4	32.9		33.3	68.4	37.4	
1–7	51.6	40.0	49.3		15.5	13.1	15.3	
≥ 8	20.2	7.7	17.8		51.2	18.5	47.3	
Family meals or dinner, d/wk				<.001				<.001
< 7 at age 2 or 4 y	59.2	68.7	61.1		45.2	70.6	48.2	
7 at age 2 and 4 y	40.8	31.3	38.9		54.8	29.4	51.8	
Weekday TV viewing at age 4 y, h				<.001				<.001
≤ 4	88.9	72.1	85.6		74.8	51.2	72.0	
> 4	11.1	27.9	14.4		25.2	48.8	28.0	
Mother's employment status in child's first year				<.001				<.001
Unemployed/out of labor force	43.3	38.3	42.3		41.2	47.2	41.9	
Part-time (< 35 h/wk)	24.4	17.0	22.9		22.5	6.4	20.6	
Full-time (≥ 35 h/wk)	32.3	44.8	34.8		36.3	46.4	37.5	
Child care in child's first year				<.001				.015
No nonparent care	50.4	33.4	47.1		52.1	50.2	51.9	
Relative care	21.3	34.6	23.9		18.6	22.2	19.0	
Nonrelative care	18.4	16.4	18.0		21.6	15.5	20.9	
Center care	8.9	14.1	9.9		7.5	11.4	8.0	
Other	1.0	1.5	1.1		0.2	0.6	0.2	

Note. BMI = body mass index; ECLS-B = Early Childhood Longitudinal Study, 2001 Birth Cohort; NLSY79-CYA = Children and Young Adults of the National Longitudinal Survey of Youth, 1979 cohort. High BMI was defined as BMI at or above the 95th percentile according to Centers for Disease Control and Prevention age- and gender-adjusted references.[1] All values are weighted percentages of the group, with the exception of mean year of survey and mean birth order. Standard errors adjusted for clustering of children within families. Unweighted sample sizes for the ECLS-B were rounded to comply with National Center for Education Statistics confidentiality requirements.
[a]Pearson χ^2 statistics for racial difference.
[b]Inflation adjusted to year 2000 dollars according to the Consumer Price Index.[29]

families.[32] For all analyses, we employed Stata version 11.[33]

We first estimated each regression model separately in the ECLS-B and NSLY79-CYA samples and then reestimated them in a sample that pooled observations across the 2 surveys. Pooled-survey estimation is conceptually similar to meta-analysis, but with the advantage of accounting for the full covariance structure of the data.[34-35] A critical step in the pooled-survey approach was assessing whether the associations between the covariates and high BMI differed between the 2 surveys. We used as a model fit statistic the quasi-likelihood under the independence model criterion (QIC)[32] to test for model improvement when adding a full set of interactions of the survey indicator with the covariates. The QIC is a modified Akaiki information criterion statistic for generalized estimating equation estimators. An improved model fit, as measured by a lower QIC when these interactions are added, would indicate no benefit from pooling observations across the 2 surveys. We also used the QIC model fit statistic to test for racial differences in the associations between the covariates and high BMI.

RESULTS

The prevalence of high BMI among non-Hispanic Black children was 19% and 17%, respectively, in the ECLS-B and NLSY79-CYA, and 12% and 13% among non-Hispanic White children (Table 1). We expected distributions of the high BMI outcome and predictor variables to differ between the ECLS-B and NLSY79-CYA because of their different sampling and measurement designs; mean year of the high BMI observation was earlier in the NLSY79-CYA than in the ECLS-B (1996 vs 2006), and mother's age and child's birth order were higher in the NLSY79-CYA. Distributions on other variables also differed between the surveys, partly as a consequence of these survey sample differences. For example, the younger age of mothers in the ECLS-B and the associations of early childbearing with economic disadvantage[36,37] may explain why income was higher in the NLSY79-CYA than ECLS-B.

We observed racial differences in the distributions of almost all predictor variables in both samples. Black children's mothers were only one third as likely as White children's mothers to have completed high school, a strong indicator of sociodemographic disadvantage. Black children were 3 to 3.5 times as likely as White children to be in a family or household whose annual income was below $25 000 (dollars inflation adjusted to 2000[30]), and their mothers were 3 to 4 times as likely to be unmarried at 1 or more assessments when the child was aged 0, 2 or 4 years. With respect to prenatal and perinatal risk factors, almost half of Black children's mothers, versus only about one third of White children's mothers, were overweight or obese before pregnancy. However, Black children were also protected by their lower likelihood of high birth weight.

Among early life protective factors, Black children were less likely than White children to be breastfed for 1 to 7 months, and only one third as likely to be breastfed for 8 months or more. Black children were also less likely than White children to have daily family meals or dinners. Regarding early life risk factors, 2 to 2.5 times as many Black as White children watched more than 4 hours of television per day during weekdays at age 4 years. Black children's mothers were more likely to be employed full time. Black children were also more likely to be cared for by relatives or in a child care center and less likely to be cared for by a nonrelative (e.g., nanny) or exclusively by their parents.

Our regression models (Tables 2 and 3) estimated the magnitude of the racial disparity in early childhood high BMI in 5 specifications, successively adding groups of risk and protective factors. The inclusion of interactions of the survey indicator with these predictor variables did not improve the fit of any of the 5 models that pooled the 2 survey samples, implying statistical equivalence of the models estimated from the ECLS-B versus the NLSY79-CYA. This is seen in the comparison of the QIC statistics (Tables 2 and 3); we had similar findings when we used likelihood ratio tests (results not shown). Similarly, including interactions between race and the predictors of high BMI did not improve model fit as assessed by a reduction in the QIC in any of the 5 single-survey or pooled-survey models (results not shown).

We focus our results presentation on the estimates from the pooled-survey models. Compared with the models estimated in either data set alone, the pooled-survey 95% confidence intervals (CIs) around the odds ratios (ORs) were narrower, allowing for stronger statistical inferences in general and about critical predictor variables (e.g., maternal overweight, breastfeeding 1–7 months, and relative child care) in particular.

From model 2, which controlled for survey sample differences between the ECLS-B and the NLSY79-CYA, we derived an estimate of the overall magnitude of the Black–White disparity in early childhood high BMI: Black children had 59% higher odds of high BMI than White children (OR = 1.59; 95% CI = 1.32, 1.92). Adding sociodemographic characteristics (model 3) reduced the odds ratio to 1.46 (95% CI = 1.17, 1.81); however, among the sociodemographic factors, only the coefficient for high BMI among children whose mothers had less than 12 years of education versus 12 years education (OR = 1.37; 95% CI = 0.99, 1.88) approached statistical significance ($P = .054$).

Adding prenatal and perinatal variables (model 4) further reduced the OR of high BMI for Black versus White children to 1.34 (95% CI = 1.07, 1.67). Maternal prepregnancy overweight (OR = 1.74; 95% CI = 1.39, 2.16) and obesity (OR = 3.24; 95% CI = 2.60, 4.03) had very large positive associations with the child's probability of high BMI. These conditions were more common among Black than White children's mothers (Table 1). High birth weight was not a statistically significant predictor. Confounding associated with low birth weight, however, significantly reduced the likelihood of high BMI. Because low birth weight was also more common among Black than White children (Table 1), it offset somewhat the risks for Black children of their mother's higher prepregnancy BMI.

Adding early life predictor variables (model 5) reduced the Black–White disparity in high BMI to a level that was no longer statistically significant (OR = 1.18; 95% CI = 0.93, 1.49). Breastfeeding for 8 months or more was associated with a 38% reduction in the odds of high BMI, and breastfeeding for 1 to 7 months was associated with a 20% reduction. Child care by relatives was marginally significant ($P = .068$) as a risk factor for high BMI (OR = 1.26; 95% CI = 0.98, 1.61). The statistical significance and substantive magnitude of these latter 2 early life risk and protective factors are notable in the context of Black children's lower prevalence and shorter duration of breastfeeding and higher prevalence of child care by relatives. Hours of television, frequency of family meals, and mother's full-time employment were not significant predictors of high BMI.

DISCUSSION

In 2 nationally representative surveys of children aged 4 to 5 years, 17% to 19% of Black children versus only 12% to 13% of White children had high BMI (at or above the Centers for Disease Control and Prevention's 95th percentile). We pooled observations across these surveys and controlled for differences in survey sample design, yielding an estimate of 59% greater odds of high BMI for Black than White children. This overall statistically significant Black–White disparity in early childhood high BMI replicates previous nationally representative findings.[4–7,11,14,16] After we adjusted for Black children's greater sociodemographic disadvantages on mother's education, marital history, and family income, the racial disparity in high BMI was reduced to 46% greater odds. Further adjustment for Black children's differential exposure to prenatal, perinatal, and early life risk and protective factors reduced the racial disparity to a statistically nonsignificant 18% greater odds of high BMI among Black than White children.

By contrast with our findings, previous studies that used nationally representative samples of young Black and White children[6,11,12,14,16] reported substantive and statistically significant Black–White disparities after adjustment for subsets of our risk and protective factors. This may be attributable to omitted predictors or less detailed measurement of the age and duration of children's exposures in those studies. In common with several of those studies and others, however, we found that maternal BMI[11,12,14,16,21] and birth weight[10–13] were again significant prenatal and perinatal predictors of high BMI. Maternal prepregnancy obesity was the strongest risk factor in our fully adjusted model. Because overweight and obesity were also most prevalent among Black children's mothers, our findings describe a troubling cycle

TABLE 2—Logistic Regressions Predicting Racial Differences in High Body Mass Index at Age 4 or 5 Years, Models 1 and 2: Early Childhood Longitudinal Study 2001 and Children and Young Adults of the National Longitudinal Survey of Youth 1979 Cohort, United States

	Model 1[a]			Model 2[b]		
	ECLS-B, OR (95% CI)	NLSY79-CYA, OR (95% CI)	Pooled, OR (95% CI)	ECLS-B, OR (95% CI)	NLSY79-CYA, OR (95% CI)	Pooled, OR (95% CI)
Race						
Non-Hispanic White (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hispanic Black	1.65*** (1.33, 2.07)	1.30 (0.96, 1.78)	1.53*** (1.27, 1.83)	1.73*** (1.37, 2.18)	1.34 (0.97, 1.84)	1.59*** (1.32, 1.92)
Survey						
ECLS-B (Ref)			1.00			1.00
NLSY79-CYA			1.11 (0.93, 1.33)			1.77* (1.07, 2.93)
Year				0.98 (0.77, 1.24)	1.06 (0.99, 1.14)	1.05 (1.00, 1.10)
Birth order				0.83*** (0.75, 0.91)	1.02 (0.89, 1.17)	0.89** (0.82, 0.97)
Mother's age at birth, y						
≤ 24				0.91 (0.69, 1.19)	1.14 (0.62, 2.09)	0.98 (0.77, 1.25)
25–29 (Ref)				1.00	1.00	1.00
30–34				0.86 (0.64, 1.17)	0.98 (0.67, 1.43)	0.94 (0.75, 1.19)
35				1.1 (0.78, 1.56)	0.76 (0.38, 1.54)	1.03 (0.75, 1.41)
Observations,[c] no.	3300	1515	4815	3300	1515	4815
QIC	2501.7	1238.7	3739.9	2495.4	1243.3	3736.2
QIC for models with survey interactions[d]			3740.4			3737.1
QIC for models with racial interactions[e]				2501.6	1250.7	3744.9

Note. BMI = body mass index; CI = confidence interval; ECLS-B = Early Childhood Longitudinal Study, 2001 Birth Cohort; NLSY79-CYA = Children and Young Adults of the National Longitudinal Survey of Youth, 1979 cohort; OR = odds ratio; QIC = quasi-likelihood under the independence model criterion. High BMI was defined as BMI at or above the 95th percentile according to Centers for Disease Control and Prevention age- and gender-adjusted references.[1] Regressions used unweighted samples.
[a]Unadjusted.
[b]Adjusted for survey sample controls.
[c]Unweighted sample sizes for the ECLS-B were rounded to comply with National Center for Education Statistics confidentiality requirements.
[d]For the pooled model (not shown) in which all coefficients were interacted with the survey indicator.
[e]For the models (not shown) in which all coefficients were interacted with the indicator for race.
*$P < .05$; **$P < .01$; ***$P < .001$.

of intergenerational transmission of racial disparities in BMI.

A unique contribution of our study was to focus on factors associated with maternal employment, which has increased substantially for young Black children in the wake of welfare reform.[38,39] Maternal employment is associated with nonparent child care,[12] duration of breastfeeding,[40–42] occurrence of family meals,[43] and children's television viewing.[12,44,45] We found that long-duration breastfeeding (≥ 8 months) was a strong early life protective factor, and that shorter-duration breastfeeding (1–7 months) had a smaller but still statistically significant benefit. This is consistent with findings from meta-analyses of an inverse dose–response relationship between breastfeeding and childhood obesity.[46,47] Our study provides new evidence from nationally representative samples supporting previous speculation that differences in breastfeeding practices by race are among the significant determinants of racial disparities in childhood obesity.[8,9,48] Together with previous cross-country comparative research,[41] this suggests that state and federal policies for paid leave and workplace support of breastfeeding are potential spheres of effective intervention for preventing high BMI and reducing racial disparities in high BMI.

We found suggestive evidence that children who are cared for by relatives are more likely to have high BMI. This is consistent with previous work in which higher BMI was not associated with center-based care, but was associated with relative care[13] and with home care outside of the child's own home.[17] Child care nutritional and physical activity standards in the United States vary by state, are voluntary, and are inconsistently practiced.[49,50] Our findings offer additional support for targeting child care environments for preventing high BMI.[50,51]

We also determined, in models depicted and in additional specifications not shown, that television viewing and family meals were significant bivariate predictors of high BMI, but that they did not significantly predict high BMI in the fully adjusted models, regardless of whether we measured them at age 2 years, at age 4 years, or at both ages. By contrast to previous studies that found statistically significant associations,[12,19–22,52–55] our models controlled for a fuller range of prekindergarten exposures. In addition, with recent exceptions,[20,21,54] most nationally

TABLE 3—Logistic Regressions Predicting Racial Differences in High Body Mass Index at Age 4 or 5 Years, Models 3–5: Early Childhood Longitudinal Study 2001 and Children and Young Adults of the National Longitudinal Survey of Youth 1979 Cohort, United States

	Model 3[a]			Model 4[b]			Model 5[c]		
	ECLS-B, OR (95% CI)	NLSY79-CYA, OR (95% CI)	Pooled, OR (95% CI)	ECLS-B, OR (95% CI)	NLSY79-CYA, OR (95% CI)	Pooled, OR (95% CI)	ECLS-B, OR (95% CI)	NLSY79-CYA, OR (95% CI)	Pooled, OR (95% CI)
Race									
Non-Hispanic White (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hispanic Black	1.54** (1.18, 2.01)	1.30 (0.89, 1.89)	1.46*** (1.17, 1.81)	1.41* (1.06, 1.86)	1.24 (0.84, 1.83)	1.34* (1.07, 1.67)	1.27 (0.95, 1.71)	1.02 (0.68, 1.54)	1.18 (0.93, 1.49)
Mother's education, y									
< 12	1.46* (1.02, 2.11)	1.20 (0.63, 2.30)	1.37 (0.99, 1.88)	1.37 (0.94, 2.00)	1.29 (0.66, 2.51)	1.35 (0.97, 1.87)	1.28 (0.82, 2.00)	1.21 (0.57, 2.57)	1.27 (0.87, 1.86)
12 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13–15	1.27 (0.84, 1.92)	1.03 (0.53, 2.02)	1.16 (0.82, 1.65)	1.19 (0.77, 1.82)	1.04 (0.52, 2.08)	1.11 (0.78, 1.59)	1.16 (0.70, 1.94)	1.02 (0.45, 2.31)	1.10 (0.72, 1.69)
≥ 16	1.01 (0.63, 1.62)	0.74 (0.36, 1.53)	0.91 (0.62, 1.34)	1.08 (0.67, 1.75)	0.82 (0.39, 1.72)	0.98 (0.66, 1.45)	0.94 (0.52, 1.71)	0.88 (0.37, 2.09)	0.91 (0.56, 1.47)
Family/household income, $									
< 25 000	0.91 (0.67, 1.25)	0.79 (0.50, 1.24)	0.88 (0.68, 1.13)	0.92 (0.66, 1.28)	0.85 (0.54, 1.34)	0.92 (0.71, 1.19)	0.95 (0.68, 1.32)	0.86 (0.53, 1.38)	0.94 (0.72, 1.23)
25 000-49 999 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
50 000–74 999	0.77 (0.54, 1.10)	1.10 (0.72, 1.66)	0.90 (0.69, 1.18)	0.88 (0.61, 1.27)	1.14 (0.75, 1.74)	1.00 (0.76, 1.31)	0.88 (0.61, 1.28)	1.10 (0.71, 1.69)	0.98 (0.74, 1.29)
≥ 75 000	0.82 (0.58, 1.17)	0.78 (0.49, 1.26)	0.82 (0.61, 1.08)	1.00 (0.69, 1.44)	0.85 (0.53, 1.37)	0.95 (0.71, 1.26)	0.96 (0.66, 1.40)	0.82 (0.51, 1.34)	0.92 (0.69, 1.24)
Mother's marital status									
Unmarried when child was aged 0, 2, or 4 y (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Married when child was aged 0, 2, and 4 y	0.81 (0.60, 1.09)	0.89 (0.58, 1.36)	0.85 (0.67, 1.08)	0.71* (0.52, 0.97)	0.83 (0.54, 1.28)	0.76* (0.59, 0.97)	0.76 (0.56, 1.05)	0.93 (0.59, 1.44)	0.81 (0.63, 1.04)
Gender									
Male (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female	1.07 (0.87, 1.32)	0.87 (0.65, 1.16)	1.00 (0.84, 1.18)	1.08 (0.87, 1.34)	0.90 (0.66, 1.22)	1.02 (0.86, 1.22)	1.10 (0.88, 1.37)	0.92 (0.68, 1.25)	1.05 (0.88, 1.25)
Mother's cigarette smoking during pregnancy, packs/d									
None or < 1 (Ref)				1.00	1.00	1.00	1.00	1.00	1.00
≥ 1				1.76 (0.84, 3.71)	0.97 (0.50, 1.88)	1.25 (0.77, 2.06)	1.72 (0.82, 3.61)	0.91 (0.46, 1.78)	1.21 (0.74, 1.99)
Mother's prepregnancy BMI									
Normal (< 25 kg/m^2; Ref)				1.00	1.00	1.00	1.00	1.00	1.00
Overweight (25–29.9 kg/m^2)				2.05*** (1.55, 2.70)	1.26 (0.86, 1.86)	1.74*** (1.39, 2.16)	2.03*** (1.53, 2.68)	1.21 (0.82, 1.79)	1.70*** (1.36, 2.12)
Obese (≥ 30 kg/m^2)				4.17*** (3.18, 5.47)	2.08*** (1.40, 3.08)	3.24*** (2.60, 4.03)	3.97*** (3.02, 5.22)	2.02*** (1.36, 2.99)	3.10*** (2.49, 3.87)
Birth weight, g									
Low (< 2500)				0.49*** (0.34, 0.71)	0.71 (0.38, 1.32)	0.53*** (0.39, 0.73)	0.48*** (0.33, 0.70)	0.69 (0.37, 1.32)	0.53*** (0.39, 0.73)
Normal (2500–4000; Ref)				1.00	1.00	1.00	1.00	1.00	1.00
High (> 4000)				1.10 (0.73, 1.65)	1.24 (0.81, 1.88)	1.22 (0.92, 1.63)	1.13 (0.75, 1.72)	1.28 (0.84, 1.96)	1.26 (0.94, 1.68)
Preterm birth, wk gestation									
≥ 37 (Ref)				1.00	1.00	1.00	1.00	1.00	1.00
< 37				0.91 (0.64, 1.30)	0.99 (0.61, 1.62)	0.92 (0.69, 1.23)	0.92 (0.64, 1.32)	0.92 (0.56, 1.51)	0.90 (0.68, 1.20)

Continued

TABLE 3—*Continued*

Breastfeeding duration, mo									
None or < 1 (Ref)							1.00	1.00	1.00
1–7							0.82 (0.64, 1.05)	0.74 (0.46, 1.18)	0.80* (0.65, 0.99)
≥ 8							0.61* (0.41, 0.90)	0.62** (0.43, 0.90)	0.62*** (0.48, 0.81)
Family meals or dinner, d/wk									
< 7 at age 2 or 4 y (Ref)							1.00	1.00	1.00
7 at age 2 and 4 y							1.13 (0.90, 1.42)	0.88 (0.65, 1.20)	1.04 (0.87, 1.26)
Weekday TV viewing at age 4 y, h									
≥ 4 (Ref)							1.00	1.00	1.00
< 4							1.04 (0.76, 1.41)	1.15 (0.82, 1.61)	1.10 (0.88, 1.38)
Mother's employment status in child's first year									
Unemployed/out of labor force (Ref)							1.00	1.00	1.00
Part-time (< 35 h/wk)							1.11 (0.79, 1.56)	0.95 (0.60, 1.49)	1.08 (0.83, 1.42)
Full-time (≥ 35 h/wk)							1.12 (0.54, 2.34)	0.97 (0.25, 3.73)	1.10 (0.59, 2.06)
(Mother employed full time)* (mother's education)									
(Full-time)*(< 12 y)							1.18 (0.52, 2.66)	1.16 (0.28, 4.86)	1.15 (0.58, 2.29)
(Full-time)*(12–15 y)							1.09 (0.47, 2.56)	1.33 (0.30, 5.77)	1.13 (0.56, 2.32)
(Full-time)*(≥ 16 y)							1.55 (0.67, 3.62)	1.25 (0.28, 5.48)	1.45 (0.71, 2.96)
Child care in child's first y									
No nonparent care (Ref)							1.00	1.00	1.00
Relative care							1.29 (0.94, 1.77)	1.19 (0.78, 1.80)	1.26 (0.98, 1.61)
Nonrelative care							1.19 (0.83, 1.72)	1.05 (0.67, 1.66)	1.11 (0.84, 1.48)
Center care							0.97 (0.63, 1.50)	1.10 (0.62, 1.97)	1.02 (0.72, 1.44)
Other[c]							1.11 (0.41, 3.05)	..	1.00 (0.37, 2.68)
Survey									
ECLS-B (Ref)			1.00						1.00
NLSY79-CYA			1.73* (1.05, 2.85)						1.44 (0.85, 2.41)
Year	0.99 (0.78, 1.26)	1.08* (1.01, 1.16)	1.05* (1.00, 1.10)				1.01 (0.79, 1.30)	1.07 (0.99, 1.15)	1.03 (0.99, 1.08)
Birth order	0.80*** (0.72, 0.89)	0.99 (0.86, 1.15)	0.87*** (0.80, 0.94)				0.78*** (0.70, 0.87)	1.00 (0.86, 1.17)	0.85*** (0.78, 0.94)
Mother's age at child's birth, y									
≤ 24	0.77 (0.57, 1.05)	1.09 (0.59, 2.00)	0.86 (0.66, 1.12)				0.91 (0.66, 1.26)	1.07 (0.57, 2.00)	0.97 (0.74, 1.27)
25–29 (Ref)	1.00	1.00	1.00				1.00	1.00	1.00
30–34	0.93 (0.68, 1.27)	1.02 (0.70, 1.49)	1.01 (0.80, 1.28)				0.95 (0.69, 1.31)	1.06 (0.72, 1.57)	1.05 (0.82, 1.34)
≥ 35	1.23 (0.86, 1.77)	0.77 (0.38, 1.57)	1.14 (0.83, 1.57)				1.39 (0.95, 2.04)	0.86 (0.42, 1.76)	1.27 (0.91, 1.77)
Observations[d]	3300	1515	4815	3300	1515	4815	3300	1511	4811
QIC	2493.7	1247.7	3729.3	2354.4	1243.4	3585.2	2353.8	1253.8	3575.4

Continued

TABLE 3—Continued

QIC for models with survey interactions[e]			3739.9			3596.0			3605.78
QIC for models with racial interactions[f]	2495.2	1258.1	3738.8	2358.5	1256.0	3599.9	2372.0	1273.9	3609.0

Note. BMI = body mass index; CI = confidence interval; ECLS-B = Early Childhood Longitudinal Study, 2001 Birth Cohort; NLSY79-CYA = Children and Young Adults of the National Longitudinal Survey of Youth, 1979 cohort; OR = odds ratio; QIC = quasi-likelihood under the independence model criterion. High BMI was defined as BMI at or above the 95th percentile according to Centers for Disease Control and Prevention age- and gender-adjusted references.[1] Regressions used unweighted samples. Standard errors adjusted for clustering of children within families.

[a]Adjusted for sociodemographic characteristics and survey sample controls.

[b]Adjusted for sociodemographic characteristics, prenatal and perinatal factors, and survey sample controls.

[c]Fully adjusted. The child care category other predicted high BMI perfectly in the NLSY79-CYA, so these 4 observations were dropped.

[d]Unweighted sample sizes for the ECLS-B were rounded to comply with National Center for Education Statistics confidentiality requirements.

[e]For the pooled model (not shown) in which all coefficients were interacted with the survey indicator.

[f]For the models (not shown) in which all coefficients were interacted with the indicator for race.

$*P < .05$; $**P < .01$; $***P < .001$.

representative studies considering television exposure have included or focused on older children and adolescents.[12,52,53,55] Although younger children may be more susceptible to television advertising,[52,54] television-related sedentary behavior may be a more critical determinant of BMI at older ages.

Limitations

Our study had limitations in both data and analytical approach. The NLSY79-CYA and ECLS-B were both designed to provide nationally representative samples of children; however, potential bias and reduced generalizability may have resulted from the sample losses incurred through our complete case analyses. Losses were larger for the NLSY79-CYA, but of a similar magnitude to previous NLSY79-CYA studies.[14] In addition, because we used surveys with nationally representative samples, we were limited in our choice of outcome variable to BMI from child's height and weight as proxy measures for underlying differences in adiposity. Recent research has shown that in older children, disparities in BMI among Black girls do not parallel disparities in measurement of percentage body fatness by dual-energy x-ray absorptiometry.[56] In light of these findings, and the broader literature debating the merits of using of BMI to measure obesity,[1,57,58] we have been cautious to distinguish between high BMI and high adiposity. However, a relationship between BMI and cardiovascular risk factors has been established in racially diverse samples, with no indication that this relationship varies between Blacks and Whites.[59–63]

We pooled observations across surveys with differences in sample designs and measurement protocols. The observed variables we used as proxies for these study design differences could not be expected to capture them completely. However, the overwhelming consistencies in our findings across 2 surveys with different protocols and only partial overlap in their periods of measurement provide a degree of robustness to our conclusions, adding to what could be gained from analysis of either a particular birth cohort (the ECLS-B) or the children of a particular maternal cohort (the NLSY79-CYA).

Conclusions

Our findings provide new insights into potentially modifiable determinants of racial disparities in early childhood high BMI. These disparities are troubling in light of stronger tracking of BMI from childhood to adulthood for Black versus White children,[64,65] and the consequent implications of high BMI for adult morbidity, including cardiovascular disease[63]— the leading cause of Black–White differences in life expectancy for several decades.[66,67] Elimination of Black–White differences in early childhood high BMI thus presents an important opportunity to reduce racial disparities in the overall health and longevity of the US population. ■

About the Authors

At the time of the study, the authors were with RAND Corporation, Santa Monica, CA.

Correspondence should be sent to Margaret M. Weden, 1776 Main St, PO Box 2138, Santa Monica, CA 90407-2138 (e-mail: mweden@rand.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Contributors

M. M. Weden and M. S. Rendall originated the study. M. M. Weden prepared the NLSY79-CYA data, conducted the ECLS-B and NLSY-CYA analyses, and had primary responsibility for writing and editing the article, with contributions from M. S. Rendall and P. Brownell. P. Brownell prepared the ECLS-B data and conducted ECLS-B preliminary analyses.

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Human Participant Protection

The research protocol was reviewed and approved by the RAND human subjects protection committee.

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