

Association between breastfeeding and intelligence, educational attainment, and income at 30 years of age: a prospective birth cohort study from Brazil

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Summary

Background Breastfeeding has clear short-term benefits, but its long-term consequences on human capital are yet to be established. We aimed to assess whether breastfeeding duration was associated with intelligence quotient (IQ), years of schooling, and income at the age of 30 years, in a setting where no strong social patterning of breastfeeding exists.

Methods A prospective, population-based birth cohort study of neonates was launched in 1982 in Pelotas, Brazil. Information about breastfeeding was recorded in early childhood. At 30 years of age, we studied the IQ (Wechsler Adult Intelligence Scale, 3rd version), educational attainment, and income of the participants. For the analyses, we used multiple linear regression with adjustment for ten confounding variables and the G-formula.

Findings From June 4, 2012, to Feb 28, 2013, of the 5914 neonates enrolled, information about IQ and breastfeeding duration was available for 3493 participants. In the crude and adjusted analyses, the durations of total breastfeeding and predominant breastfeeding (breastfeeding as the main form of nutrition with some other foods) were positively associated with IQ, educational attainment, and income. We identified dose-response associations with breastfeeding duration for IQ and educational attainment. In the confounder-adjusted analysis, participants who were breastfed for 12 months or more had higher IQ scores (difference of 3.76 points, 95% CI 2.20–5.33), more years of education (0.91 years, 0.42–1.40), and higher monthly incomes (341.0 Brazilian reals, 93.8–588.3) than did those who were breastfed for less than 1 month. The results of our mediation analysis suggested that IQ was responsible for 72% of the effect on income.

Interpretation Breastfeeding is associated with improved performance in intelligence tests 30 years later, and might have an important effect in real life, by increasing educational attainment and income in adulthood.

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Introduction

Breastfeeding has clear short-term benefits for child survival through reduction of morbidity and mortality from infectious diseases.¹ Breastfeeding also has long-term benefits. The results of a meta-analysis² of 14 observational studies showed that breastfeeding was associated with an increase of 3.5 points (95% CI 1.9–5.0) on intelligence tests at childhood and adolescence. Two randomised trials^{3,4} have also investigated this topic. In Belarus, intelligence quotients (IQs) at 6.5 years of age were, on average, 7.5 points higher in a group whose mothers received breastfeeding promotion than in a comparison group.³ In the UK, the mean IQ was higher in preterm children who were randomly allocated to receive breast milk than in those who received formula.⁴

Three observational studies^{5–7} have explored the association between breastfeeding and performance in intelligence tests in adults. In Denmark, Mortensen and colleagues⁵ noted that breastfeeding duration was

positively associated with performance on the Wechsler Adult Intelligence Scale (mean age 27 years), while Richards and colleagues⁶ reported a positive association with performance in the National Adult Reading Test in participants aged 53 years in the 1946 British cohort. In the Hertfordshire cohort, participants were classified as being bottle-fed, breastfed, or mixed fed; the breastfed group had increased mean scores in the AH4 IQ test, but the association disappeared after the investigators controlled for confounding variables.⁷

Evidence from observational studies from high-income countries has been criticised because of the social patterning of breastfeeding. In particular, longer durations for mothers with high socioeconomic position than for those with low position might positively confound, and thus overestimate, the benefit of breastfeeding. Comparison of observational studies with different confounding structures has been used to improve causal inference. Brion and colleagues⁸ reported that breastfeeding was positively associated with performance

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in intelligence tests in the 1993 Pelotas (Brazil) and ALSPAC (UK) birth cohorts. Because breastfeeding was positively associated with family income in ALSPAC but not in Pelotas, the positive association in Brazil was probably not caused by residual confounding.

Whether or not apparently small IQ gains affect real life achievement—eg, educational attainment—is debatable. In the 1946 British Births cohort,⁶ the probability of participants obtaining advanced educational qualifications was 1.58 (95% CI 1.15–2.18) times higher in participants who had been breastfed for more than 7 months than in those who had never been breastfed. In New Zealand, breastfeeding duration was positively associated with performance in secondary school tests in students aged 18 years.⁹ However, the results of a pooled analysis¹⁰ of four cohort studies from low-income and middle-income countries (including data from the 23-year-follow-up visit to the 1982 Pelotas cohort) did not show consistent associations between breastfeeding duration and number of school years completed, although associations were present in two of the sites.

Because of the association between intelligence and educational attainment, the notion that breastfeeding can also increase individual income, and thus contribute to economic productivity, has been postulated.^{11,12} However, our systematic review of the literature did not reveal any studies with results showing that breastfeeding was associated with income in adults.

We aimed to assess the associations between infant feeding and IQ, educational attainment, and income in participants aged 30 years in a large population-based birth cohort, in a setting where no strong social patterning of breastfeeding exists.

Methods

Participants

In 1982, five maternity hospitals in Pelotas, Brazil, were visited daily and all births were identified from labour ward records; 5914 neonates whose families lived in the urban area of the city were examined and their mothers were interviewed soon after delivery. The initial refusal rate was less than 1%, and the cohort has been followed up on several occasions.¹³ The study protocol is available online.

Members of the original cohort were traced in 1984 (5161 [87%] individuals) and 1986 (4979 [84%] individuals). Between June 4, 2012, and Feb 28, 2013, cohort members were invited to visit a research clinic to be interviewed and examined.

The Ethical Review Board of the Faculty of Medicine of the Federal University of Pelotas approved the study, and we obtained written informed consent from all participants.

Procedures

Information about duration of breastfeeding and age at introduction of complementary foods was obtained in 1984, when the average age of participants was 19 months.

For participants who were not interviewed in 1984, this information was obtained when they were seen in 1986 at a mean age of 42 months (SD 3.68); these 263 individuals represented 5% of the 5332 participants with infant feeding data. We defined duration of predominant breastfeeding as the age when foods other than breastmilk, teas, or water were introduced. We assessed exclusive breastfeeding but did not include it in the present analysis, because it was seldom practised at that time. We combined participants who had never been breastfed with those who were breastfed for less than 1 month because the incidence of breastfeeding was very high and evidence suggested misclassification between these two categories.¹⁴

We assessed intelligence using the Wechsler Adult Intelligence Scale, third version, at a mean age of 30.2 years, with the arithmetic, digit symbol, similarities, and picture completion subtests. Four psychologists who were unaware of participant feeding history administered the tests. Educational attainment was recorded as the highest grade completed successfully. In the 2012–13 visit, we asked the participants to report their income in the previous month. Information on income was gathered in Brazilian reals (R\$; US\$1 was worth 0.49 real in 2012).

The confounding variables measured in the perinatal study were monthly family income, maternal education, maternal smoking during pregnancy (non-smokers, 1–14 cigarettes a day, or ≥ 15 cigarettes a day), maternal age, maternal pre-pregnancy body-mass index (height was measured by the research team, and pre-pregnancy weight was based on information from antenatal care records or—when not available—by recall), type of delivery (caesarean or vaginal), gestational age (in full weeks, based on the date of the last menstrual period), and birthweight (from calibrated paediatric scales). Additional confounders measured during the 1984 and 1986 visits were parental education (in full years), household assets index (obtained through factor analysis and based in the ownership of household goods), and genomic ancestry. Genomic ancestry analysis was based on DNA samples that were genotyped using the Illumina Omni 2.5M array (Illumina, San Diego, CA, USA). Admixture analyses were based on 370 539 single nucleotide polymorphisms shared by samples from the HapMap Project, the Human Genome Diversity Project (HGDP), and the Pelotas cohort. The following HapMap samples were used as external panels: 266 Africans, 262 Europeans (American and Italian), 77 admixed Mexican Americans, 83 African Americans, and 93 Native Americans from the HGDP. For each individual, the proportion of European, African American, and Native American ancestry was estimated.

Statistical analysis

We used ANOVA to compare means, and multiple linear regression to adjust the estimates for confounders. In the linear regression models, we graphically tested the normality of residuals and homoscedasticity (homogeneity of variance). We assessed multicollinearity between the

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