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Breastfeeding Associations with Childhood Obesity and Body Composition: Findings from a Racially Diverse Maternal–Child Cohort

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Abstract

Background: Studies suggest breastfeeding lowers obesity risk in childhood, but generalizability of existing evidence is limited. We examined associations of breastfeeding with childhood overweight, obesity, and percentage body fat, in a racially diverse maternal–child cohort.
Methods: This cross-sectional study included 823 children, ages 4–8 years, enrolled in the Environmental Exposures and Child Health Outcomes (ECHO) cohort, a subset of the National Institute of Child Health and Human Development Fetal Growth Studies cohort. Logistic regression was used to estimate odds ratios and 95% confidence intervals (CIs) for overweight [BMI (kg/m2) 85th to <95th percentile] and obesity (BMI ‡95th percentile) in relation to breastfeeding including duration of exclusive and total breastfeeding. Linear regression was used to evaluate association between breastfeeding and percentage body fat measured by bioelectrical impedance analysis.
Results: Fifty-two percent of children were male, 32% non-Hispanic Black, 29% Hispanic, 27% non-Hispanic White, and 13% Asian; 16% were overweight and 13% obese. Six months of exclusive breastfeeding, compared with no breastfeeding, was associated with 60% lower odds of obesity (95% CI 0.18–0.91) adjusting for age, gender, race, socioeconomic status, maternal BMI, and child's activity. Percentage body fat was inversely associated with breastfeeding duration. For none, <6, and ‡6 months of exclusive breastfeeding, adjusted mean percentage body fat was 16.8, 14.5, and 13.4, respectively. Results did not differ by gender, race/ethnicity, or maternal BMI status.
Conclusions: Exclusive breastfeeding for the first 6 months of life is inversely and significantly associated with obesity and percentage body fat at ages 4–8 years. These findings support current breastfeeding guidelines.

Keywords: adiposity; body fat; breastfeeding; childhood obesity; exclusive breastfeeding

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Introduction

Epidemiologic evidence suggests that breastfeeding lowers obesity risk in childhood.[1–7] A recent meta-analysis of published data on this topic estimated an average 22% lower risk of childhood obesity associated with ever versus never breastfeeding.8 Results from individual studies vary, however, with several studies reporting equivocal[9–11] or conflicting findings.[12,13] Reasons for the variation in study results are unclear but may be due to differences in study methods, particularly with respect to breastfeeding assessment. No consistent standards exist for ascertainment and analysis of breastfeeding duration and exclusivity (i.e., use of supplemental formula, water, other liquid, or solid food), as related to childhood adiposity.[8,14,15] The World Health Organization (WHO) recommends exclusive breastfeeding for the first 6 months of life and continuation of breastfeeding with ''safe and adequate'' complimentary foods up to 2 years or longer.[16] Understanding the health benefits of adherence to this recommendation, including the risk of childhood obesity, could help to coalesce research on this topic around a standard of measurement, and resolve remaining controversies.

Classification of overweight and obesity in children is also inconsistent, though generally based upon the BMI (kg/m2) z-score or equivalent percentile classification in the population. The U.S. Centers for Disease Control and Prevention (CDC) defines childhood overweight as having a BMI in the 85th to <95th percentile and obesity in the ‡95th percentile for age and gender.17 However, because BMI does not distinguish between fat and lean body mass, it is not

an ideal measure of excess adiposity. In childhood, body composition (BC) changes rapidly depending upon gender and race, but the upward trajectories of BMI that occur during this period do not necessarily reflect increases in fat mass.[18,19] This limitation may be overcome by objective measures of fat and fat-free mass using validated instruments such as bioelectrical impedance analysis (BIA). Studies assessing BC in children are scant. One recent study that examined breastfeeding in relation to BMI and percentage body fat measured by BIA in a large multicultural population observed a stronger inverse association with body fat than with BMI endpoints.[2] Despite a substantial body of literature on the association between breastfeeding and childhood obesity, generalizability of study findings to diverse populations in the United States is limited. Two studies that examined race-specific associations between breastfeeding and obesity found inverse associations in White, but not in Black children.[20,21] Given that breastfeeding rates are lower, and obesity rates higher, among non-Hispanic Black than among White children,[22,23] understanding the relationship between modes of early-life nutrition and adiposity among minority children has important implications for racial equity in research and public health. The aim of this study was to evaluate associations between breastfeeding type and duration with excess adiposity and BC as measured by BIA in a racially diverse maternal–child cohort. Effect modification by gender, race/ethnicity, and maternal BMI status was also investigated.

Methods

Study Population

We used data collected from maternal–child pairs originally enrolled in the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Fetal Growth Studies-Singletons cohort who also enrolled and completed an in-person examination in 2017–2019, at 10 sites throughout the United States, in the Environmental Exposures and Child Health Outcomes (ECHO) study. The NICHD Fetal Growth Studies are described in detail elsewhere. [24] Demographic and lifestyle information were collected from the mothers upon enrollment in ECHO through a self-administered questionnaire and clinical interview/assessment of the child, which included height and weight measurement and BIA for measurement of fat and fat-free body mass. Women also completed questionnaires for maternal characteristics including infant feeding practices. Children whose mothers did not complete a maternal questionnaire and those who did not present in person for
clinical measurement of height and weight were excluded. Ethical oversight of the ECHO cohort is conducted by the Medical University of South Carolina and Columbia University Central Institutional Review Boards.

Assessment of Breastfeeding

Women were asked at the time of enrollment in ECHO whether they ever breastfed their child and, if so, to estimate the duration of the breastfeeding in days, weeks, months, or years. Initiation of formula feeding and introduction of any nutritional substances other than breast milk or formula were also queried. Breastfeeding questions were included in two surveys, with 45% of women responding
to both. If responses differed, durations were averaged. We derived continuous months of total and exclusive breastfeeding, as well as the following categorical variables: (1) any breastfeeding (yes/no), (2) total breastfeeding duration (none, >0 to <6 months, 6–<12 months, ‡12 months),

and (3) exclusive breastfeeding duration (none, >0 to <6 months, ‡6 months). None (never breastfed) provided the referent for all comparisons.

Assessment of Obesity and Body Fat

Weight and height were measured during the child's clinical assessment. BMI (kg/m2) percentile was assigned based on CDC gender- and age-specific growth charts and categorized as normal weight (<85th percentile), overweight (85th to <95th percentile), or obese (‡95th percentile).[17] Fat mass and fat-free mass were assessed using the RJL Systems Body Composition (BC) 4.0 software.[25,26] Continuous percentage body fat was computed as [fat mass/(fat + fat-free mass) · 100].

Covariates

Covariates were chosen for evaluation of confounding based on a priori knowledge of association with breastfeeding and adiposity including child's age, gender, race, ethnicity, activity level, birth weight, and gestational age at delivery, in addition to maternal height and weight, smoking status, marital status, education, and socioeconomic status (SES) defined based on the household having received federal food assistance. All variables, except for child's birth weight and gestational age at delivery, were collected through self-report questionnaires administered at the time of enrollment in ECHO. Child's activity level was based on the Preschool Physical Activity Questionnaire (Pre-PAQ), a validated instrument for quantitative assessment of physical activity in children.[27] Birth weight (kg) and gestational age at delivery (weeks) were ascertained at birth following the NICHD Fetal Growth Studies protocol.[24]

Statistical Analysis

We used maximum likelihood methods to examine associations between breastfeeding and adiposity, taking into account age (discrete years), gender (male, female), race/ethnicity [non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic, and Asian], child's activity level (low, medium, and high), maternal BMI (18.5 to <25.0, 25.0 to <30.0, ‡30.0, <18.5 or unknown kg/m2), maternal smoking status (smoker or nonsmoker), marital status (married or partnered, unmarried), maternal education (£high school or any postsecondary), SES (household ever received federal food assistance, yes/no), low birth weight (</‡2500 kg), and gestational age at delivery (continuous weeks). Bivariate associations with breastfeeding (yes/no) were assessed using chi-square p-values for categorical variables, analysis of variance (ANOVA) t-tests for normally distributed continuous variables, and Kruskal–Wallis tests for non-normal continuous data.

Multinomial logistic regression was used to estimate the odds ratio (OR) and 95% confidence interval (CI) of overweight or obesity, versus normal weight, in relation to breastfeeding. We evaluated the effect of each covariate on the regression coefficients of the association of interest and fit a minimally adjusted model (Model 1), with age, gender, race, and SES; a second model (Model 2) additionally adjusted for maternal BMI and child's activity.

Gestational age at delivery, birth weight, mother's marital/partner status, smoking status, and education level were not statistically significant in the model and had no appreciable effects (<10% change) on the parameters of interest and were, therefore, dropped from the models for parsimony. The inclusion of continuous maternal BMI for potential residual confounding after adjustment for maternal overweight/obesity status was also uninformative and dropped. Effect modification by gender, race/ethnicity, and maternal BMI status was evaluated by entering cross-product terms (i.e., breastfeeding*gender, breastfeeding*race, breastfeeding* maternal BMI) and assessing the sum of squares type III t-test for the interaction term at a = 0.10.

Generalized linear models were used to examine associations with continuous percentage body fat. We examined patterns of missing percentage body fat due to not having BIA to evaluate the assumption of missing at random (MAR) for multiple imputation. Missingness appeared related to enrollment site, race, and SES, but not to any anthropometric measures that might be predictive of BC. Therefore, under the assumption of MAR, we used multivariate normal (Markov Chain Monte Carlo) multiple imputation with five iterations to impute percentage body fat. Non-missing auxiliary variables including enrollment site, birth weight, BMI z-score, and percentile were used in the imputation procedure in addition to all covariates in the analytic model. Percentage body fat was regressed on breastfeeding among the imputed and the observed sample for comparison. Final models adjusted for age, gender, race, SES, maternal BMI, and child's activity level. Interactions between breastfeeding and gender, race/ethnicity, and maternal BMI were also evaluated. Type III t-tests were evaluated for significance of model parameters at a = 0.05, except for interaction terms, which were deemed significant at a = 0.10. We plotted the least squares (LS) mean and CI of percentage body fat by breastfeeding to visualize results. Model assumptions were checked by analysis of the residuals.

To evaluate whether the data were influenced by the inclusion of children entering prepubertal status, we conducted a sensitivity analyses restricting to children younger than 8 years. All statistical tests were two-sided. SAS 9.4 was used for all analyses.

Results

After all exclusions, the final analytic cohort consisted of 823 children, including a subset of 605 who had BIA (Fig. 1). For 12 children, BIA values were deemed potentially unreliable due to testing difficulty. Percentage body fat was imputed for these plus the 26% of the cohort who did not undergo BIA. Median BMI was similar between those who had BIA (16.4 kg/m2) and those who did not (16.2 kg/m2) (Kruskal–Wallis p = 0.99) (Supplementary Table S1).

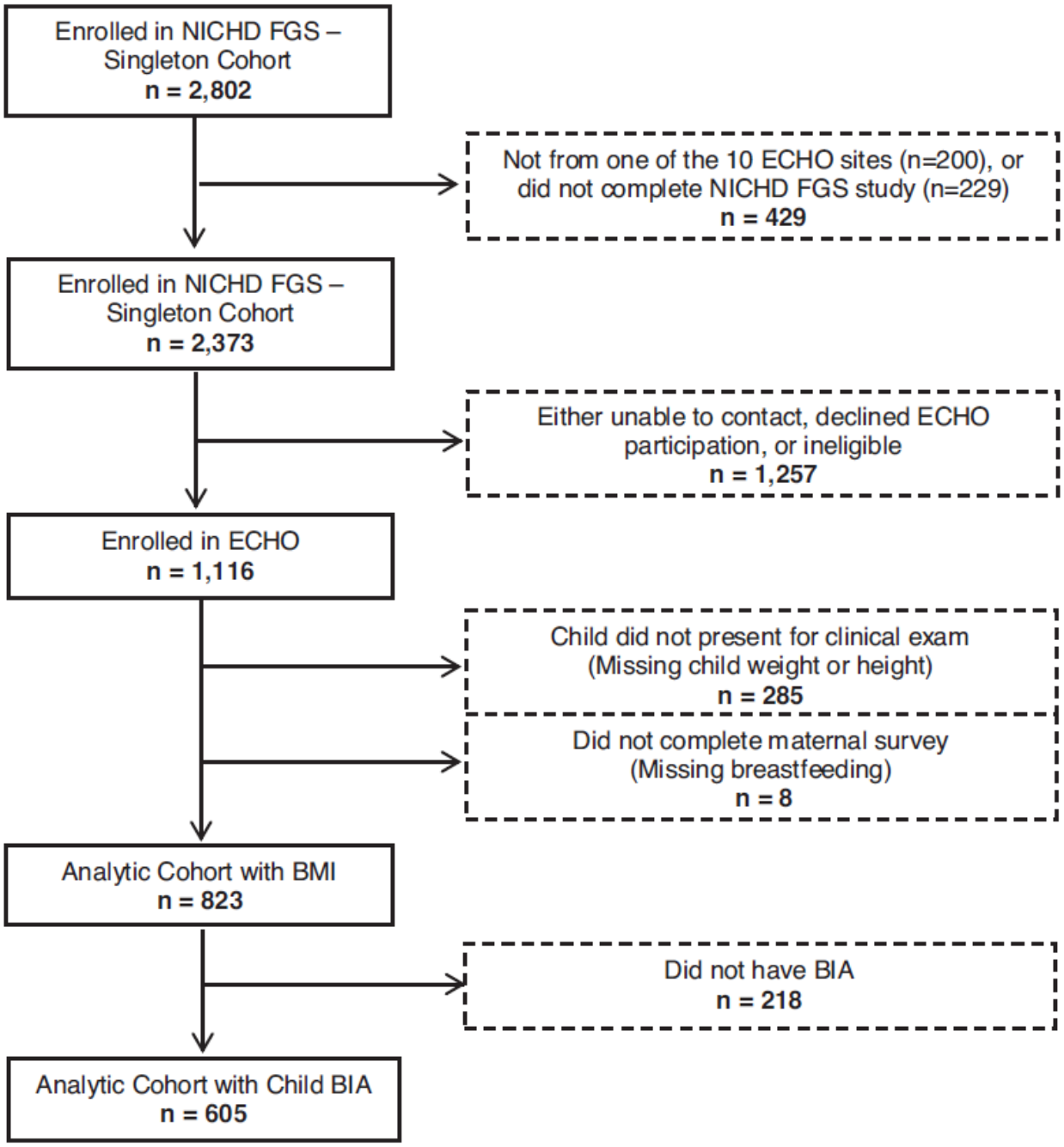

Figure 1. Flowchart of ECHO study participants available for analysis of overweight, obesity, and percentage body fat. BIA, bioelectrical impedance analysis; BMI, body mass index (kg/m^2); ECHO, Environmental Exposures and Child Health Outcomes; FGS, fetal growth studies; NICHD, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development.

Child age at enrollment was 4–8 years (median 6, interquartile range 5–7); 99 children (12%) were age 8 years. Overall, 16% of children were overweight and 13% were obese. Prevalence of breastfeeding initiation was high in this cohort with 81% of mothers reporting ever breastfeeding. Among children who were breastfed, average duration of exclusive and total breastfeeding was 4.6 months (SD 2.5) and 9.3 months (SD 7.8), respectively. The population was racially and ethnically diverse (31.6% NHB, 28.8% Hispanic, 27% NHW, and 12.6% Asian), with race/ethnicity associated with breastfeeding status (Table 1). Women who never breastfed were more likely to be obese than those who did.

Table 1. Descriptive Characteristics Overall and According to Breastfeeding Status among Environmental Exposures and Child Health Outcomes Participants

		Breastfed		
Characteristic	Total (*N* = 823)	No (*N* = 155)	Yes (*N* = 668)	p[a]
Child's age at enrollment, mean (SD)	6.3 (1.05)	6.1 (1.01)	6.3 (1.05)	0.01
Child's BMI (kg/m^2), median (min–max)	16.2 (12–31.8)	16.4 (13.2–27.8)	16.2 (12–31.8)	0.50
Child's percentage body fat, mean (SD)[b]	17.3 (8.3)	19.1 (9.8)	17 (7.92)	0.02
Child's gender				
Female	398 (48.4)	68 (43.9)	330 (49.4)	0.21
Male	425 (51.6)	87 (56.1)	338 (50.6)	
Child's race/ethnicity				
NHW	222 (27)	22 (14.2)	200 (29.9)	<0.001
NHB	260 (31.6)	89 (57.4)	171 (25.6)	
Hispanic	237 (28.8)	30 (19.4)	207 (31)	
Asian	104 (12.6)	14 (9)	90 (13.5)	
Mother's BMI (kg/m^2)				
18.5 to <25.0	284 (35.5)	44 (29.1)	240 (37)	0.01
25.0 to <30.0	259 (32.4)	43 (28.5)	216 (33.3)	
≥30.0	257 (32.1)	64 (42.4)	193 (29.7)	
Household received federal food assistance				
No	352 (42.8)	30 (19.4)	322 (48.2)	<0.001
Yes	471 (57.2)	125 (80.6)	346 (51.8)	
Child's activity level				
Low	307 (38.4)	51 (33.6)	256 (39.5)	0.01
Medium	250 (31.3)	40 (26.3)	210 (32.4)	
High	243 (30.4)	61 (40.1)	182 (28.1)	

Columns may not sum to 100% due to missing data.

[a]Chi-square test for heterogeneity (categorical variables), *t*-test for differences in the mean (continuous normally distributed variables), or Kruskal–Wallis test (continuous non-normally distributed variables).

[b]Restricted to those with observed valid values (*N* = 605).

NHB, non-Hispanic Black; NHW, non-Hispanic White; SD, standard deviation.

Six months of exclusive breastfeeding was associated with a 60% lower odds of obesity (95% CI 0.18–0.91, p-trend = 0.03) relative to no breastfeeding, adjusting for age, gender, race, SES, mother's BMI status, and child's activity level (Table 2). ORs of overweight and obesity were 8% lower for each month of exclusive breastfeeding (95% CI 0.86–0.99 for overweight, 0.84–1.00 for obesity). This association was not modified by gender (p-interaction = 0.49),

race/ethnicity (p-interaction = 0.63), or maternal BMI status (p-interaction =0.87). Restricting to children age 4–7 years did not materially alter results (OR 0.45, 95% CI 0.19–1.06 for 6 months of exclusive breastfeeding compared with none). The odds of obesity declined modestly across categories of total breastfeeding, but the estimates were not statistically significant.

Table 2. Associations of Breastfeeding Type and Duration with Overweight and Obesity in Environmental Exposures and Child Health Outcomes

	BMI (kg/m²) percentile						
	<85th	85th to <95th			≥95th		
	N	*N*	Model 1[a] OR (95% CI)	Model 2[b] OR (95% CI)	*N*	Model 1[a] OR (95% CI)	Model 2[b] OR (95% CI)
Any breastfeeding							
No	105	24	1.00	1.00	26	1.00	1.00
Yes	481	107	0.95 (0.56–1.59)	0.97 (0.57–1.64)	80	0.79 (0.47–1.34)	0.80 (0.47–1.38)
Total breastfeeding duration							
None	105	24	1.00	1.00	26	1.00	1.00
>0 to <6 months	156	46	1.16 (0.65–2.05)	1.17 (0.66–2.09)	34	0.83 (0.46–1.52)	0.87 (0.47–1.60)
6 to <12 months	138	30	0.90 (0.49–1.68)	0.90 (0.48–1.70)	23	0.86 (0.44–1.65)	0.83 (0.42–1.62)
≥12 months	171	25	0.62 (0.33–1.20)	0.67 (0.35–1.29)	18	0.61 (0.30–1.23)	0.65 (0.32–1.33)
p-Value[c,d]			0.07	0.11		0.20	0.25
Continuous months[d]	462	101	0.98 (0.95–1.01)	0.98 (0.95–1.01)	75	0.98 (0.95–1.02)	0.99 (0.95–1.02)
p-Value[d]			0.11	0.19		0.36	0.68
Exclusive breastfeeding duration							
None	105	24	1.00	1.00	26	1.00	1.00
>0 to <6 months	316	81	1.07 (0.63–1.83)	1.09 (0.64–1.87)	60	0.87 (0.51–1.52)	0.91 (0.51–1.59)
≥6 months	141	19	0.60 (0.30–1.18)	0.62 (0.31–1.23)	10	0.39 (0.17–0.88)	0.40 (0.18–0.91)
p-Value[c,d]			0.11	0.14		0.03	0.03
Continuous months[d]	457	100	0.92 (0.85–0.99)	0.92 (0.86–0.99)	70	0.92 (0.84–1.00)	0.92 (0.84–1.00)
p-Value[d]			0.03	0.03		0.05	0.05

[a]Adjusted for age, gender (male, female), race/ethnicity (NHW, NHB, Hispanic, Asian), and SES (household received federal food assistance y/n).
[b]Additionally adjusted for mother's BMI status (18.5 to <25.0, ≥25.0, <18.5/missing) and child's activity level (low, medium, high).
[c]Wald chi-square *p*-value for trend.
[d]Excludes subjects breastfed for unknown duration (*N* = 27 total, *N* = 41 exclusive).
CI, confidence interval; OR, odds ratio; SES, socioeconomic status.

Inverse associations were observed between breastfeeding and percentage body fat in fully adjusted models. Twelve or more months of total breastfeeding was associated with a 4.1 percentage point reduction in percentage body fat compared with the referent (p = 0.02), and ‡6 months exclusive breastfeeding was associated with a 3.5 percentage point reduction (p = 0.04) in the imputed sample (Table 3). Modest statistically significant decreases in percentage body fat were observed for each additional month of total (b=-0.095, p = 0.006) and exclusive (b=-0.352, p = 0.003) breastfeeding. No evidence of effect modification was found (p-interaction = 0.91, 0.69, and 0.39, for gender, race/ethnicity, and maternal BMI, respectively). Percentage body fat decreased in relation to exclusive breastfeeding duration (Fig. 2). For none, <6, and ‡6 months of exclusive breastfeeding, the LS mean percentage body fat was 16.8 (95% CI 14.4–19.3), 14.5 (95% CI 12.5–16.5), and 13.4 (95% CI 11.1–15.7), respectively.

Table 3. Regression Model Parameter Estimates of Breastfeeding Type and Duration with Percentage Body Fat in Environmental Exposures and Child Health Outcomes

	Observed sample ($N = 605$)*			Imputed sample ($N = 823$)		
	β	95% CI	*p*	β	95% CI	*p*
Any breastfeeding[a]						
No	0			0		
Yes	−1.8636	−4.3108 to 0.5836	0.14	−2.0021	−4.2897 to 0.2855	0.09
Total breastfeeding duration[a,b]						
None	0			0		
>0 to <6 months	−2.1308	−5.0111 to 0.7494	0.15	−2.2168	−5.2529 to 0.8193	0.15
6 to <12 months	−0.8055	−4.1736 to 2.5626	0.64	−0.7559	−3.7958 to 2.2840	0.62
≥12 months	−4.0956	−7.7552 to −0.4360	0.03	−4.1156	−7.4347 to −0.7965	0.02
Continuous months	−0.1346	−0.2191 to −0.0501	0.003	−0.0950	−0.1847 to −0.0318	0.006
Exclusive breastfeeding duration[a,c]						
None	0			0		
>0 to <6 months	−1.8667	−4.4437 to 0.7103	0.16	−1.8901	−4.4742 to 0.6940	0.15
≥6 months	−3.8365	−7.5136 to −0.1593	0.04	−3.4696	−6.7787 to −0.1604	0.04
Continuous months	−0.3123	−0.5388 to −0.0859	0.006	−0.3520	−0.5827 to −0.1214	0.003

Enrolled in NICHD FGS—Singleton Cohort.

[a]Adjusted for age, gender (male, female), race/ethnicity (NHW, NHB, Hispanic, Asian), SES (household received federal food assistance y/n) mother's BMI status (18.5 to <25.0, ≥25.0, <18.5/missing), and child's activity level (low, medium, high).

[b]Excludes breastfed for unknown duration ($N = 27$).

[c]Excludes breastfed exclusively for unknown duration ($N = 41$).

FGS, fetal growth studies.

Discussion

In this racially diverse cohort of children of ages 4–8 years, exclusive breastfeeding ‡6 months was associated with 60% lower odds of obesity, taking into account demographic factors, child's activity level, and maternal BMI. No statistically significant associations were observed between total breastfeeding and obesity. Breastfeeding was inversely and linearly associated with percentage body fat among all children, irrespective of gender, race/ethnicity, and maternal BMI status.

Choosing a cut point of 6 months of exclusive breastfeeding to reflect current guidelines,[28] we observed a protective effect with adherence. Our findings are consistent with other studies demonstrating lower obesity rates among children of similar age breastfed for ‡6 months, either exclusively[4,29,30] or almost exclusively (infrequent supplementation with water or other hydration liquids).[1–3,31] We did not find a statistical association with total breastfeeding duration, but our study was underpowered to detect the weaker effects that may be expected with mixed feeding. Nevertheless, modestly lower odds of obesity with any breastfeeding were* not ruled out in these data; thus our results do not refute the significant inverse associations found in other studies.[6,7]

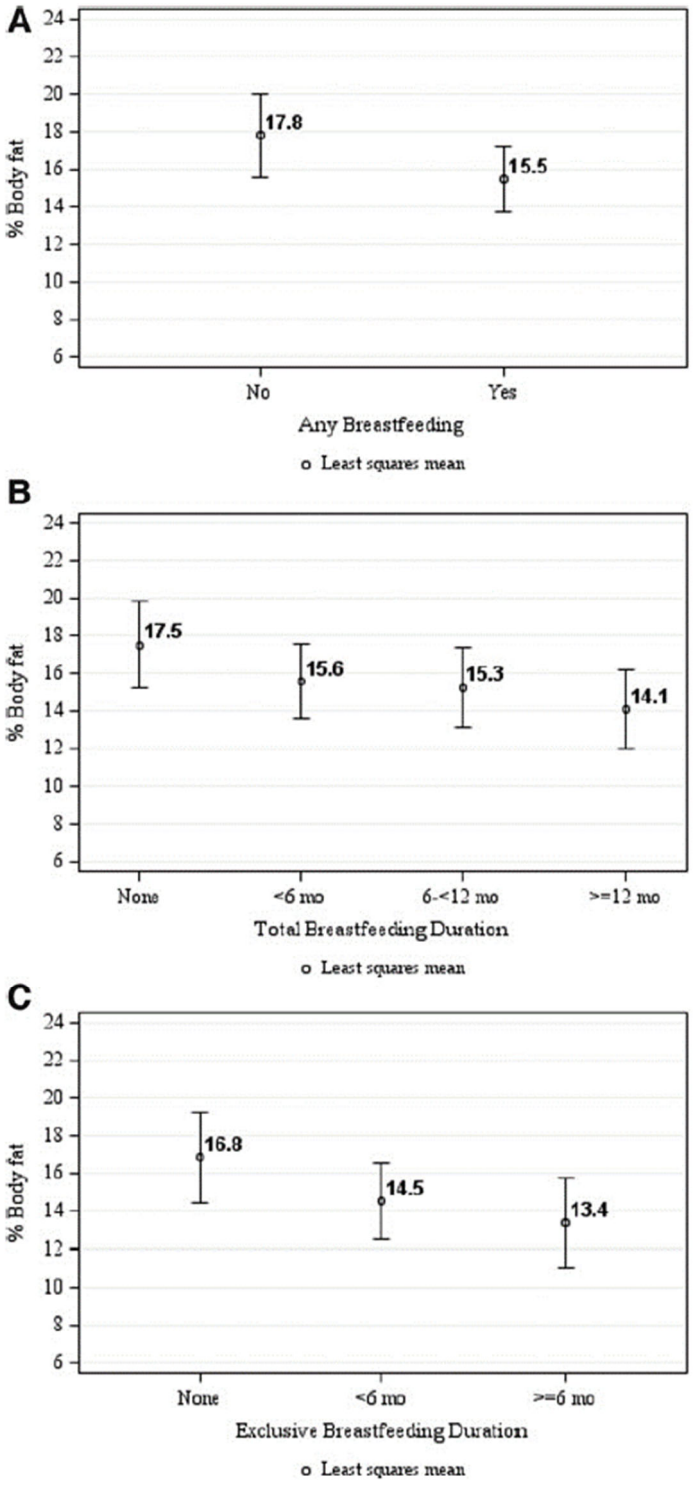

Figure 2. Mean percentage body fat (95% CI) adjusted for age, gender (male, female), race/ethnicity (NHW, NHB, Hispanic, Asian), SES (household received federal food assistance y/n), mother's BMI status (18.5 to <25.0, ‡25.0, <18.5/missing), and child's activity level (low, medium, high). (A) Any breastfeeding; (B) total breastfeeding; (C) exclusive breastfeeding. CI, confidence interval; NHB, non-Hispanic Black; NHW, non-Hispanic White; SES, socioeconomic status.

A meta-analysis found a combined protective effect of 22% for ever versus never breastfeeding and a dose–response relationship with duration of total breastfeeding.[8] Variation in the precision and magnitude of effect estimates across individual studies complicates definitive conclusions as to the nature and public health relevance of the association. Measurement of any and total breastfeeding is inherently imprecise, as the quantity and quality of complementary feeding are unaccounted for. This may help to explain conflicting results reported in some studies. A population-based prospective study of >8000 Asian children in Hong Kong's ''Children of 1997'' cohort found no effect of breastfeeding on weight status at age 7 years, but the prevalence of obesity was low in this population (4.5%), and the authors acknowledged the common practice, at that time, of regularly giving breastfeeding infants sugared drinks.[13] Such practices would likely attenuate effect estimates toward the null value and reduce precision. Several other studies that are often cited as contesting a protective effect of breastfeeding actually found inverse relationships, but lacked sufficient statistical power for inferences on the modest effects observed.[9,10,12] The report by Kramer et al.[12] warrants clarification as to study design—this was a cluster randomized intervention study to promote breastfeeding, and the comparison was between breastfeeding infants who were assigned to the intervention versus breastfeeding infants assigned to the control arm. The lack of a non-breastfeeding referent group makes this study somewhat of an outlier in the literature.

BMI, despite its widespread use in epidemiologic research, is a proxy measure of adiposity that provides no information as to BC. Breastfed infants are observed to have more favorable BC with more lean than fat mass.[32] Although data on breastfeeding and BC in school-aged children are sparse, descriptive studies of fat and fat-free mass according to age and gender provide a valuable reference to advance research in this area.[18,19] The recent study by Ma et al.[2] is noteworthy, because they assessed detailed breastfeeding in relation to both BMI and percentage body fat in a large diverse population representing 12 countries. Six months of breastfeeding was inversely associated with obesity and high body fat, but the results for body fat were more pronounced (OR 0.76 and 0.60, respectively). These results, along with our findings of inverse associations for total as well as exclusive breastfeeding in relation to percentage body fat, highlight the additional information that may be gained by using measures of BC as an essential outcome variable.

Other studies show that childhood fat mass and fat-free mass trajectories may differ by race.18 It is, therefore, important to understand the factors that influence adiposity and obesity with respect to race, so that messaging and interventions can be tailored effectively. Two previous studies found inverse associations between breastfeeding and obesity in White, but not in Black children.[20,21] In contrast, we found inverse association between breastfeeding and adiposity with no evidence of effect modification by race. Racial differences in this association reported in prior studies may be due to unmeasured confounding by social determinants of health (SDOH) associated with race and ethnicity.

The strengths of this study are objectively measured anthropometry including BIA-assessed BC, and detailed assessment of breastfeeding with information on the introduction of other liquid and solid foods. The ECHO cohort is racially and geographically diverse representing seven states in five regions in the United States (southeast, northeast, mid-Atlantic, midwest, and California), which bolsters the external validity of our study. The main weakness of this study is cross-sectional assessment of exposure and outcome and retrospective collection of breastfeeding information. However, recall of breastfeeding, even after many years, is shown

to be accurate and reliable.[33,34] It is important to note that the BIA subset differed from the overall cohort with respect to social and economic factors and thus biased. Although our models were adjusted for SES, we cannot rule out the possibility of unmeasured confounding. This study was underpowered to detect modest associations that may be attributable to nonexclusive or short-duration breastfeeding.

In 2001, WHO revised its guideline on breastfeeding to recommend exclusive breastfeeding for the first 6 months of life. The previous guideline was 4–6 months. This shift in policy was supported by extensive evidence of the beneficial short- and long-term effects of breastfeeding on both child and maternal health.35 The biologic plausibility of a favorable effect of breastfeeding on childhood body weight and composition is supported by several avenues of scientific research including appetite regulation, human milk oligosaccharides, leptin, gut microbiome diversity, and lower early-life exposure to the high protein content of infant formula.[5,36–39]

Prevalence of obesity in children aged 6–11 years in the United States is 19.3%.[23] Its etiology is multifactorial, and breastfeeding is only one of many variables that may affect risk. Due to high prevalence of overweight and obesity in the population, even small reductions in risk like those observed with breastfeeding could have meaningful public health impact. Breastfeeding is increasing in the population with initiation >80%, although considerably less (25%) continue exclusive breastfeeding for 6 months.[22] Importantly, only 69% of NHB women initiate compared with 85% NHW women, as estimated from a representative U.S. sample of 167,842 respondents to the National Immunization Survey-Child.[22] Future research should aim to resolve controversies that remain regarding the benefits of breastfeeding in minority populations by carefully controlling for the effects of SDOH, which may be acting to suppress evidence of a protective association. Public health efforts should focus on continuation of breastfeeding in adherence to recommendations for optimal benefit.

Conclusions

This study provides evidence, based on data from a racially diverse population, of a lower risk of childhood obesity related to exclusive breastfeeding through the first 6 months of life. Our findings help to clarify associations between different measures of breastfeeding and childhood adiposity and contribute additional support for current breastfeeding guidelines.

Authors' Contributions

J.S.H. was in charge of conceptualization, methodology, data visualization, formal analysis, writing—original draft, and writing—review and editing. P.L.F. was responsible for conceptualization, methodology, data curation, project administration, and writing—review and editing. A.C.S., M.P.N., K.P., D.W.S., and D.M.C. carried out primary data collection and review of the final article. W.A.G., R.B.N., A.T.T., and R.J.W. carried out conceptualization, primary data collection, and writing—review and editing. C.Z. was involved in conceptualization and writing—review and editing. B.N. was involved in review of the final article and funding acquisition. J.E.V. was in charge of conceptualization, writing—review and editing, and funding acquisition. K.J.H. took care of conceptualization, methodology, data curation, project administration, writing—review and editing, funding acquisition, and supervision.

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Author Disclosure Statement

J.S.H. is an employee of Target RWE Health Evidence Solutions.

Supplementary Material

Supplementary Table S1

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