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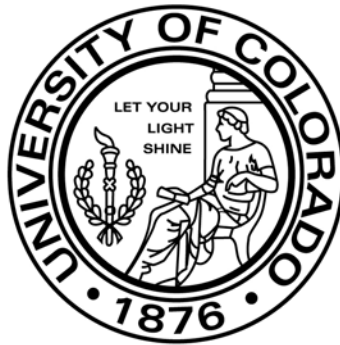
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**The Effect of Breastfeeding on Educational
Attainment: Evidence from Sibling Data**

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The Effect of Breastfeeding on Educational Attainment: Evidence from Sibling Data

Abstract

Using data on sibling pairs drawn from the National Longitudinal Study of Adolescent Health, we estimate the effect of having been breastfed on high school graduation, high school grades, and college attendance. Our results suggest that breastfeeding is associated with substantial increases in high school GPA and in the probability of college attendance. Adding measures of cognitive ability and adolescent health to our model explains more than one half of the estimated effect of being breastfed on high school grades and approximately one-fifth of the estimated effect on college attendance. We conclude that improvements in cognitive ability and adolescent health may be important pathways through which breastfeeding affects long-term academic achievement.

Keywords: breastfeeding, schooling, human capital

I. INTRODUCTION

Breastfeeding rates have been on the rise since the early 1990s, and a large number of states have passed legislation designed to protect the rights of mothers who breastfeed their infant children.¹ At the beginning of this decade, the U.S. Department of Health and Human Services (HHS) declared that it would like to see seventy-five percent of mothers in the United States breastfeed their children before being discharged from the hospital. In 2005, the HHS reported that substantial progress had been made towards this goal (U.S. Department of Health and Human Services 2000, 2005).

One of the impetuses for the promotion of breastfeeding is that it reduces the incidence of childhood illnesses and chronic disease (American Academy of Pediatrics 1997). In addition, advocates of breastfeeding claim that it yields important short- and long-run cognitive development benefits. A number of studies have, in fact, found a positive association between being breastfed and cognitive ability.² However, there is a growing concern that this association may be a reflection of omitted family-level variables.

Two recent, but influential, analyses have attempted to address the omitted-variables problem by using data on sibling pairs. Evenhouse and Reilly (2005) found that breastfeeding was associated with an increase in Peabody Picture Vocabulary Test (PPVT) scores. In contrast, Der et al. (2006) found no relationship between breastfeeding and Peabody Individual Achievement Test (PIAT) scores. Building on the work of Der et al. (2006) and Evenhouse and Reilly (2005), this study exploits sibling differences in order to estimate the effect of breastfeeding on cumulative high school grade point average, high school graduation, and

¹ The Centers for Disease Control and Prevention (2007) and Jacknowitz (2007) provide national data on the prevalence of breastfeeding.

² Anderson et al. (1999), Jain et al. (2002) and Horta et al. (2007) provide reviews of this literature. Also see Kramer et al. (2008a).

college attendance. In addition, we explore the importance of two key mechanisms through which breastfeeding may affect academic achievement: improvements in adolescent health and cognitive ability.

We find that having been breastfed is associated with substantial increases in high school grades and the probability of college attendance. These associations are robust to adding controls for the quality of the respondent's relationship with his or her parents, and the degree of parental involvement in the respondent's education. When measures of adolescent health and cognitive ability are included as explanatory variables, the estimated effect of breastfeeding on academic achievement is attenuated. We conclude that adolescent health and cognitive ability may be important pathways through which breastfeeding affects academic achievement.

II. BACKGROUND

In their recent review of the literature on breastfeeding and cognitive ability, Horta et al. (2007, p. 36) noted that most brands of infant formula lack long chain polyunsaturated fatty acids (LCPUFAs), which have been recognized as “fundamental for normal physical growth and brain maturation” (Wroble et al. 2002, p. 100). Horta et al. went on to cite research by Makrides et al. (1994) showing that breastfed infants have higher concentrations of docosahexaenoic acid, an important LCPUFA, in their brain cortex than their formula-fed counterparts, and hypothesized that the lack of LCPUFAs in infant formula could explain the strong positive relationship between being breastfed and cognitive ability found by researchers such as Johnson et al. (1996) and Mortensen et al. (2002).³

³ Johnson et al. (1996) found that having been breastfed was associated with a 4.6 point IQ increase among 3-year-olds. Mortensen et al. (2002) found that having been breastfed for 7 to 9 months was associated with a 6.6 point increase in adult IQ as compared to being breastfed for less than 1 month. Makrides et al. (1994, p. 189) observed that formula not only lacks docosahexaenoic acid (DHA), but contains a high proportion of linoleic acid (LA),

Although many medical researchers are convinced that the breast milk is richer in nutrients that contribute to brain development than standard infant formula, alternative explanations have been proposed for the positive relationship between being breastfed and IQ. For instance, it is possible that, on average, mothers who breastfeed provide a more stimulating home environment than those who do not breastfeed (Mortensen et al. 2002), or that the act of breastfeeding creates a closer bond between mother and child. If this latter explanation is correct, then mothers who elect not to breastfeed could potentially compensate through other activities such as cuddling, talking or singing.

In order to control for the influence of difficult-to-measure factors having to do with the home environment, Der et al. (2006) used data on 545 sibling pairs from the 1979 National Longitudinal Survey of Youth. They found that being breastfed was associated with only a small, statistically insignificant increase in PIAT scores, and concluded that, “while breastfeeding has many advantages for the child and mother, enhancement of the child’s intelligence is unlikely to be among them” (p. 945). The Der et al. (2006) study can be viewed as casting doubt on whether breastfeeding is causally related to cognitive development. However, a large randomized trial study recently conducted in Belarus came to the opposite conclusion to that of Der et al. (2006). Specifically, Kramer et al. (2008a, p. 578) concluded that, “prolonged and exclusive breastfeeding improves children’s cognitive development.” Additional support for the hypothesis that breastfeeding improves cognitive development comes from Evenhouse and Reilly (2005). These authors used data on 2,734 sibling pairs from the National Longitudinal Study of Adolescent Health, the same data source as is used in the current study. They found that having been breastfed was associated with an increase in PPVT scores,

which could inhibit an infant’s ability to synthesize DHA. Raising issues of effectiveness, safety and cost, Wroble et al. (2002) argued that producers should not be forced to add LCPUFAs to infant formula.

although there was no evidence that breastfeeding impacted a variety of health measures or self-reported grades.

Aside from Evenhouse and Reilly (2005), we know of only three other previous studies that have examined the association between breastfeeding and academic outcomes such as high school grades or college attendance (as opposed to intelligence/cognitive ability): Richards et al. (2002), using data on individuals born in the United Kingdom in 1946, found that having been breastfed was associated with an increase in the probability of attaining an advanced degree; Victora et al. (2005), using data on 18-year old males in Brazil, found that having been breastfed was associated with an increase in the number of years of schooling completed; and Horwood and Fergusson (1998), using data on individuals born in Christchurch New Zealand in 1977, found that having been breastfed was associated with higher test scores in reading and math, and a lower probability of leaving high school without a degree.

Neither Richards et al. (2002), nor Victora et al. (2005), nor Horwood and Fergusson (1998) used sibling data, and therefore one potential explanation for the positive relationship between breastfeeding and academic achievement documented by these authors is that it is a reflection of family-level unobservables such as maternal intelligence or the quality of the mother-infant interactions. An alternative explanation is that the relationship is causal in nature and is driven by the cognitive benefits of breastfeeding. In fact, Richards et al. (2002) found evidence that the effect of having been breastfed on attaining an advanced degree worked almost entirely through cognitive ability measured at the age of 15.⁴ Finally, the health benefits of breastfeeding may explain its relationship to achievement. If improved health allows children to

⁴ Numerous studies have shown that IQ is strongly related to academic performance. These studies include: McCall (1977), Brodnick and Ree (1995), Frey and Detterman (2004), Duckworth and Seligman (2005), Chamorro-Premuzic and Furnham (2006), Spinks et al. (2006), and Leeson et al. (2008). Zax and Rees (2002) found that one-third or more of the effect of IQ on adult earnings was explained by academic performance.

avoid missing school, or even to study harder or more efficiently, then it is possible that it explains the positive relationship between having been breastfed and academic achievement.⁵

The empirical analysis below attempts to distinguish between the above hypotheses. In order to control for the influence of unobservables, we rely on within-family variation for identification. Following Evenhouse and Reilly (2005), who used the number of joint respondent-mother activities to account for within-family heterogeneity, we test the sensitivity of our estimates to controlling for the quality of the adolescent-mother relationship and the degree of parental involvement in the respondent's education. After documenting a positive association between breastfeeding and long-term academic outcomes, we examine the potential pathways through which breastfeeding might operate. Because the Adolescent Health study administered a shortened version of the PPVT to its respondents, we are able to test whether breastfeeding impacts high school grades, the probability of high school graduation, and the probability of college attendance through cognitive ability. In addition, the Adolescent Health data contain extensive information on the health of respondents when most were between the ages of 12 and 18. This information allows us to examine whether adolescent health mediates the relationship between having been breastfed and academic achievement.

III. DATA AND BASIC MEASURES

The data used in this study come from the National Longitudinal Study of Adolescent Health, conducted by the Carolina Population Center at the University of North Carolina at

⁵ As noted in the introduction, there is strong evidence that breastfeeding provides important health benefits, such as immunization from infectious illnesses and a reduction in the likelihood of chronic illnesses (American Academy of Pediatrics 1997). Moreover, there is evidence that childhood health strongly predicts educational attainment (Case et al. 2005).

Chapel Hill. The Adolescent Health data collection effort began with the identification of more than 26,000 schools in the United States that served 11th graders and had an enrollment of at least 30 students. Eighty high schools were chosen from this population with unequal probability based on their size, region of the country, level of urbanization, type (public vs. private), and racial mix. Most were then matched with a junior high or middle school from the same community, bringing the total number of participating schools to 132.

From the student rosters of these 132 schools, a core sample was randomly chosen to be administered the Adolescent Health Wave I (baseline) in-home survey, which was completed by 20,746 adolescents between April and December of 1995, and produced a nationally representative sample of students in grades 7 through 12. A follow-up survey was administered approximately one year later, and a second follow-up, the Wave III in-home survey, was administered in 2001 when respondents were between the ages of 18 and 28.⁶

Three outcome variables were constructed from the Adolescent Health data. The first is equal to 1 if the respondent had received a high school diploma by the time of the Wave III survey in 2001, and equal to 0 if he or she dropped out. The second is equal to 1 if the respondent was attending college at the time of the Wave III survey or had completed at least one year of college prior to the survey.⁷ The third outcome is the respondent's cumulative high

⁶ Further information regarding the Adolescent Health data collection effort is available from a variety of sources. See, for instance, Harris et al. (2002).

⁷ A small number of respondents (n = 12) were excluded from the analysis because they were still attending high school when the Wave III survey was administered in 2001. Inclusion of these respondents in the analysis did not qualitatively change the results presented below. Because 11.3% of the respondents were still teenagers when interviewed at Wave III, it is likely that some proportion subsequently graduated high school and went on to attend college. Restricting the sample to respondents who were at least 20 years of age at the time of the Wave III interview produced qualitatively similar estimates of the relationship between having been breastfed and achievement as those presented below.

school grade point average (GPA), which was calculated using the official transcripts made available to researchers with access to the restricted-use Adolescent Health data.

Information on whether and for how long the respondent was breastfed comes from answers to the Adolescent Health parent in-home questionnaire, administered at the time of the Wave I survey. One of the respondent's parents (typically the biological mother) was asked for how long the respondent was breastfed. Possible answers were:

1. less than 3 months
2. 3 months to less than 6 months
3. 6 months to less than 9 months
4. 9 months to less than 12 months
5. 12 months to less than 24 months
6. 24 months or more
7. He/She was not breastfed
8. Don't know

Based on these answers, two breastfeeding variables were created: *Breastfed* (equal to 1 if the respondent was breastfed, and equal to 0 otherwise), and *Months Breastfed*, which was based on the midpoints of the categories listed above (for instance, respondents in the less-than-3-months category were assigned a breastfeeding duration of 1.5 months, respondents in the 3-months-to-less-than-6-months category were assigned a breastfeeding duration of 4.5 months).⁸ Because no follow-up questions were asked of the respondent's parent, we cannot distinguish between breastfeeding and being fed breast milk from a bottle.

Approximately 56 percent of the Adolescent Health respondents with non-missing information on the variables used in this analysis were never breastfed. Among those who were,

⁸ *Months Breastfed* was set equal to 24 for respondents whose parent reported that were breastfed for 24 months or more. The results reported below were not sensitive to setting *Months Breastfed* equal to 30 or 36 for these respondents. Approximately three and a half percent of respondents had parents who filled out the parental questionnaire, but refused to answer the breastfeeding question or answered "don't know." The results reported below were not sensitive to treating these respondents as not having been breastfed, nor were they sensitive to placing them in a separate breastfeeding category.

the mean duration was 7 months. Appendix Table 1 shows the means of *Breastfed* and *Months Breastfed* by the outcomes under study.⁹ It provides evidence of a positive association between having been breastfed and academic achievement. For instance, respondents with better high school GPAs were more likely to have been breastfed, and conditional on having been breastfed, respondents with better high school GPAs were typically breastfed longer.

IV. EMPIRICAL MODEL

We begin by testing whether the positive association between breastfeeding and academic achievement documented in Appendix Table 1 is robust to controls for a standard set of observables. Specifically, we estimate the following using the full sample of respondents:

$$A_i = \beta_0 + \beta'_1 \mathbf{X}_i + \beta_2 \text{Breastfed}_i + \varepsilon_i, \quad (1)$$

where A_i represents the achievement of respondent i ; the vector \mathbf{X}_i includes controls for the respondent's age (at Wave III), race and ethnicity, household income, family size, birth order, parental education, whether the respondent's mother worked (at Wave I), and region¹⁰; the variable *Breastfed* is define above; and ε_i is a random error term. Our primary focus is on β_2 ,

⁹ The means in Appendix Table 1 are based on unweighted data. Using the Wave III longitudinal sample weights, we estimate that 46.9 percent of respondents in our sample had been breastfed as infants, a figure that is consistent with the results of breastfeeding surveys conducted during the period in which the Adolescent Health respondents were born. For instance, according to Martinez and Nalezienski (1981), 45.1 percent of infants were breastfed at one week of age in 1978, and 49.7 percent were breastfed in 1979. Martinez and Krieger (1985) found that 54 percent of infants were breastfed in 1980 and that 56.4 percent were breastfed in 1981, but argued that these estimates were based on data in which blacks and other minorities were underrepresented, and noted that blacks were much less likely to breastfeed than whites during this period. Using a revised set of weights to account for the underrepresentation of minorities in their data, Martinez and Krieger (1985) found that 34 percent of infants were being breastfed three to four months after birth in 1983, and that 25 percent of infants were being breastfed 5 to 6 months after birth. In our data, 32.3 percent of respondents were breastfed for 3 months or longer, and 21.4 percent were breastfed for 6 months or longer.

¹⁰ The full set of controls is provided in Appendix Table 2.

which represents the relationship between having been breastfed and educational attainment, although equation (1) can easily be modified to explore the relationship between the length of time a respondent was breastfed and his or her academic achievement by replacing *Breastfed* with *Months Breastfed*.¹¹

The regression model outlined above can generate an unbiased estimate of the effect of breastfeeding provided that the appropriate controls are included on the right-hand side. However, in practice it is often difficult to obtain information on all of the controls that might be in the vector \mathbf{X}_i . For instance, although we can control for the highest degree received by the respondent's parent, we have no information on the mother's cognitive ability, her parenting skills, her work history, her health endowment, or the health care services she received while pregnant.

In order to address this issue, we restrict our sample to siblings raised in the same family. Following Der et al. (2006) and Evenhouse and Reilly (2005), estimates of the following equation in which κ_j is a vector of family fixed effects are presented:

$$A_{ij} = \beta_0 + \beta'_1 \mathbf{X}_i + \beta_2 \text{Breastfed}_{ij} + \kappa_j + \varepsilon_{ij}, \quad (2)$$

where the vector \mathbf{X}_i includes controls for gender, birth weight, age (at Wave III), and number of siblings. The advantage of this estimation strategy is that only the within-family variation is used to estimate the effect of breastfeeding on achievement. All factors common to both siblings are controlled for by the vector κ_j , eliminating the need to observe and measure a myriad of potentially important confounders.

¹¹ We also allow for nonlinear effects by including a set of categorical variables for breastfeeding duration.

While the estimation of (2) accounts for family-level unobservables, there are at least three drawbacks to this identification strategy that are worthy of note. First, it entails a substantial reduction in sample size and identifying variation. Second, estimates obtained from a sample of siblings may not be generalizable to only children. Third, controlling for family fixed effects does not account for unmeasured within-family heterogeneity resulting from the fact that the decision to breastfeed is not random and is in fact potentially driven by factors related to the respondent's academic achievement.

A new mother's decision to work represents one possible source of unmeasured within-family heterogeneity. Numerous studies have shown that the decision to work outside the household following the birth of a child is negatively related to breastfeeding (Ryan and Martinez 1989, Blau et al. 1996, Lindberg 1996, Chatterji and Frick 2003, and Baker and Milligan 2008). If having a working mother in turn affects cognitive ability, then the result could be a biased estimate of β_2 .¹² It is also possible that maternal health is related to whether a child is breastfed, or the decision to breastfeed may reflect some aspect of the mother's relationship with her child or even the personality of the child. For instance, if one sibling is systematically favored over the other, then being breastfed may be positively correlated with other parental investments that could impact academic achievement (Evenhouse and Reilly 2005, p. 1789). Alternatively, mothers may try to equalize inputs among their children by, for instance, spending more time with the sibling who was not breastfed. In order to minimize the influence of

¹² There is, in fact, evidence that the decision to work on the part of new mothers can have small negative effects on the cognitive ability of their children. Ruhm (2004), for instance, found that working was associated with lower cognitive ability for 3 and 4 year-olds, but not for 5 or 6-year-olds. Gregg et al. (2005, p. F74) found negative effects associated with maternal work, but noted that they were "quantitatively small and often insignificant." See Waldfogel et al. (2002) for a brief review of the earlier literature in this area. It is also possible that the dissolution of a marriage could impact both the decision to work and to breastfeed. There is strong evidence that having parents who divorce negatively affects educational outcomes (Gruber 2004), although divorce presumably impacts all of the children in a family.

unmeasured within-family heterogeneity due to the fact that breastfeeding is not randomly assigned, we take advantage of the wealth of respondent-specific information available in the Adolescent Health data.

Because there is strong evidence that birth weight is related to the mother's consumption of prenatal care (Liu 1999) and whether she smoked, drank, or used other substances during pregnancy (Shankaran et al. 2004), all specifications include a continuous birth weight measure (in grams) as a control.¹³ This measure should capture any within-family differences in maternal health investments that would go unmeasured in an empirical model that did not include birth weight as a control.

In addition, although the Adolescent Health data do not contain information on maternal work history or time inputs at the time of the respondent's birth, all specifications include a set of indicators for the number of siblings at the birth of the respondent and the number of siblings born subsequent to the birth of the respondent.¹⁴ Previous studies have shown that the mother's decision to work is strongly influenced by the number of young children in the household.¹⁵ These indicators are intended to control for differences related to birth order or family size in the probability that the respondent's mother chose to stay out of the labor market in order to provide child care after the birth of the respondent. The sibling indicators should also capture other

¹³ Replacing birth weight in grams with an indicator of low birth weight produced qualitatively similar results to those reported in the paper.

¹⁴ Specifically, 5 indicators are included: a variable equal to 1 if the respondent had one sibling at birth, and equal to 0 otherwise; a variable equal to 1 if the respondent had two siblings at birth, and equal to 0 otherwise; a variable equal to 1 if the respondent had three or more siblings at birth, and equal to 0 otherwise; a variable equal to 1 if the respondent had two younger siblings, and equal to 0 otherwise; and a variable equal to 1 if the respondent had three or more younger siblings, and equal to 0 otherwise. The omitted category is composed of respondents with one younger sibling.

¹⁵ In particular, mothers with young children tend to reduce their labor supply (Browning 1992).

differences in parental investments due to the potential tradeoff between child quantity and quality.¹⁶

Finally, although the Adolescent Health data provide no information on the quality of the infant-mother relationship, a number of questions were asked with regard to the quality of the *adolescent*-mother relationship. We experiment with using the answers to the following four questions as additional controls:

1. How close do you feel to your mother? (=1 “not at all”; =2 “very little”; =3 “somewhat” or “quite a bit”; =4 “very much”)
2. How much do you think [your mother] cares about you? (=1 “not at all”; =2 “very little”; =3 “somewhat” or “quite a bit”; =4 “very much”)
3. Do you get along well with your child? (=1 “always”; =2 “often”; =3 “sometimes”; =4 “seldom”; =5 “never”)
4. Do you and your child make decisions about his/her life together? (=1 “always”; =2 “often”; =3 “sometimes”; =4 “seldom”; =5 “never”)¹⁷

Controlling for the quality of the adolescent-mother relationship in this fashion is similar to the approach taken by Evenhouse and Reilly (2005) who used the number of joint respondent – mother activities as an independent variable in order to, “distinguish the effects of infant feeding mode from the effects of a more general pattern of unequal investment in two siblings” (p. 1796).

¹⁶ Becker (1960) and Becker and Lewis (1973) proposed a model in which parents face a tradeoff between child quantity and quality. According to this model, family size and parental investments in their children should be negatively related. Breastfeeding can be thought of as an investment in child quality, but the amount of time spent with a child and the quality of that time are other potentially important forms of parental investment. The sibling indicator variables are intended to control for any differences in parental investment correlated with family size and the breastfeeding decision. Price (2008) provides evidence that family size and birth order are important determinants of the amount of quality time parents spend with their children.

¹⁷ The first two questions were asked as part of the Wave I in-home survey; the final two come from the parent questionnaire. Four sets of dichotomous variables were created capturing all of the possible answers to each question and missing values. Appendix Table 2 shows that respondents from the same family often provided different answers to these questions. For instance, 45.0 percent of respondents in the sibling sample reported a different degree of closeness to their biological mother than did their sibling, and 39.0 percent of parents reported differences in how well they got along with their children.

We also experiment with adding a set of controls intended to measure the degree to which the respondent's parents were involved in their child's education at Wave I. The controls are based on answers to the following four questions:

1. Have you talked about your school work or grades with your mother in the past 4 weeks?
2. On a scale of 1 to 5, where 1 is low and 5 is high, how disappointed would [your mother] be if you did not graduate from high school?
3. On a scale of 1 to 5, where 1 is low and 5 is high, how disappointed would [your mother] be if you did not graduate from college?
4. If [your child] could be one of the following in high school, which would be most important to you? (a) a brilliant student, (ii) a leader in school activities, (iii) an athletic star, (iv) the most popular.¹⁸

If estimates of β_2 are not robust to adding controls for the quality of the adolescent-mother relationship and the degree of parental involvement in the respondent's education, this would support the hypothesis that breastfeeding is associated with long-term differences in parental investment patterns between siblings.

V. RESULTS

Full Sample Estimates

The top panel of Table 1 presents OLS estimates of the relationship between breastfeeding and the three outcome variables. The results suggest that having been breastfed is

¹⁸ The first three questions were asked as part of the Wave I in-home survey in-home; the final question comes from the parent questionnaire. Four sets of dichotomous variables were created capturing all of the possible answers to each question and missing values. Appendix Table 2 of the appendix shows that respondents from the same family often provided different answers to these questions. For instance, 41.1 percent of respondents reported differences from their sibling in whether their mother had talked about grades or school work in the previous four weeks, and 57.7 percent reported differences in the degree of disappointment their mother would feel if they did not graduate from high school.

associated with a 0.118 increase in high school GPA, or an approximately 4.6 percent increase in the GPA of the typical Adolescent Health respondent. It is also associated with a 0.024 increase in the probability of graduating from high school, and a 0.067 increase in the probability of attending college.

In the second panel of Table 1, we replace the dichotomous measure, *Breastfed*, with the continuous measure, *Months Breastfed*, introduced in Section III. The results suggest that the length of time a respondent was breastfed is positively related to the three outcomes. Specifically, an additional month of breastfeeding is associated with a 0.010 increase in high school GPA. It is also associated with a 0.002 increase in the probability of high school graduation, and a 0.006 increase in the probability of college attendance.

In the third and final panel of Table 1 we show the relationship between achievement and three duration categories (breastfed 1-5 months, 6-11 months, and 12 or more months). This specification allows breastfeeding duration to have a nonlinear effect on academic achievement. The omitted category is composed of respondents who were never breastfed. The results confirm that breastfeeding duration is positively related to the outcomes under study.¹⁹

In summary, the results in Table 1 are consistent with much of the previous literature (Horwood and Fergusson 1998; Richards et al. 2002; Victora et al. 2005) and, if naively interpreted, suggest that breastfeeding leads to substantial increases in academic achievement and provide evidence of a dose-response relationship. However, if family-level unobservables are correlated with both breastfeeding and the outcomes under study, then this interpretation may

¹⁹ For instance, having been breastfed for less than 6 months is associated with a 0.021 increase in the probability of graduating high school as compared to not having been breastfed (the omitted category); having been breastfed for 6 to months is associated with a 0.026 increase in this probability; and having been breastfed for 12 months or more is associated with a 0.036 increase in this probability.

be incorrect. Below we attempt to control for unmeasured family-level factors through the examination of sibling data and the introduction of family fixed effects.

Estimates Based on Sibling Data

The top panel of Table 2 presents fixed effects estimates of the impact of having been breastfed (yes/no) on high school grades, the probability of graduating high school, and the probability of attending college. The odd-numbered columns show estimates of a baseline model. The even-numbered columns show estimates controlling for the quality of the adolescent-mother relationship and the degree of parental involvement in the respondent's education.²⁰

The results suggest that having been breastfed leads to a substantial improvement in academic performance as measured by high school grades. Specifically, it is associated with a 0.325 to 0.380 increase in high school GPA, or a 12.2 to 14.3 percent increase for the typical respondent in the sibling sample. There is no evidence that the estimated effect of breastfeeding (yes/no) on grades is reduced by the inclusion of controls for parental educational involvement or the quality of the adolescent-mother relationship.

²⁰ Because siblings in the same family who received identical breastfeeding treatments as infants do not contribute to the identification of β_2 , the sample is restricted to siblings who received different treatments. If a family contributed information on two siblings to the Adolescent Health data, this restriction means that one sibling was breastfed, while the other was not. If a family contributed three siblings, then at least one was breastfed and at least one was not. When grades are the dependent variable, the sample is composed of 126 siblings from 59 families (7 of whom were either monozygotic or dizygotic twins or twins of unknown zygosity). When high school completion or college attendance is on the left-hand side, the sample is composed of 191 siblings from 90 families (17 of whom were either monozygotic or dizygotic twins or twins of unknown zygosity). If the sample is expanded to include all sibling pairs in the Adolescent Health data, the results are qualitatively unchanged from those presented.

Panels II and III of Table 2 present fixed effects estimates of the relationship between breastfeeding duration and academic achievement.²¹ The results indicate that *Months Breastfed* is positively related to high school grades, providing evidence of a dose-response relationship. With or without the added controls, an increase in breastfeeding duration of one month is associated with an increase in high school GPA of 0.019 points, or about 1 percent for the typical respondent in the sibling sample (Panel II). Having been breastfed for 1-5 months is associated with a 0.214 to 0.298 point increase in GPA as compared to never having been breastfed, and having been breastfed for 6-11 months is associated with a 0.373 to 0.454 point increase (Panel III).²²

Although the results presented in Table 2 provide little evidence that breastfeeding is related to the probability of graduating from high school, we do find evidence of a positive relationship between *Months Breastfed* and the probability of attending college. Specifically, an additional month of breastfeeding is associated with a 0.014 increase in the probability of college attendance (Panel II). In addition, there is evidence that the college attendance effect is largest for respondents who were breastfed for 12 or more months, while having been breastfed for 1 to 5 months is not associated with a statistically significant increase in the probability of attending college (Panel III). These latter estimates are reduced somewhat, but are still statistically

²¹ Again, the sample is restricted to siblings who received different breastfeeding treatments as infants. This restriction implies that if a family contributed information on two siblings to the Adolescent Health data, each was breastfed for different periods of time. If a family contributed information on three siblings, then at least one was breastfed for a different period of time than the other two. When grades are the dependent variable, the sample is composed of 333 siblings from 159 families. When high school completion or college attendance is on the left-hand side, the sample is composed of 459 siblings from 220 families. If the sample is expanded to include all sibling pairs in the Adolescent Health data, the results are qualitatively unchanged from those presented.

²² Having been breastfed for 12 or more months is associated with a 0.274 to 0.287 increase in GPA, although these estimates are less precise than the estimates for the other two duration categories. In general, controlling for the quality of the adolescent-mother relationship and the degree of parental involvement in the respondent's education tends to reduce the estimated coefficients of the breastfeeding duration indicators.

significant, after controlling for the quality of the adolescent-mother relationship and the degree of parental involvement in the respondent's education.

Falsification Tests

One method of testing whether unequal parental investment is driving the results in Table 2 is through the use of falsification tests. This strategy requires identifying a set of outcomes that should be impacted by parental investments of time (for instance, in the form of supervision), but in theory should not be affected by breastfeeding.

Using sibling data, we examine the relationship between breastfeeding and four such outcomes measured at Wave I: an indicator of binge drinking equal to 1 if the respondent reported being “drunk or very high on alcohol” at least twice in the previous year, and equal to 0 otherwise; an indicator of whether the respondent smoked cigarettes in the past month; the number of hours of television the respondent watched per week; and an indicator for whether the respondent had been in a physical fight in the last year.²³ Because there is very little evidence in the medical literature that breastfeeding is related to any of these outcomes, a causal interpretation of the results presented in Table 2 would be called into question if we found evidence of breastfeeding effects.²⁴

²³ The means of these outcomes are presented in Appendix Table 2.

²⁴ We identified two studies that examined the effects of having been breastfed on substance use. Using a sample of Danish men, Goodwin et al. (1999) found that having been breastfed for less than 3 weeks was associated with alcohol dependence as an adult. In contrast, Fergusson and Woodward (1999) used data on adolescents from New Zealand to explore if breastfeeding was related to delinquent behaviors, substance use, or mental health. They found no evidence that breastfeeding was related to these outcomes and concluded that, “it would be unwise to promote breastfeeding on the grounds that it leads to better social adjustment” (p. 155). Kramer et al. (2008b), who used a randomized trial study to examine the effects of breastfeeding duration on child behavior, echoed this conclusion. They wrote, “[d]espite the substantial increase observed in both the duration and the exclusivity of breastfeeding in the experimental group, that increase did not lead to any detectable reductions in emotional difficulties, hyperactivity, or conduct...” (p. e439).

Table 3 shows the falsification test results. Without exception, the estimated effect of breastfeeding falls short of statistical significance at conventional levels. Moreover, the estimated coefficient is often of the opposite sign than would be expected if breastfeeding were proxying for unequal parental investment. For instance, having been breastfed is associated with a 0.035 *increase* in the probability of the respondent was drunk more than three times in the past year and a 0.057 *increase* in the probability of smoking in the last 30 days. This pattern of results bolsters the case for interpreting the results in Table 2 as causal.

Exploring Potential Pathways

In Table 4 we explore two potential pathways through which having been breastfed might impact academic achievement. Column (1) of Table 4 reproduces the fixed effects estimates of the relationship between breastfeeding and high school grades originally presented in Table 2. In column (2) we show what happens to these estimates when the PPVT score, a measure of cognitive ability, is added to \mathbf{X}_i .²⁵ Controlling for the PPVT score reduces, but does not eliminate, the estimated effect of breastfeeding on high school grades. For instance, the estimated coefficient of *Breastfed* falls from 0.325 to 0.268, a reduction of about 18 percent (Panel I). A similar pattern of results emerges when *Breastfed* is replaced by the duration variables (Panels II and III).

Column (5) of Table 4 reproduces the estimates of the relationship between breastfeeding and college attendance originally presented in Table 2. In column (6) we add the PPVT score as an explanatory variable. The estimated effect of having been breastfed for an additional month

²⁵ The PPVT measures verbal comprehension and vocabulary. The respondent is read a word, and then chooses which of four illustrations best fits the word. The standard PPVT consists of 78 items (Harris and Thomas 2002). Adolescent Health respondents were administered 39 of these 78 items.

on the probability of college attendance falls from 0.014 to 0.013; the estimated effect of having been breastfed for 6 to 11 months on the probability of college attendance (as compared to never breastfed) falls from 0.154 to 0.136; the estimated effect of having been breastfed for 12 or more months falls from 0.233 to 0.223.

The findings discussed above provide some evidence that cognitive ability mediates the relationship between breastfeeding and academic achievement. However, it would seem that cognitive ability, at least as measured by the PPVT score, cannot account for the entire effect of breastfeeding on achievement. One interpretation of this finding is that the PPVT score does not adequately capture IQ gains due to breastfeeding. An alternative interpretation is that there exist additional mediators through which breastfeeding impacts schooling.

One such mediator may be adolescent health. There is strong evidence in the medical literature that breastfeeding protect infants from a variety of ailments. The case for long-term health benefits is weaker, but nevertheless many medical professionals argue that breastfeeding confers lifelong immunologic protection (Jackson and Nazar 2006). Case et al. (2005) provide evidence that childhood health is a strong predictor of educational attainment and adult socioeconomic status.

In order to test whether adolescent health mediates the effect of having been breastfed on academic achievement, we created two health indexes. The first was based on answers to 9 questions asked at Wave I about the respondent's general health; the second was based on answers to the same 9 questions asked at Wave II. For example, respondents were asked how frequently in the last 12 months they had had a stomach ache. If they answered "about once a week," "almost every day," or "every day" they were coded as suffering from stomach aches. Similarly, respondents were asked about headaches, feeling hot, cold sweats, feeling physically

weak, sore throats or coughs, frequent or painful urination, and feeling “very sick.” Adding up the number of ailments reported by a respondent produced an adolescent health index ranging from 0 to 9. Respondents were also asked at the Wave I and II interviews about the number of times they were absent from school in the past school-year for a full day with an excuse (“for example, because you were sick or out of town”).²⁶ Possible responses, which were dichotomized, included “never” (the omitted category), “1 or 2 times,” “3 to 10 times,” or “more than 10 times.”²⁷

In columns (3) and (7) of Table 4, we introduce controls for the number of excused absences from school and the adolescent health indices described above to the baseline estimating equation. The results suggest that adolescent health mediates the relationship between having been breastfed and academic performance as measured by high school grades. For instance, the estimated coefficient of *Breastfed* falls from 0.325 to 0.236 when the adolescent health controls are added. It falls to 0.150 and loses statistical significance when controls for both cognitive ability and adolescent health are added. There is also evidence that adolescent health can explain part of the relationship between having been breastfed and college attendance. For instance, the estimated coefficient of *Months Breastfed* falls from 0.014 to 0.012 when the adolescent health controls are added, and falls to 0.011, or 21 percent, when controls for both cognitive ability and adolescent health are added.

²⁶ Using state-mandated test date shifts and weather-related school cancellations as sources of exogenous variation in instructional time, Hansen (2007) found that losing one day of school can reduce test scores by .005 to .039 standard deviations. Taking a similar approach to identifying the effects of instructional time on student performance, Marcotte (2007) found that heavy snowfall was associated with a significant decrease in test scores. Romer (1993) and Durden and Ellis (1995) provide evidence that absences lead to lower grades in economics classes.

²⁷ Because of collinearity issues, the Wave I “3 to 10 times” category was combined with the Wave I “more than 10 times” category.

VI. CONCLUSION

Although numerous studies have investigated the effect of breastfeeding on cognitive ability and academic achievement, most have struggled with the issue of unobservables. If, for instance, mothers who choose to breastfeed on average provide a more stimulating environment to their children, then the standard estimates in the literature may be misleading.

The current study builds on the work of Evenhouse and Reilly (2005) and Der et al. (2006) in that we also utilize sibling data to control for family-level unobservables. Fixed effects results suggest that being breastfed is associated with substantial increases in high school grades and the probability of college attendance. Because these estimates are potentially subject to within-family heterogeneity bias due to, for instance, parents systematically favoring one sibling over the other, we exploit the wealth of information available in the Adolescent Health data to control for the quality of the adolescent-mother relationship and parental involvement in the respondent's education. These measures are far from perfect, but tellingly their inclusion has only a modest impact on our estimates of the relationship between being breastfed and academic achievement. In fact, our estimates often retain their magnitude with their inclusion.

The case for interpreting the fixed effects estimates of the relationship between being breastfed and academic achievement as casual is bolstered by falsification tests. There is very little evidence in the medical literature that being breastfed is related to drinking, smoking, the amount of television watched, and fighting. In fact, regressions based on sibling data show that being breastfed is unrelated to these alternative outcomes, a pattern of results that suggests unmeasured within-family heterogeneity due to unequal parental investment is unlikely to be an issue.

The final section of the paper explores the mechanisms through which breastfeeding might be causally related to long-term academic achievement. We argue that the two obvious conduits are cognitive ability and health. In fact, these factors when simultaneously entered as controls explain more than one-half of the estimated effect of length of time breastfed on high school grades. In contrast, they explain only about one-fifth of the effect of breastfeeding on college attendance.

At a minimum, this research shows that the basic results of Horwood and Fergusson (1998), Richards et al. (2002), and Victora et al. (2005) are robust to the use of sibling data. It is clear, however, that more work has to be done in order to identify the precise mechanisms through which having been breastfed is related to academic achievement. The decision to breastfeed is difficult to model given the information available in the Adolescent Health data. We do not know why mothers chose to breastfeed one sibling but not the other, nor can we discern whether a respondent was breastfed or fed breast milk from a bottle. Additional information on the labor force participation decisions of new mothers and whether they fed their infant breast milk from a bottle could help future researchers better distinguish between the effects of breast milk, the act of breastfeeding, and presence of a new mother in the home as opposed to at work. Although we control for the quality of the adolescent-mother relationship, we cannot rule out the possibility that the association between breastfeeding and academic achievement is caused through the creation of a more intimate connection between mother and child. Likewise, although we control for family size and birth order (factors that are related to the labor force participation decisions of new mothers), we cannot rule out the possibility that this association is tied to maternal work and its effect on cognitive ability.

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Table 1. OLS Estimates of Effect of Breastfeeding Duration on Educational Attainment

	<i>Cumulative HS GPA</i>	<i>HS Graduation</i>	<i>College Attendance</i>
	(1)	(2)	(3)
Panel I: Breastfed (yes/no)			
Breastfed	0.118*** (0.017)	0.024*** (0.008)	0.067*** (0.013)
Panel II: Duration of Breastfeeding			
Months Breastfed	0.010*** (0.001)	0.002*** (0.001)	0.006*** (0.001)
Panel III: Duration Categories¹			
1 Month ≤ Breastfed < 6 Months	0.089*** (0.018)	0.021** (0.009)	0.054*** (0.013)
6 Months ≤ Breastfed < 12 Months	0.155*** (0.025)	0.026** (0.010)	0.072*** (0.015)
Breastfed ≥ 12 Months	0.169*** (0.029)	0.036** (0.013)	0.110*** (0.017)
N	10,201	12,651	12,651

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level

Notes: Standard errors corrected for clustering at the family level are in parentheses. Estimates are from unweighted OLS regressions based on data drawn from Waves I and III of the National Longitudinal Study of Adolescent Health. Although not shown, all models include controls for region, and personal, family and school characteristics. Appendix Table 2 lists the controls.

¹Omitted category is composed of respondents who were not breastfed.

Table 2. Family Fixed Effects Estimates of Effect of Breastfeeding Duration on Educational Attainment¹

	<i>Cumulative HS GPA</i>		<i>HS Graduation</i>		<i>College Attendance</i>	
	Baseline	Added Controls	Baseline	Added Controls	Baseline	Added Controls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel I: Breastfed (yes/no)						
Breastfed	0.325*** (0.108)	0.380*** (0.121)	0.021 (0.043)	0.024 (0.043)	0.083 (0.059)	0.092 (0.070)
	[126] {59}	[126] {59}	[191] {90}	[191] {90}	[191] {90}	[191] {90}
Panel II: Duration of Breastfeeding						
Months Breastfed	0.019** (0.008)	0.019** (0.009)	0.001 (0.004)	-0.001 (0.003)	0.014*** (0.005)	0.014*** (0.004)
	[333] {159}	[333] {159}	[459] {220}	[459] {220}	[459] {220}	[459] {220}
Panel III: Duration Categories²						
1 Month ≤ Breastfed < 6 Months	0.298*** (0.110)	0.214* (0.113)	0.029 (0.046)	0.011 (0.044)	0.019 (0.060)	0.037 (0.060)
6 Months ≤ Breastfed < 12 Months	0.454*** (0.124)	0.373*** (0.133)	0.037 (0.053)	0.023 (0.053)	0.154** (0.069)	0.138* (0.070)
Breastfed ≥ 12 Months	0.287* (0.155)	0.274 (0.159)	-0.016 (0.073)	-0.041 (0.064)	0.233*** (0.083)	0.217*** (0.082)
	[333] {159}	[333] {159}	[459] {220}	[459] {220}	[459] {220}	[459] {220}

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level

Notes: Sample sizes are in brackets and unique families are in braces. Standard errors corrected for clustering at the family level are in parentheses. Estimates are from unweighted fixed effects regressions based on data drawn from Waves I and III of the National Longitudinal Study of Adolescent Health. The baseline model includes indicators for the number of older and younger siblings, and controls for the respondent's age at Wave III, birthweight, and the sex of the respondent. Specifications with the added controls also include indicators for the quality of the adolescent-mother relationship and parental involvement in the respondent's education.

Table 3. Falsification Tests¹

	Drunk \geq 3X/Year	Smoked last 30 days	TV Hours per Week	Physical Fight
	(1)	(2)	(3)	(4)
Panel I: Breastfed (yes/no)				
Breastfed	0.035 (0.042)	0.057 (0.043)	-1.35 (1.38)	0.053 (0.050)
	[263] {125}	[263] {125}	[261] {124}	[261] {124}
Panel II: Duration of Breastfeeding				
Months Breastfed	0.005 (0.003)	-0.000 (0.004)	-0.078 (0.138)	0.004 (0.004)
	[606] {288}	[606] {288}	[599] {285}	[604] {287}
Panel III: Duration Categories²				
1 Month \leq Breastfed < 6 Months	0.018 (0.044)	0.058 (0.048)	-0.668 (1.45)	0.037 (0.051)
6 Months \leq Breastfed < 12 Months	0.021 (0.051)	-0.011 (0.057)	-1.02 (1.71)	0.019 (0.067)
Breastfed \geq 12 Months	0.086 (0.061)	0.041 (0.066)	-2.17 (2.76)	0.130 (0.079)
	[606] {288}	[606] {288}	[599] {285}	[604] {287}

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level

Notes: Sample sizes are in brackets and unique families are in braces. Standard errors corrected for clustering at the family level are in parentheses. Estimates are from unweighted family fixed effects regressions based on data drawn from Waves I and III of the National Longitudinal Study of Adolescent Health. All models include indicators for the number of older and younger siblings, and controls for the respondent's age at Wave III, birthweight, and the sex of the respondent.

¹The sample is restricted to siblings with non-missing information on the educational outcome of interest, breastfeeding duration, and sex. In Panel I, the sample is limited to sibling pairs where one sibling was breastfed and one was not. In Panels II and III, the sample also includes siblings with different breastfeeding durations.

²Omitted category consists of respondents who were not breastfed.

Table 4. Examining Factors that Mediate Fixed Effects Estimates of Relationship Between Breastfeeding and Educational Attainment¹

	<i>Cumulative HS GPA</i>				<i>College Attendance</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel I: Breastfed (yes/no)								
Breastfed	0.325*** (0.108)	0.268** (0.110)	0.236** (0.108)	0.150 (0.107)	0.083 (0.059)	0.066 (0.058)	0.079 (0.072)	0.071 (0.070)
Wave I PVT Score		0.017** (0.007)		0.019*** (0.007)		0.007 (0.005)		0.007 (0.005)
1-2 Absences Wave I			-0.381 (0.240)	-0.297 (0.247)			0.096 (0.136)	0.118 (0.133)
3+ Absences Wave I			-0.029 (0.263)	-0.067 (0.269)			0.066 (0.155)	0.029 (0.150)
1-2 Absences Wave II			-0.579*** (0.216)	-0.553** (0.215)			-0.392 (0.239)	-0.094 (0.143)
3-9 Absences Wave II			-0.338 (0.211)	-0.423* (0.219)			-0.135 (0.130)	-0.260* (0.145)
10+ Absences Wave II			-0.268 (0.409)	-0.323 (0.406)			-0.277** (0.128)	-0.233 (0.205)
Illness Index Wave I			-0.047 (0.078)	-0.052 (0.082)			-0.003 (0.034)	-0.019 (0.032)
Illness Index Wave II			-0.006 (0.087)	0.041 (0.083)			-0.020 (0.041)	-0.016 (0.043)
	[126] {59}	[126] {59}	[126] {59}	[126] {59}	[191] {90}	[191] {90}	[191] {90}	[191] {90}

Table 4 Continued

	<i>Cumulative HS GPA</i>				<i>College Attendance</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel II: Duration of Breastfeeding								
Months Breastfed	0.019** (0.008)	0.016* (0.008)	0.011 (0.009)	0.008 (0.008)	0.014*** (0.005)	0.013*** (0.005)	0.012*** (0.005)	0.011** (0.005)
Wave I PVT Score		0.016*** (0.004)		0.016*** (0.004)		0.007** (0.003)		0.007** (0.003)
1-2 Absences Wave I			-0.146 (0.157)	-0.124 (0.147)			0.109 (0.101)	0.117 (0.096)
3+ Absences Wave I			-0.080 (0.160)	-0.083 (0.159)			0.159 (0.101)	0.152 (0.097)
1-2 Absences Wave II			-0.390** (0.151)	-0.359** (0.147)			-0.117 (0.080)	-0.102 (0.079)
3-9 Absences Wave II			-0.364*** (0.132)	-0.389*** (0.136)			-0.155* (0.083)	-0.161** (0.081)
10+ Absences Wave II			-0.574*** (0.182)	-0.574*** (0.188)			-0.238** (0.104)	-0.234** (0.102)
Illness Index Wave I			-0.026 (0.037)	-0.022 (0.034)			-0.010 (0.020)	-0.004 (0.019)
Illness Index Wave II			-0.067 (0.051)	-0.061 (0.049)			-0.012 (0.024)	-0.011 (0.023)
	[333] {159}	[333] {159}	[333] {159}	[333] {159}	[459] {220}	[459] {220}	[459] {220}	[459] {220}

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level

Notes: Sample sizes are in brackets and unique families are in braces. Standard errors corrected for clustering at the family level are in parentheses. Estimates are from unweighted family fixed effects regressions based on data drawn from Waves I and III of the National Longitudinal Study of Adolescent Health. All models include indicators for the number of older and younger siblings, and controls for the respondent's age at Wave III, birthweight, and the sex of the respondent.

¹The sample is restricted to siblings with non-missing information on the educational outcome of interest, breastfeeding duration, and sex. In Panel I, the sample is limited to sibling pairs where one sibling was breastfed and one was not. In Panels II and III, the sample also includes siblings with different breastfeeding durations.

²Omitted category consists of respondents who were not breastfed.

Appendix Table 1. Mean Breastfeeding Rates and Duration of Breastfeeding by Child's Educational Attainment

	<i>Cumulative HS GPA</i>			<i>HS Graduation</i>		<i>College Attendance</i>	
	Lower third (1)	Middle third (2)	Upper third (3)	Dropout (4)	HS Grad (5)	No College (7)	College (8)
Panel I: Breastfed (yes/no)							
Breastfed	0.357 (0.479)	0.454 (0.498)	0.555 (0.497)	0.355 (0.479)	0.462 (0.499)	0.347 (0.476)	0.508 (0.500)
Panel II: Duration of Breastfeeding							
Months Breastfed	2.28 (4.60)	3.05 (5.24)	4.20 (5.94)	2.28 (4.67)	3.27 (5.41)	2.16 (4.46)	3.72 (5.72)
Panel III: Duration Categories							
1 Month ≤ Breastfed < 6 Months	0.217 (0.412)	0.269 (0.443)	0.283 (0.450)	0.215 (0.411)	0.255 (0.436)	0.214 (0.411)	0.271 (0.444)
6 Months ≤ Breastfed < 12 Months	0.093 (0.290)	0.116 (0.320)	0.178 (0.383)	0.092 (0.289)	0.134 (0.341)	0.090 (0.286)	0.152 (0.359)
Breastfed ≥ 12 Months	0.047 (0.212)	0.069 (0.254)	0.094 (0.291)	0.047 (0.212)	0.072 (0.259)	0.042 (0.201)	0.085 (0.279)
N	3,367	3,395	3,439	2,182	10,469	5,049	7,602

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level

Notes: Standard deviations are in parentheses. Means are unweighted and are based on data drawn from Waves I and III of the National Longitudinal Study of Adolescent Health.

Appendix Table 2. Means of Dependent and Independent Variables in Full Sample

<u>Dependent Variables</u>		<u>Control Variables</u>		Public School	0.923 (0.266)
Cumulative High School GPA (Transcript) ¹	2.59 (0.834)	Divorced	0.141 (0.348)	% Enrolled in college courses	47.4 (31.2)
Received High School Diploma (Excluding GED)	0.828 (0.378)	Separated	0.049 (0.215)	Female	0.53 (0.499)
Attend College	0.601 (0.490)	Widowed	0.034 (0.182)	Small School Size	0.161 (0.368)
<u>Breastfeeding Variables</u>		Rural	0.182 (0.386)	Medium School Size	0.377 (0.485)
Breastfed	0.443 (0.497)	Suburban	0.535 (0.499)	Birthweight	3311 (571.1)
Months Breastfed	3.10 (5.31)	West	0.236 (0.425)	Three or more older siblings	0.073 (0.259)
1 Month ≤ Breastfed < 6 Months	0.248 (0.432)	Midwest	0.260 (0.438)	Two older siblings	0.125 (0.330)
6 Months ≤ Breastfed < 12 Months	0.127 (0.333)	South	0.370 (0.483)	One older sibling	0.302 (0.459)
Breastfed ≥ 12 Months	0.068 (0.252)	Catholic	0.261 (0.439)	One younger sibling	0.324 (0.468)
<u>Control Variables</u>		Baptist or Methodist	0.382 (0.486)	Two younger siblings	0.127 (0.333)
Age at Wave 3	21.8 (1.74)	Other Christian	0.198 (0.398)	Three or more younger siblings	0.052 (0.222)
Log Household Income	10.5 (0.811)	Non-Christian Relig	0.041 (0.198)	Parent worked outside the home at Wave I	0.738 (0.440)
Parent Completed High School	0.290 (0.454)	Black	0.213 (0.409)	<u>Falsification Outcomes</u> ²	
Parent Trade School	0.095 (0.294)	Asian	0.056 (0.230)	Drunk ≥ 3X last year	0.172 (0.377)
Parent Some College	0.200 (0.400)	Indian	0.016 (0.125)	Smoked last 30 days	0.267 (0.443)
Parent College Ed	0.147 (0.355)	Hispanic/Other	0.161 (0.368)	TV Hours per week	14,6 (13.2)
Parent Post-College Education	0.096 (0.294)	Class Size	26.4 (5.65)	Physical Fight	0.301 (0.459)
Single Parent	0.052 (0.223)				

Note: Standard deviations appear in parentheses; N = 12,651. Means are unweighted.

¹Sample restricted to those with non-missing transcript information on cumulative GPA; N = 10,201.

²Sample restricted to those siblings analyzed in Table 3.

Appendix Table 3. Mean proportion of siblings who differ on quality of the parent-child relationship and schooling involvement

	Any Breastfeeding Sibling Sample (Panel I)	Months Breastfeeding Sibling Samples (Panels II and III)
Perceived closeness of child to biological mother	0.450 (0.498)	0.460 (0.499)
Perceived belief that biological mother cares for child	0.162 (0.369)	0.179 (0.383)
Parent reports getting along well with child	0.390 (0.489)	0.418 (0.494)
Parent reports that she and child make decisions about life together	0.523 (0.500)	0.490 (0.500)
Parent talked with child about school grades	0.411 (0.493)	0.423 (0.495)
Parent disappointed if child does not complete HS	0.192 (0.395)	0.233 (0.423)
Parent disappointed if child does not attend college	0.577 (0.495)	0.593 (0.492)
Parent's view on child identity in HS (brilliance, leader, etc.)	0.252 (0.453)	0.266 (0.442)

Note: Standard deviations appear in parentheses. Means are unweighted. Sample sizes correspond to those reported in Table 2.