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Breastfeeding and the developing brain

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In past ages success was measured by physical strength and prowess as a warrior. But in the modern age maximising intelligence, cognitive development and language skills at the community and individual level is paramount. The influence of early nutrition and particularly breastfeeding, in cognitive development has been of research interest over the past century. The first modern study published in the medical literature was in 1929 and reported on a study of 338 children aged between 7 and 11 years and found that breastfed infants performed better at school (Hoefer & Crumpton Hardy 1929). In common with many subsequent studies, exposure to breastfeeding was ascertained retrospectively with the reporting errors and risk of misclassification this is likely to bring (Binns et al 2012). A typical example of cohort studies of infant feeding and cognitive development was the *Dunedin multidisciplinary health and development study*, a 15-year longitudinal study that commenced in 1972 (Silva 1990). However, assessment of breastfeeding status was obtained retrospectively at the age of 3 years and breastfeeding was recorded as grouped data and not as a continuous variable (<1 week n=463, 1–4 weeks n=98 ... more than 51 weeks n=30). At 3, 5 and 7 years the children who were breastfed for longer, had higher scores on the battery of intelligence tests administered (Fergusson et al 1982).

Over the next two decades a number of cohort studies measuring infant feeding (exposure) and cognitive development (the outcome) were published from several different cultures. There have also been several meta-analyses and systematic reviews published that have included the results of the epidemiological studies. In 1999 Anderson reviewed 20 studies, 11 of which

controlled for important covariates including age, birth weight and breastfeeding duration (Anderson et al 1999). After adjustment for covariates, there was an increase in cognitive function of 3.16 (95% CI 2.35–3.98) points when compared with formula-fed infants. Significantly higher levels of cognitive function were seen in infants who were breastfed when compared with formula-fed children at 6–23 months of age and in older children. Infants with a low birth weight had a higher level of improvement (5.18 points).

In 2000 Drane reviewed 24 studies published in the previous two decades and concluded that breastfed term infants had an advantage of 2 to 5 points IQ, and low birth weight infants were up to 8 points higher (Drane & Logemann 2000). The authors noted the difficulties with methodology and the effect was less in studies that adequately adjusted for socio-economic differences. Then in 2002 Jain published the most comprehensive meta-analysis undertaken to date (Jain et al 2002). A total of 40 relevant studies published between 1929 and 2001 were identified. Twenty-seven (68%) concluded 'that breastfeeding promotes intelligence'. The reviewers found that only two papers were of high quality, including blinded assessment and control for critical confounders and only one study found a significant effect from being breastfed.

In 2007 the World Health Organization and the US Agency for Healthcare Research and Quality published reviews of the long-term benefits of breastfeeding and the cognition chapters updated the older reviews of Anderson, Drane and Jain (Horta et al 2007; Ip et al 2007). Both reviews concluded that breastfeeding conferred an advantage of about 5 points in cognitive development, while

recognising that the possibility of residual confounding, particularly from socio-economic variables still remained. A smaller ($n=302$) Australian cohort study found that socio-economic status appeared to be a more important determinant of intelligence than breastfeeding, but this study did not differentiate between 'exclusive' and 'any breastfeeding' (Zhou et al 2007).

Since these major reviews there have been several studies that have added to the strength of the association. In 2008 Kramer and colleagues published the results of the 8-year PROBIT cluster randomised controlled trial conducted in Belarus (Kramer et al 2008). While this was a study of a health promotion program designed to increase exclusive breastfeeding rates, the long term systematic follow-up of the cohort has enabled associations between breastfeeding and several important outcomes to be documented. The experimental group (higher rates of breastfeeding) had achieved higher scores on the Wechsler Abbreviated Scales of Intelligence measures, eg for the verbal scales 7.5 (95% CI 0.8–14.3) points. Also the children's teachers consistently gave higher academic ratings to the experimental group for both reading and writing (Kramer et al 2008).

Two studies have used novel approaches using the latest available technology to test associations between breastfeeding and intelligence. Steer and colleagues added to an earlier study by Caspi on the relationship between polymorphisms on the FADS2 gene and breastfeeding and intelligence as a means of controlling for confounding variables (Caspi et al 2007; Steer et al 2010). While their results show some confirmation of an association, they caution against interpreting the data this way pending further studies. A Canadian study used magnetic resonance imaging to measure the thickness of the brain cortex. They found that the duration of exclusive breastfeeding was associated with increased cortical thickness in the superior and inferior parietal lobules, although the biological significance of this requires further research. Using more traditional epidemiology they also found an association between breastfeeding and general intelligence in their cohort (Kafouri et al 2013).

The most recent epidemiologic study from Europe included 1400 French children and found that longer breastfeeding duration was associated with better cognitive and motor development in 2- and 3-year-old children (Bernard et al 2013). Ever breastfed infants scored 4 points higher than never breastfed infants after adjusting for confounding. The authors also found a dose-response relationship.

Overall the pattern of evidence indicates that breastfeeding is associated with higher levels of cognitive development and that there is a dose-response relationship. Exclusive breastfeeding to 6

months is associated with a gain of at least 5 points on the commonly used intelligence scales. The response is graded and any breastfeeding is better than no breastfeeding. This appears to be the same order of effect (but in the reverse direction) that is caused by subclinical toxic influences on the developing brain, such as iodine deficiency or exposure to lead in the environment. One possible explanation for the beneficial effect of breastmilk may be the differing fatty acid profile between the feeding methods. Breastmilk is a very complex living tissue and there may be more than one explanation for its beneficial effect on the brain. A 5% improvement may not seem much, but for the whole community it is very significant. For the individual this can mean the difference between achieving their educational goals or settling for something else.

These studies, using a variety of methodologies have shown that breastfeeding in early life affects cognitive development. As with all studies involving breastfeeding we must acknowledge the possibility of confounding from unknown socio-economic variables. However, given the strength of evidence that is continuing to accumulate we can confidently advise parents that if they want a smarter infant, and who wouldn't, breastfeeding provides the best cognitive start to life.

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