



The effect of breastfeeding on children's educational test scores at nine years of age: Results of an Irish cohort study

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ABSTRACT

This retrospective cross-sectional paper examines the relationship between early breastfeeding exposure and children's academic test scores at nine years of age independent of a wide range of possible confounders. The final sample comprised 8226 nine-year-old school children participating in the first wave of the Growing Up in Ireland study. The children were selected through the Irish national school system using a 2-stage sampling method and were representative of the nine-year population. Information relating to breastfeeding initiation and exposure duration was obtained retrospectively at nine years of age via parental recall and children's academic performance was assessed using standardised reading and mathematics tests. Hierarchical linear regression analysis with robust standard errors to control for clustering at the school level was used to quantify the effect of breastfeeding on children's test scores. Propensity score matching was used to compare treatment effects across groups defined by their propensity to breastfeed. In unadjusted analysis, children who were breastfed scored 8.67 percentage points higher on reading and 7.42 percentage points higher on mathematics compared to those who were never breastfed. While the breastfeeding advantage attenuated appreciably when adjusted for a range of child, maternal, socio-economic and socio-environmental characteristics, children who were breastfed continued to enjoy a significant test score advantage of 3.24 ($p < 0.001$) and 2.23 ($p < 0.001$) percentage points on reading and mathematics respectively compared to those who were never breastfed. Any amount of breastfeeding was associated with significantly higher test scores than no exposure, but evidence of a dose-response relationship was weak. The results of the propensity score matching analysis indicated that the test score advantage of breastfed children is robust and that the magnitude of the effect varies across groups defined by their propensity to breastfeed, being largest amongst the most socially disadvantaged and falling to near zero among the most advantaged group.

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Introduction

Numerous studies have shown that children who were breastfed in infancy score more highly on tests of cognitive ability than children who were not breastfed (Anderson, Johnstone, & Remley, 1999; Mortensen, Michaelsen, Sanders, & Reinisch, 2002; Oddy et al., 2003). What is less clear however, is whether the benefit which breastfeeding provides is the result of a direct nutritional advantage over artificial feeding or the artefact of other socio-economic or environmental factors that influence both breastfeeding initiation and children's cognitive performance (Jacobson & Jacobson, 2006). The former hypothesis has been subjected to rigorous scrutiny and while the magnitude of the association tends to attenuate appreciably when one controls for socio-economic

confounders, studies still tend to demonstrate a beneficial effect of breastfeeding on children's cognitive outcomes.

Anderson et al. (1999) for example conducted a meta-analysis of the available literature and found that the cognitive developmental score of breastfed children was 3.2 points higher than that of bottle-fed children after controlling for covariates such as socio-economic status and parental education. Their analysis of the data revealed that these differences manifested as early as 6–23 months, persisted through childhood (2–9 years) and were still evident in adolescence (10–15 years). Moreover, there was clear evidence of a dose–response relationship with longer breastfeeding exposure conferring higher cognitive developmental gains. Fewer studies have examined whether these putative gains extend into adulthood, though a prospective study found that breastfeeding duration was significantly positively related to IQ scores at 18 and 27 years of age in two separate cohorts independent of a wide range of possible confounding factors (Mortensen et al., 2002).

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However, a separate review by Jain, Concato, and Leventhal (2002), which examined studies for their methodological rigour, was more equivocal regarding the cognitive benefits to be derived from breastfeeding. Of the nine published studies that satisfied their criteria for inclusion, 4 concluded that breastfeeding promotes intelligence and 5 did not. These authors acknowledged the difficulty in trying to reach a balanced conclusion across studies given the varying precision with which breastfeeding has been defined, differences in the set of perinatal, demographic and socio-economic characteristics selected for adjustment, and varying levels of statistical power. They surmised that while the majority of studies concluded that breastfeeding promotes intelligence, the evidence from higher quality studies was less convincing.

Although the early debate centred on the impact of socio-economic variables, more recent studies have begun to explore other socio-environmental factors such as parental nurturance and maternal IQ that may mediate the relationship between breastfeeding and higher cognitive scores (Jacobson, Chiodo & Jacobson, 1999; Jacobson & Jacobson, 2006). A recent study of 302 children participating in a prospective Australian study found that the mean difference in IQ scores for a child who was breastfed for 6 months was only 0.2 of a point higher than those who were never breastfed at 4.5 years of age after adjustment for socio-economic characteristics and the quality of the home environment (Zhou, Baghurst, Gibson, & Makrides, 2007). A retrospective cross-sectional study by Der, Batty, and Deary (2006) which used data collected as part of the National Longitudinal Study of Youth (NLSY) to explore the relationship between breastfeeding and children's cognitive test scores ($n = 5745$) found that while the breastfeeding-IQ relationship remained robust to controls for SES and the parental cognitive stimulation a child receives, it disappeared entirely after adjustment for parental IQ. Two other recent population based studies have also concluded that the effect of breastfeeding on children's IQ is negligible when one includes adequate controls for confounding variables (Gibson-Davis & Brooks-Gunn, 2006; Silva, Mehta, & O'Callaghan, 2006).

It is difficult to reconcile these findings with those of other studies that continue to find a positive association between breastfeeding and cognitive ability (Doyle & Timmins, 2008; Oddy et al., 2003; Whitehouse, Robinson, Li, & Oddy, 2011). Doyle and Timmins (2008) for example, reported evidence of advantages to breastfeeding (after adjustment for confounders including the quality of the home environment) for children's school readiness scores at 3 years of age using the Millennium Cohort Study data. Interestingly, they found that the effects of exclusive breastfeeding tended to level off after 6 months of age, while those for complementary feeding tended to peak around 10–12 months. A recently published study by Oddy, Li, Whitehouse, Zubrick, and Malacova (2011) of 1038 Australian children reported beneficial effects of breastfeeding for 6 months or more for boys, but not girls, when reading, writing and spelling scores were assessed at 10 years of age after controlling for family income, maternal factors, and early stimulation at home through reading (Oddy et al., 2011).

Recognising that observational study designs may suffer from residual confounding, other investigators have attacked this problem using a methodology known as sibling comparison analysis that compares treatment effects for pairs of siblings, one of whom was breastfed, and one of whom was not. Again though, findings across studies have been inconsistent. Thus while Der et al. (2006) reported no significant difference in IQ scores or confounding factors between 332 sibling pairs discordant for breastfeeding status; a study by Evenhouse and Reilly (2005) utilising data for some 2734 sibling pairs participating in the National Longitudinal Study of Adolescent Health found that each additional month of breastfeeding was associated with a significant 0.16 percentile rank increase in Peabody Picture Vocabulary score in the

within-family model (which amounted to about $\frac{3}{4}$ of the between-family effect).

An interesting study is that of Kramer et al. (2008), which randomly assigned more than 17,000 women (matched for baseline characteristics) participating in the Promotion of Breastfeeding Intervention Trial (PROBIT) to one of two conditions. All women participating in the study had already made the decision to breastfeed but those assigned to the experimental condition received an intervention that was designed to increase the duration and exclusivity of breastfeeding. The intervention led to substantially higher rates of breastfeeding among the experimental group at 3, 6, 9 and 12 months of age. When children's cognitive performance was assessed at 6.5 years of age, those in the experimental group had significantly higher scores on the verbal (+7.5 points) and full scale IQ measure (+5.9 points), but not on the performance IQ measure (2.9 points). However, a shortcoming of this study was that the pediatricians who were administering the cognitive tests were not blind to the experimental condition.

This discrepant pattern of results reinforces the need for further studies addressing the effects of breastfeeding on children's development. This paper uses cross-sectional data collected from 8226 children participating in the Growing Up in Ireland study, a cohort study from the Republic of Ireland, to examine the relationship between retrospectively recalled breastfeeding data and children's scores on standardised tests of reading and mathematical ability at nine years of age.

Data and methods

Sample

The sample comprised 8568 nine-year-old school children participating in the Growing Up in Ireland study, a nationally representative cohort study of children living in the Republic of Ireland. The sample was selected through a two-stage sampling method within the national school system. In the first stage, 1105 primary schools from the national total of 3200 were randomly selected using a probability proportionate to size (PPS) sampling method. In the second stage, a random sample of eligible children was selected within each school. Eligible children were those who were born between 1st November 1997 and 31st October 1998. Interviews were carried out with children and parents at home and with teachers within the school. At the school level, a response rate of 82% was achieved, while at the level of the household (i.e. eligible child selected within the school) a total of 57% of children and their families participated in the study. The data were weighted prior to analysis to account for the complex sampling design, which involves the structural adjustment of the sample to the population while maintaining the case base of 8568 children. More detailed information about the sample selection process and derivation of weights is contained in the sampling document that accompanies the anonymised microdata file (ISSDA, 2010). All stages of the Growing Up in Ireland project were subject to rigorous ethical review by the Health Research Board's standing Research Ethics Committee based in Dublin. This included a review of all instrumentation, recruitment, consent, and implementation protocols adopted at all stages of the study.

Missing cases

76 cases (0.8% of the sample) were missing any information on breastfeeding and a further 222 children (2.6%) were missing data on either the reading or maths tests. For most covariates the rate of missing data was low. The exception was household income, which was missing data for some 626 cases (7.3% of the sample).

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