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# Does breastfeeding contribute to the racial gap in reading and math test scores?

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ABSTRACT

*Purpose:* The aim of this study was to examine the impact of divergent breastfeeding practices between Caucasian and African American mothers on the lingering achievement test gap between Caucasian and African American children.
*Methods:* The Child Development Supplement of the Panel Study of Income Dynamics, beginning in 1997, followed a cohort of 3563 children aged 0–12 years. Reading and math test scores from 2002 for 1928 children were linked with breastfeeding history. Regression analysis was used to examine associations between ever having been breastfed and duration of breastfeeding and test scores, controlling for characteristics of child, mother, and household.
*Results:* African American students scored significantly lower than Caucasian children by 10.6 and 10.9 points on reading and math tests, respectively. After accounting for the impact of having been breastfed during infancy, the racial test gap decreased by 17% for reading scores and 9% for math scores.
*Conclusions:* Study findings indicate that breastfeeding explains 17% and 9% of the observed gaps in reading and math scores, respectively, between African Americans and Caucasians, an effect larger than most recent educational policy interventions. Renewed efforts around policies and clinical practices that promote and remove barriers for African American mothers to breastfeed should be implemented.


## Introduction

Disparities in educational outcomes between different socioeconomic groups are a major concern of educational reformers. Indeed, educational policies mandated in No Child Left Behind are aimed mostly at low-income, minority students. There is limited evidence, however, that these policies work. Because of the variation in breastfeeding practices across racial and ethnic groups and the association between breastfeeding and positive cognitive development, we consider whether different breastfeeding practices can explain some of the childhood "test gap" between Caucasians and African Americans.

The gap in achievement test scores between racial groups in America is stubbornly persistent; although it has decreased by 30% in the past 30–40 years, African Americans are still 2–3 years of learning behind Caucasians [1]. Why one racial group achieves more in school than another is a complex question, which makes it difficult to craft programs that increases achievement for low-performing groups. Although policy enacted to reduce the test gap has typically focused on changes within the school system, research shows that other factors have a greater impact on academic performance [2–5]. With children spending merely 15% of waking hours between birth and the age of 18 years in the classroom [6], research has consistently shown that family characteristics comprise, at minimum, two-thirds of the gap in academic performance between socioeconomic groups [7]. The negative impact of the test gap is unquestionable. Gaps in academic achievement have been linked with future income, health outcomes, and risk of incarceration [1] and can explain enduring socioeconomic stratification in American society.

### *Cognitive effects of breastfeeding*

Research has shown that breastfeeding is associated with positive cognitive development and academic performance. Kramer et al. [8] found that increased duration and exclusivity of breastfeeding is associated with higher scores on the Weschler Abbreviated Scales of Intelligence at the age of 6.5 years. Oddy et al. [9] found that children who were mostly breastfed for more than 6 months had higher test scores at 10 years old. Additionally, a meta-analysis of 11 studies found that children breastfed as infants had significantly higher cognitive development than children who had been formula-fed as infants [10].

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*The current study*

The objective of this study was to examine the impact of breastfeeding practices between Caucasian and African American mothers on the achievement test gap between Caucasian and African American children. Although several studies have examined the relationship between breastfeeding and cognitive development, past research has not considered how different breastfeeding practices may affect the achievement test gap. Furthermore, we capitalize on a nationally representative sample cohort that assessed breastfeeding duration throughout infancy and children's achievement test scores to determine the association between breastfeeding and children's achievement.

Rates and longevity of breastfeeding are known to vary greatly across different racial groups [11,12]. According to data collected through the National Immunization Survey between 2004 and 2008, 74% of Caucasian children and only 54% of African American children were ever breastfed [12]. If African Americans breastfed at similar rates as Caucasians, millions more African American children would be breastfed. Thus, it seems probable that some of the achievement test gap between Caucasians and African Americans results from this discrepancy. Because research shows breastfeeding improves cognitive development and there are divergent breastfeeding practices between Caucasian and African American mothers, we hypothesize that after accounting for the impact of having been breastfed during infancy, the difference in achievement test scores between Caucasian and African American children will be reduced. Figure 1 displays the conceptual model that guides our empirical analysis.

## Methods

*Data and sample selection*

We examined the research question using data from the first two waves of the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). The PSID is a longitudinal survey that collects demographic information and socioeconomic characteristics from a nationally representative sample of individuals and their families annually between 1968 and 1997 and biennially thereafter. Beginning in 1997, the PSID supplemented its core data with additional information from a group of children aged 0–12 years ($N = 3563$) in the CDS. The same children were interviewed three times in 1997, 2002, and 2007, respectively, if they were still younger than 18 years at the time of each interview. The recruiting, eligibility, and attrition of the PSID–CDS have been described elsewhere [13,14]. The CDS collected the breastfeeding information of children in the first wave (1997) and conducted standardized achievement tests on children older than 6 years in all three waves.

To maximize the sample size, we included African American and Caucasian children who were interviewed in 2002 ($N = 2552$) and had valid information on breastfeeding and achievement test scores ($N = 2257$). The study further limited subjects to children living with biological mothers and having parents (i.e., mothers, fathers, or stepfathers) as their householders ($N = 2002$) because biological mothers are more likely to report reliable information on breastfeeding and household dynamics could be different for children living with parents and those living with grandparents or other relatives. Finally, the few children with missing values on variables listed in Table 1 were excluded; the final sample size was 1928.

*Outcome variables*

The two outcome variables were children's reading and math scores in the Woodcock-Johnson Revised Tests of Achievement administered in the second wave of the CDS in 2002. Two subtests on reading ability, the Letter–Word Identification and the Passage Comprehension, and one subtest on math ability, the Applied Problems, were conducted. The raw scores of reading and math tests were standardized to a 0–200 continuous variable, respectively. The Woodcock-Johnson Revised Tests of Achievement have been widely used and have demonstrated excellent reliability and validity [15].

*Independent variables*

We used three major independent variables: children's race, a dichotomous indicator on whether children were breastfed, and a categorical variable of the duration of breastfeeding. Children's race was coded as "1" for African American if caregivers indicated that children were "Black non-Hispanic" and coded as "0" for Caucasian if caregivers indicated that children were "White non-Hispanic." In regards to breastfeeding, caregivers were first questioned, "Was the child breastfed as an infant?" Children who had ever been breastfed had the value "1" on the dichotomous measure of breastfeeding and

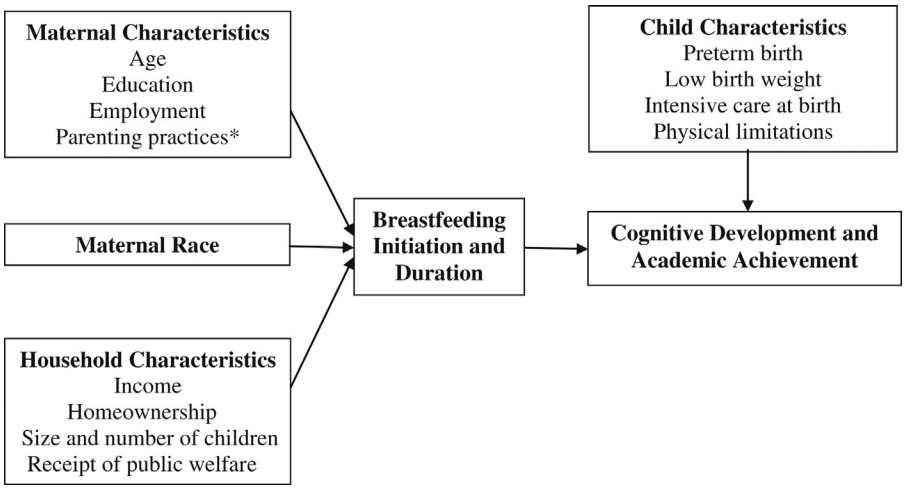


**Fig. 1.** Conceptual model of breastfeeding and academic achievement. * Parenting practices includes behaviors such as maternal warmth, emotional support, and cognitive stimulation.

**Table 1**
Characteristics of the analytical sample: PSID–CDS, 1997 and 2002 ($N = 1928$)

| Variables* | Mean (SD) or % |
|---|---|
| Outcome variables (measured in 2002) | |
| WJ-R reading score | 104.9 (23.7) |
| WJ-R math score | 106.9 (16.6) |
| Major independent variables | |
| African American children | 18.6 |
| Whether children were breastfed | 56.3 |
| % of African American children who were breastfed† | 23.3 |
| % of Caucasian children who was breastfed | 63.9 |
| Duration of breastfeeding | |
| No breastfeeding | 43.7 |
| ≤1 mo | 7.0 |
| 2–4 mo | 13.0 |
| 5–7 mo | 14.6 |
| 7–9 mo | 7.4 |
| >9 mo | 14.4 |
| Covariates | |
| Children's characteristics | |
| Gender (male) | 50.7 |
| Age in years (measured in 2002) | 11.3 (3.6) |
| Preterm birth (yes) | 9.6 |
| Low birth weight (yes) | 2.8 |
| Neonatal care at birth (yes) | 11.3 |
| Physical or mental limitations | 3.4 |
| Mothers' characteristics | |
| Age in years | 34.4 (6.5) |
| Education in years | 13.4 (2.4) |
| Employment status (yes) | 66.3 |
| Parental warmth | 4.6 (0.5) |
| Emotional support to children | 9.9 (2.1) |
| Cognitive simulation to children | 10.1 (2.2) |
| Household level | |
| Household size | 4.2 (1.1) |
| Number of children | 2.3 (1.0) |
| Food stamp participation (yes) | 15.5 |
| AFDC participation (yes) | 7.4 |
| Household income ($) | 55,163.4 (47,668.1) |

AFDC = Aid to Families with Dependent Children; WJ-R = Woodcock-Johnson Revised.

* All variables were measured in the 1997 PSID–CDS except for those specified in the table.

† The percentage of African American children who were breastfed is statistically lower than the percentage of Caucasian children ($P < .001$).

others had the value "0." Caregivers were then asked, "How many months old was the child when breastfeeding stopped?" Based on caregiver responses, children's duration of breastfeeding was divided into six categories following previous literature [10,16]: no breastfeeding, less than or equal to 1 month, 2–3 months, 4–6 months, 7–9 months, and more than 9 months.

*Covariates*

We adjusted for three groups of covariates, but for presentation purposes, we only reported the coefficients for our key explanatory variables (race and breastfeeding). The first group was children's characteristics, including age and age squared, gender (1 = male and 0 = others), preterm birth (1 = gestational age <37 weeks and 0 = others), low birth weight (1 = birth weight <1500 g and 0 = others), neonatal intensive care at birth (1 = yes and 0 = others), and physical or mental limitations on childhood or school activities (1 = yes and 0 = others).

The second group was mothers' characteristics, including age, number of schooling years (1–17 years), employment status (1 = yes and 0 = others), and mothers' parenting practices. We controlled for three indicators of parenting practices: parental warmth, emotional support, and cognitive stimulation. Ranging from 1 to 5, parental warmth was a standardized scale measuring the warmth of the relationship between mothers and children, including the frequency of showing physical affection, appreciation, and so on. Emotional support and cognitive stimulation were based on observed interactions between mothers and children in home environment by the interviewers. Emotional support ranged from 2 to 11 and was summarized from survey items such as "mother caressed, kissed, or hugged child at least once" and "mother conversed with child at least twice." Cognitive stimulation ranged from 2 to 14 and included items such as "how many books the child has read" and "mother provided toys or interesting activities."

Finally, we adjusted for five household characteristics: household size, number of children in households, food stamp program participation (1 = yes and 0 = others), Aid to Families with Dependent Children or Temporary Assistance for Needy Families participation (1 = yes and 0 = others), homeownership (1 = yes and 0 = others), and log-transformed household income. The analyses also controlled for state fixed effects. All these covariates were collected in the first wave of the PSID–CDS (1997) except for children's age, which was measured in the second wave (2002).

*Statistical analyses*

Following descriptive analyses, we conducted a series of ordinary least squares regressions to examine the relationship between breastfeeding and racial differences in achievement tests. Model 1 regressed achievement test scores on children's race and other covariates to identify racial differences in test scores. Models 2 and 3 added the dichotomous and duration measures of breastfeeding to model 1, respectively. In addition, we used ordinary least square regression to test the association between breastfeeding and achievement tests by children's race separately and compared the association between breastfeeding and achievement tests by race. For all statistical analyses, weighted estimates to account for the oversampling of African American children and data attrition and standard errors were computed using Stata 12.1SE [17]. This approach implemented a Taylor series linearization to adjust standard errors of estimates for complex survey sampling design effects including clustered data.

The analyses discussed above used the Baron and Kenny [18] approach to examine the mediation from race to test scores through breastfeeding. This approach assumes that there is no interaction between race and breastfeeding, which might not be true here [19]. We further tested this mediation relationship in a sensitivity test using a new approach within the counterfactual framework proposed by VanderWeele [20,21].

## Results

Table 1 reports summary statistics. The mean reading and math scores were 104.9 (standard deviation = 23.7) and 106.9 (16.6), respectively, in the sample. Nearly 19% of subjects were African American children, and about 56% of the sampled children were breastfed. Consistent with previous literature, African American children were statistically less likely to be breastfed than their Caucasian counterparts (23.3% vs. 63.9%). Half of the children were male, and, on average, they were 11 years old when the tests were taken. The mean age of their mothers was 34 years in 1997, and the mean schooling years for mothers was 13. Nearly two-thirds of mothers were employed in 1997. On average, children lived in a household with four members (including two children) and an income of about $55,000.

Table 2 presents results predicting children's reading test scores. As shown in model 1, African American children had reading scores 10.6 points lower than Caucasian children (95% confidence interval [CI], −14.4 to −6.7) after controlling for the three groups of covariates. The inclusion of a dichotomous measure of breastfeeding in

**Table 2**
OLS regression predicting children's reading test score ($N = 1928$)*

| Variables | Model 1 β (95% CI) | Model 2† β (95% CI) | Model 3‡ β (95% CI) |
|---|---|---|---|
| African American children | −10.6*** (−14.4 to −6.7) | −8.8*** (−12.6 to −5.0) | −8.7*** (−12.5 to −4.9) |
| Whether children were breastfed (yes) | — | 6.3*** (3.5–9.1) | — |
| Duration of breastfeeding (reference category: no breastfeeding) | | | |
| ≤1 mo | — | — | 6.6* (1.4–11.8) |
| 2–4 mo | — | — | 4.8* (0.7–9.0) |
| 5–7 mo | — | — | 7.4*** (3.3–11.5) |
| 7–9 mo | — | — | 3.5 (−1.2 to 8.3) |
| >9 mo | — | — | 8.1 (4.2–11.9) |
| $R^2$ | 0.21 | 0.22 | 0.22 |

OLS = ordinary least square.
* $P < .05$, ** $P < .01$, *** $P < .001$.
* All three models are adjusted for the following covariates: (1) children's age and age squared, gender, preterm birth, low birth weight, neonatal intensive care, and physical or mental limitation; (2) mother's age, education, employment status, parental warmth, emotional support, and cognitive stimulation; and (3) household's size, number of children, food stamp participation, Aid to Families with Dependent Children or Temporary Assistance for Needy Families participation, homeownership, and household income.
† An adjusted Wald test indicates the regression coefficients of children's race are statistically different in models 1 and 2 ($P < .001$).
‡ An adjusted Wald test indicates the regression coefficients of children's race are not statistically different in models 2 and 3 ($P = .72$). Adjusted Wald tests suggests that, except for the category of "no breastfeeding," regression coefficients of other categories do not differ from each other statistically.

model 2 reduced the racial difference in reading scores by 1.8 points or 17% from −10.6 to −8.8 (95% CI, −12.6 to −5.0). A Wald test shows that the coefficient of children's race in model 2 was statistically smaller than that in model 1 ($P < .001$). In addition, breastfeeding increased children's reading scores by 6.3 points (95% CI, 3.5–9.1). The sensitivity test based on the mediation analysis proposed by VanderWeele had consistent results: the natural indirect effect of race on reading test scores through breastfeeding is about 1.3 points (95% CI, 0.23–2.63) or 18% of the marginal total effect of race.

Model 3 used the duration of breastfeeding to replace the dichotomous measure of breastfeeding but did not further explain away the racial gap in reading scores. African American children still had reading scores 8.7 points lower than Caucasian children (95% CI, −12.5 to −4.9). A Wald test indicated that the regression coefficients of children's race in models 2 and 3 was not statistically different from each other ($P = .72$). Furthermore, except for the category of "no breastfeeding," regression coefficients of other categories on the duration of breastfeeding did not differ from each other statistically.

Results on children's math scores presented in Table 3 are consistent with those in Table 2. The inclusion of a dichotomous measure of breastfeeding in model 2 decreased the racial gap in math scores from −10.9 to −9.9, a one-point, or 9%, change. This change in the regression coefficient of children's race between two models is statistically different from 0 ($P < .001$). In sensitivity tests using the mediation analysis proposed by VanderWeele, the natural indirect effect of race on math test scores through breastfeeding is about 0.84 points (95% CI, 0.11–1.65) or 9% of the marginal total effect of race.

Finally, we regressed reading and math scores on breastfeeding and other covariates by children's race, respectively, and report results in Table 4. Breastfeeding was positively associated with reading scores (African American: β = 8.3, 95% CI, 4.5–12.1; Caucasian: β = 5.4, 95% CI, 2.1–8.6) and math scores (African American: β = 4.8, 95% CI, 1.3–8.4; Caucasian: β = 3.1, 95% CI, 1.0–5.2) for both racial groups but had a greater marginal effect for African American children. However, as shown by adjusted Wald tests, the difference in marginal effects of breastfeeding does not vary statistically by race.

## Discussion

Our results suggest that breastfeeding reduces the test gap between African American and Caucasian children. Once we included variables for whether children were breastfed and the duration of breastfeeding, we saw that the test gap between Caucasians and African Americans was reduced substantially. Unlike previous studies, such as Oddy et al. [9], there does not appear to be any consistent linear relationship between the duration of

**Table 3**
OLS regression predicting children's math test score ($N = 1928$)*

| Variables | Model 1 β (95% CI) | Model 2† β (95% CI) | Model 3‡ β (95% CI) |
|---|---|---|---|
| African American children | −10.9*** (−13.4 to −8.3) | −9.9*** (−12.6 to −5.0) | −9.9*** (−12.5 to −4.9) |
| Whether children were breastfed (yes) | — | 3.5*** (1.6–5.3) | — |
| Duration of breastfeeding (reference category: no breastfeeding) | | | |
| ≤1 mo | — | — | 2.6 (−0.4 to 5.6) |
| 2–4 mo | — | — | 3.5* (0.7–6.2) |
| 5–7 mo | — | — | 4.0** (1.4–6.6) |
| 7–9 mo | — | — | 2.1 (−1.6–5.8) |
| >9 mo | — | — | 4.4** (1.4–7.5) |
| $R^2$ | 0.27 | 0.28 | 0.28 |

OLS = ordinary least square.
* $P < .05$, ** $P < .01$, *** $P < .001$.
* All three models are adjusted for the following covariates: (1) children's age and age squared, gender, preterm birth, low birth weight, neonatal intensive care, and physical or mental limitation; (2) mother's age, education, employment status, parental warmth, emotional support, and cognitive stimulation; and (3) household's size, number of children, food stamp participation, Aid to Families with Dependent Children or Temporary Assistance for Needy Families participation, homeownership, and household income.
† An adjusted Wald test indicates the regression coefficients of children's race are statistically different in models 1 and 2 ($P < .001$).
‡ An adjusted Wald test indicates the regression coefficients of children's race are not statistically different in models 2 and 3 ($P = .79$). Adjusted Wald tests suggest that, except for the category of "no breastfeeding," regression coefficients of other categories do not differ from each other statistically.

**Table 4**
OLS regression predicting children's achievement test scores by race*

| Variables | Reading score† | | Math score† | |
|---|---|---|---|---|
| | AA‡ ($n = 848$) | Cau§ ($n = 1080$) | AA‡ ($n = 848$) | Cau§ ($n = 1080$) |
| Whether children were breastfed (yes) | 8.3*** (4.5–12.1) | 5.4*** (2.1–8.6) | 4.8** (1.3–8.4) | 3.1** (1.0–5.2) |
| Wald test of difference between racial groups | 2.9‖ | | 1.7‖ | |

OLS = ordinary least square.
* $P < .05$, ** $P < .01$, *** $P < .001$.
* All three models are adjusted for the following covariates: (1) children's age and age squared, gender, preterm birth, low birth weight, neonatal intensive care, and physical or mental limitation; (2) mother's age, education, employment status, parental warmth, emotional support, and cognitive stimulation; and (3) household's size, number of children, food stamp participation, Aid to Families with Dependent Children or Temporary Assistance for Needy Families participation, homeownership, and household income.
† Regression coefficient and its 95% confidence interval are reported in the table.
‡ African American.
§ Caucasian.
‖ Difference between the regression coefficient of breastfeeding for African American children and that for Caucasian children.

breastfeeding and improved test scores, but this may reflect that other studies did not control for the extensive array of potential confounds such as parenting practices. Thus, we may be isolating the nutritional from the emotional and cognitive benefits of breastfeeding. Based on our findings and those of Oddy et al. [9], it seems that the nutritional benefits of breastfeeding may most occur in the first months of breastfeeding, but the emotional benefits play out over a longer period.

Furthermore, the analysis demonstrated that breastfeeding is likely to be equally effective for both groups. This is important because it suggests that African Americans would benefit from breastfeeding as much as Caucasians. Thus, expanded breastfeeding among African Americans would have a positive effect on reducing the test gap.

### *Implications*

Initiatives that encourage African American mothers to breastfeed their children must be undertaken, with a particular emphasis on eliminating barriers faced by African American mothers. Surveys have found African American mothers to report more barriers to breastfeeding than Caucasian and Hispanic mothers [22]. These barriers include lack of knowledge, pain or discomfort during breastfeeding, and stopping breastfeeding to return to work [22,23]. Thus, an emphasis on altering laws regarding parental work leave, such as breaks at work to allow for the pumping of breast milk, and expanding programs that educate mothers on the benefits of breastfeeding will address these barriers. In particular, encouragement from medical professionals for new mothers, especially African American mothers, to breastfeed their children can positively impact breastfeeding initiation. As Bently et al. [24] found, expectant African American mothers aware of their doctors' desire for them to breastfeed are significantly more likely to intend to breastfeed on the birth of their child. Thus, medical professionals stressing the important benefits of even short-term breastfeeding is important. Our results show that even 1 month or less of breastfeeding produces positive results.

In addition to the support from medical professionals, peer counseling can eliminate additional barriers to breastfeeding by connecting new mothers with a peer experienced in breastfeeding and specially trained to provide the informational and emotional support needed to continue breastfeeding [25]. Peer counseling programs have been proven to significantly increase breastfeeding rates among African American mothers [26–29].

An important question is how the effect of breastfeeding on test scores compares with educational interventions aimed at decreasing the achievement test gap. Interventions created as a result of No Child Left Behind include 21st Century Community Learning Centers and the Reading First program, with the programs costing over $1 billion annually. National evaluations of both 21st Century Community Learning Centers and Reading First sites have found no participant improvements in academic outcomes or reading comprehension [30,31]. Unlike these costly education interventions, the breastfeeding initiatives aforementioned would encourage additional African American mothers to breastfeed and almost certainly reduce the test gap between Caucasians and African Americans. Although systematic analysis will need to be conducted, the certainty of such a payoff may justify the expenses associated with efforts to encourage African American mothers to breastfeed.

### *Limitations*

As with any observational study, it is possible that breastfeeding is serving as a proxy for some unobserved variable. Given the extensive array of confounds we control for, however, this concern is minimized. Like other studies, we also rely on parental reports of breastfeeding, which are subject to the possibility of overreporting due to social desirability bias. However, we see no reason why Caucasians and African Americans would differ systematically in overreporting. Finally, the age range of the children in the study (6–12 years in 1997) is relatively large. The children are at different developmental stages when their test scores were measured. Because the age distribution was similar for Caucasians and African Americans, this does not affect our main conclusion, but the effect size of breastfeeding may vary depending on age. In addition, the relationship between breastfeeding and academic achievement could be quite complicated and involve many factors. Thus, some covariates (e.g., children's limitations on childhood and school activities) in the analysis may be mediators between breastfeeding and outcome measures. The dynamic relationships among these factors should be addressed in future studies.

### *Conclusion*

Although recent research has begun to identify some of the reasons for disparities in breastfeeding practices between Caucasians and African Americans [22,23], there still remains several gaps. For example, research by Evans et al. [22] found that the availability and intensity of breastfeeding support services provided through the Women, Infants, and Children program varied by the predominant racial group served, with programs serving predominantly African Americans offering less breastfeeding support services. It is unclear, however, whether this trend is consistent across the country. Additionally, although peer counseling programs have been proven to significantly increase breastfeeding

initiation and duration for minority women, the optimal length of time for these services is unclear. Greater clarity in these areas will allow for the development of policies and programs that reduce disparities in both breastfeeding practices and academic achievement for Caucasians and African Americans.

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