

Breastfeeding, Childhood Obesity and the Prevention of Chronic Diseases

After carefully reviewing the scientific evidence, the USA Centre for Disease Control and Prevention (CDC) concluded that there are only two potential, cost-effective interventions that can be put into place immediately to deal with the childhood obesity¹ epidemic: decreased television viewing and breastfeeding promotion². The purpose of this editorial is to summarize the evidence linking breastfeeding with the prevention of childhood and adolescent obesity, but first, it is important to say a few words about the relevance of breastfeeding promotion for the area of chronic diseases in general.

Obesity has become a global pandemic and is a major risk factor for hypertension, heart disease, type 2 diabetes, and several types of cancer. Thus, this condition is decimating the health care budgets of countries worldwide. In the USA, the direct and indirect costs of obesity are estimated to be over US\$100 billion per year as a result of direct medical expenditures and lost productivity caused by chronic diseases. In Brazil, the prevalence of overweight in children increased from 4.1% to 13.9%³. If breastfeeding can really make a difference, the recent longer duration (median around 10 months) found in Brazil⁴ might represent hope for a lower incidence of obesity. The reason why it is crucial for obesity prevention interventions to start early on in life is that once a child becomes obese, it is quite likely that s/he will remain obese as an adult.

Thus, breastfeeding represents a potentially ideal window of opportunity for obesity prevention. Dewey⁵ has recently reviewed the literature on this topic and concluded that breastfeeding is likely to be associated with a reduction in the risk of child obesity to a moderate extent. Dewey reviewed eleven observational studies with adequate sample sizes and with children's obesity data beyond 3 years of age. Only one of the studies was longitudinal and all were conducted in industrialized nations in North America, Europe, Australia and New Zealand. Of these eleven studies, eight showed an inverse relationship between breastfeeding and child obesity after controlling for potential confounders. The three studies where such an association was not documented lacked data as to the exclusivity of breastfeeding. Since Dewey's review was published, two additional studies have been printed with somewhat contradictory results^{6,7}, but here again both studies lack a clear definition of what is considered to be exclusive breastfeeding. These two studies highlight the need for doing more research in developing country populations and among ethnic minorities in developed countries. Although much work remains to be done in this area, particularly in regard to the need for well-designed, longitudinal studies that allow for a clear description of different breastfeeding modalities, the preponderance of the epidemiological evidence strongly suggests a link between breastfeeding and the prevention of obesity in the childhood and adolescent period.

However, because association does not prove causation, it is important to discuss the biological plausibility of these findings. First, individuals who were breastfed have a leptin profile that may favour adequate appetite regulation and less fat deposition. With regards to appetite regulation, Pérez-Escamilla *et al.*⁸ showed that Honduran babies adjusted their milk intake volume in an inverse proportion to the energy density of their mother's breastmilk. It has also been proposed that the reason that the milk fat content toward the end of the feeding episode (i.e. "hind milk") is higher than at the start of the episode ("fore milk") is that it signals the baby that the feeding episode is coming to an end. Obviously, formula-fed babies are not exposed to such "physiological signalling" as the fat concentration in formula remains constant throughout the feeding episode. A corollary of this is that among formula-fed babies it is the caretaker and not the infant who controls the child's caloric intake. Second, breastfed babies gain less weight than formula-fed infants during the first year of life. Third, formula-fed babies have higher insulin levels circulating in their blood stream, as a result of the higher protein content in infant formula, which in turn may stimulate a higher deposition of fat stores. Fourth, it is possible that breastmilk influences the development of a taste receptors profile that can foster a preference for lower energy diets later on in life.

1 Because of the psychosocial implications for children, some researchers in the USA use the term "overweight" instead of "obesity" when referring to children. For the purpose of consistency and clarity, the term obesity is used throughout this editorial. Usually, overweight and obesity are defined based on the BMI (Body Mass Index), calculated by dividing weight in kilograms by the square of height in metres. There is overweight when the BMI is between 25 and 29.9, obesity when it is 30 and over.

2 Dietz WH. Breastfeeding may help prevent childhood overweight. *JAMA*. 2001; 285:2506-7.

3 Wang, Y, Monteiro, C, Popkin, BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China and Russia. *Am J Clin Nutr* 2002; 75:971-7.

4 Rea, MF. Reflexões sobre a amamentação no Brasil: de como passamos a 10 meses de duração. *Cadernos de Saúde Pública*, R. Janeiro, 2003; 19:109-118.

5 Dewey KG. Is breastfeeding protective against child obesity? *J Hum Lact*. 2003;19:9-18.

6 Grummer-Strawn LM, Mei Z. Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centres for Disease Control and Prevention Paediatric Nutrition Surveillance System. *Pediatrics*. 2004;113:e81-6.

7 Victora CG, Barros FC, Lima RC, Horta BL, Wells J. Anthropometry and body composition of 18-year-old men according to duration of breastfeeding: a birth cohort study from Brazil. *BMJ* 2003;327:901-4.

8 Pérez-Escamilla R, Cohen RJ, Brown KH, Rivera LL, Canahuati J, Dewey KG. Maternal anthropometrical status and lactation performance in a low-income Honduran population: evidence for the role of infants. *Am J Clin Nutr*. 1995 61:528-34.

We are still far from having conclusive evidence regarding the biological mechanism(s) that may explain a link between breastfeeding and the prevention of obesity. However, the high biological plausibility for this link coupled with the preponderance of the epidemiological evidence gives us a lot of room for optimism that putting resources into breastfeeding promotion indeed represents a major investment in the prevention of serious and costly chronic diseases later on in life. Considering all these arguments, it is important to support implementation of a strong *WHO Global Strategy on Diet, Physical Activity and Health* which puts public health rather than profits in the centre-stage.

Breastfeeding why...

Obesity

Toschke AM, et al. Overweight and obesity in 6- to 14-year-old Czech children in 1991: protective effect of breastfeeding. *J Pediatr* 2002;141:764-9

In 1991, more than 33,000 Czech children aged 6-14 years were studied in a cross sectional survey to assess the impact of breastfeeding on childhood overweight and obesity; 9.3% of them were *never* breastfed. Among these, 12.4% were overweight and 4.4% obese, compared to 9.3% and 3.2% among the 30,641 *ever* breastfed. Longer duration of breastfeeding was associated with a significantly lower prevalence of overweight, but no effect was seen for obesity. The fact that the baby's intake varies at each feed during breastfeeding, a lower energy density of human milk compared with formula milk, and thus a better self-control of food consumption in breastfed children, are possible explanations for the observed effect of breastfeeding.

Parsons TJ, Power C, Manor O. Infant feeding and obesity through the lifecourse. *Arch Dis Child* 2003;88:793-4

In another study all children born in England, Wales and Scotland in 1958 were studied, with the result that, differently from the above article on Czech children, no relationship was found between breastfeeding and BMI. Data were obtained for 98% of 17,733 births. BMI was calculated from heights and weights, at 7, 11, 16 and 33 years. Breastfeeding was protective against increased BMI in females at ages 16 and 33 years, and in males at 33 years, but this effect was reduced and no longer significant after adjustment for confounding factors.

Li L, Parsons TJ, Power C. Breastfeeding and obesity in childhood: cross-sectional study. *BMJ* 2003;327:904-5

In a British study of 2,631 children - offspring born from the 1958 cohort described above - no protective effect of breastfeeding on obesity was found. Adjustments for confounding factors - birth weight, mother's smoking during pregnancy - did not alter these findings.

Victora CG et al. Anthropometry and body composition of 18-year-old men according to duration of breastfeeding: a birth cohort study from Brazil. *BMJ* 2003;327:901-4

2,250 18-year-old men of a relatively affluent Brazilian city were studied to look at the effect of breastfeeding on several measures of adiposity, including BMI. They had been enrolled at birth in a large cohort study. Neither the duration of total breastfeeding nor that of predominant breastfeeding showed significant association with BMI. However, a significant reduction in obesity was found among those breast-

fed between 3 to 5 months, which is difficult to explain. The authors speculate about whether truly exclusive breastfeeding would have resulted in a clearer pattern of association with obesity.

Frye C, Heinrich J. Trends and predictors of overweight and obesity in East German children. *Int J Obes Relat Metab Disord* 2003;27:963-9

In three consecutive surveys performed in Eastern Germany (1992-3; 1995-6 and 1998-9) with 5- to 14-year-old school children, more than 7,000 were assessed in order to analyze the trends in overweight and obesity, according to selected factors. A significant increase was shown for 11-14 y and for 8-10 y, but not for the school entrants aged 5-7 y. Low-birth weight and higher parental education were protective factors against overweight and obesity, while breastfeeding was protective only with regard to obesity. This effect was stronger if the children were exclusively breastfed.

Grummer-Strawn LM, Mei Z. Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centers for Diseases Control and Prevention Pediatric Nutrition Surveillance System. *Pediatrics* 2004;113:e81-6

Among a huge sample of children (177,304 up to 60 months of age), the authors of this study examined whether increased duration of breastfeeding is associated with a lower risk of obesity in a low-income American population. A statistical analysis was performed controlling for gender, ethnicity, and birth weight. For 12,587 children, data from pregnancy were available also. The longer the duration of breastfeeding beyond 6 months, the higher the protective effect and the lower the risk of overweight among non-Hispanic whites, but not among Blacks or Hispanics. Breastfeeding for any duration was also protective against underweight.

Butte NF. The role of breastfeeding in obesity. *Pediatr Clin North Amer* 2001;48:189-98

In a review of 18 studies, this author concludes that the protective effect of breastfeeding on later obesity remains controversial. 12 studies found a non significant effect, while only 4 showed a protective effect. Parental obesity continues to be the strongest determinant for childhood obesity; this may be partly due to genetic factors (studies on twins and adopted children had already provided estimates of genetic contribution) and partly to shared dietary habits. This review confirms that childhood obesity is caused by several factors; disentangling the effect of breastfeeding is difficult and requires control of many confounding variables on which information is not always available or complete.

Dewey KG. Is breastfeeding protective against child obesity? *J Human Lact* 2003;19:9-18

The author reviews the different studies published up to 2003 that investigate childhood obesity and breastfeeding. She concludes that to understand the relationship, it is necessary to know how to control as many confounding variables as possible; but calls attention on the difficulty to control: 1) child-feeding practices and parental control over feeding, and 2) physical activity. Breastfeeding might reduce child overweight by metabolic programming in early life, but this has to be studied in more depth.

High blood pressure

Owen CG, Whincup PH, Gilg JA, Cook DG. Effect of breast feeding in infancy on blood pressure in later life: systematic review and meta-analysis. *BMJ* 2003;327:1189-95

The association between infant feeding and blood pressure in later life is controversial. A systematic review of 25 studies concludes that the selective publication of small studies with positive findings may have exaggerated claims that breastfeeding in infancy reduces blood pressure in later life. The results of larger studies suggest that feeding in infancy has, at most, a modest effect on systolic blood pressure, of limited clinical or public health importance, and no effect on diastolic blood pressure.

Singhal A, Cole TJ, Lucas A. Early nutrition in pre-term infants and later blood pressure: two cohorts after randomised trials. *Lancet* 2001;357:413-9

Consumption of human milk has been shown to have many benefits for infants - both pre-term and full term - including a reduced risk of necrotizing enterocolitis, atopy, infections and improved later cognitive development. The hypothesis that consumption of human milk also may lower blood pressure is supported by this randomised trial and by two other studies. Both mean and diastolic blood pressures were lower comparing infants fed donated human milk with those fed pre-term formula. Even among those babies whose mothers decided to provide breastmilk in addition to the assigned formula diet, diastolic, systolic and mean blood pressure were lower. Further investigation may elucidate mechanisms for early life nutritional programming leading to low or high blood pressure.

Martin RM, Ness AR, Gunnell D, Emmett P, Smith GD. Does breastfeeding in infancy lower blood pressure in childhood? The Avon Longitudinal study of parents and children (ALSPAC). *Circulation* 2004;109:1259-66

Breastfeeding was associated with lower systolic blood pressure at 7 years in a study done with more than 7,000 UK children. Of all mothers, 83% reported having ever breastfed and 34% reported exclusive breastfeeding beyond 2 months (although some water might be included in this definition, it was restrictive for all other liquids besides breastmilk). Of those who breastfed, 49% did so for 6 months. The systolic and diastolic blood pressures of breastfed children were 1.2 mm Hg lower and 0.9 mm Hg lower, respectively, compared with children who

were never breastfed, after controlling for age, sex, room temperature and field observer. Overall, there was a 0.2 mm Hg reduction in systolic blood pressure for each 3 months of any breastfeeding. The importance of this study is that it took place during the 1990s, when infant formula contained less salt than formula manufactured earlier. Even so, children fed infant formula compared to those breastfed presented higher blood pressure. One explanation is the higher sodium content of infant formula. The authors also discuss the implications of this small reduction: lower systolic pressure in 1% of the population is associated with approximately 1.5% reduction in all-cause mortality.

Cholesterol

Owen CG, Whincup PH, Odoki K, Gilg JA, Cook DG. Infant feeding and blood cholesterol: a study in adolescents and a systematic review. *Pediatrics* 2002;110:597-608

The authors examined the influence of infant feeding methods on total serum cholesterol (TC) and low-density lipoprotein (LDL) cholesterol, both associated with high incidence of coronary heart disease and arteriosclerosis. They conducted a cross-sectional study of 13-to 16-year-olds and reviewed a number of observational studies on the effects of infant feeding on cholesterol in infancy (<1 year), childhood/adolescence (1-16 years), and adulthood (17 years or over). 1,532 individuals (92% white; 55% male; mean age: 15.1 years) in ten British towns were examined; and 37 studies with 52 observations on TC/LDL (26/7 in infancy, 17/4 in childhood or adolescence, and 9/6 in adulthood) were reviewed. The results show that breastfeeding is associated with increased mean TC and LDL levels in infancy, but lower levels in adulthood. These results suggest that breastfeeding may have long-term benefits for cardiovascular health.

Singhal A, Cole TJ, Fewtrell M, Lucas A. Breastmilk feeding and lipoprotein profile in adolescents born pre-term: follow-up of a prospective randomised study. *Lancet* 2004;363:1571-8

Breastfeeding is associated with reduced cholesterol concentration later in life, but previous studies have not used random assignment of infant diet with prospective follow-up. This study did so in 926 infants born pre-term and randomly assigned to receive donated banked breastmilk or pre-term formula in one trial, or standard term formula or pre-term formula in a second trial, as sole diet or as supplement to mother's milk in both trials. 216 participants were followed up to age 13-16 years. Adolescents who had been randomised to banked breastmilk had a lower C-reactive protein (CRP, a measure of the inflammatory process associated with arteriosclerosis) and LDL to HDL (high density lipoprotein, associated with a lower risk of heart disease) ratio than those given pre-term formula. A greater proportion of human milk intake in infancy was associated with lower ratios of LDL to HDL and of other lipoproteins associated with heart disease, independent of gestation and potential confounding factors. The authors conclude that their data provide experimental evidence for the long-term benefits of breastmilk feeding on the risk of arteriosclerosis.

Diabetes

Ziegler AG, Schmid S, Huber D, Hummel M, Bonifacio E. Early infant feeding and risk of developing type 1 diabetes-associated autoantibodies. *JAMA* 2003;290:1721-8

To determine whether breastfeeding duration, food supplementation, or age at introduction of gluten-containing foods influence the risk of developing auto-antibodies against islet (the insulin-producing tissue of the pancreas), a study of 1,610 children was conducted from 1989 to 2003 in inpatient/outpatient clinics in Germany. Blood samples were obtained at birth, age 9 months, 2, 5, and 8 years. Dropout rate was 14.4% by the age of 5 years. Breastfeeding data were obtained by questionnaires, and food supplementation data by family interview. Life-table islet auto-antibody frequency was 5.8% by the age of 5. Reduced total or exclusive breastfeeding duration did not significantly increase the risk of developing islet auto-antibodies. Food supplementation with gluten-containing foods before the age of 3 months, however, was associated with a significant, four-fold increase in islet auto-antibody risk. Children who first received gluten-containing foods after the age of 6 months did not have increased risks for islet or celiac disease (a severe lifelong disease due to gluten intolerance) auto-antibodies. The authors conclude that ensuring compliance to WHO infant feeding guidelines is a possible way to reduce the risk of developing type 1 diabetes auto-antibodies.

Sadauskaite-Kuehne V, et al. Longer breastfeeding is an independent protective factor against development of type 1 diabetes mellitus in childhood. *Diabetes Metab Res Rev* 2004;20:150-7

Is early nutrition a risk factor for diabetes? A case-control study was carried out in Sweden on 517 children and in Lithuania on 286 children 0 to 15 years old with newly diagnosed type 1 diabetes mellitus, a type of that starts in childhood. The study included three age- and sex-matched health controls. In Sweden, exclusive breastfeeding longer than 5 months (longer than 2 months in Lithuania), total breastfeeding longer than 7 or 9 months, and breastfeeding substitution later than the 3rd month were shown to be protective against diabetes when adjusted for all other factors. The authors advise that postponing introduction of breast-milk substitutes might protect children from type 1 diabetes.

Constipation

Aguirre AN, Vitolo MR, Puccini RF, de Moraes MB. Constipation in infants: influence of type of feeding and dietary fiber intake. *J Pediatr (Rio J)* 2002;78:202-8

Breastfeeding may be a protective factor against constipation in the first 6 months of life. This is the conclusion drawn after a study of 275 infants consecutively enrolled in two primary care clinics in the

city of Embu, near São Paulo. Constipation was found in 25% of them; the prevalence was higher between 6 and 24 months (39%) than in the first 6 months (15%). The statistical analysis demonstrated that formula-fed infants were 4.5 times more liable to develop constipation than infants who were predominantly breastfed. The daily dietary fiber intake was similar among the constipated and non-constipated infants. Constipation was defined by the elimination of hard stool associated with one of the following: painful or difficult defecation, hard or round cracked stools and less than three defecations a week.

Andiran F, Dayi S, Mete E. Cows milk consumption in constipation and anal fissure in infants and young children. *J Paediatr Child Health* 2003;39:329-31

This study confirms the above findings using a different research design. 30 infants and young children aged 4 months to 3 years with chronic constipation and anal fissure (surgical causes were excluded) were compared with 30 children in the same age range with normal bowel habits. The mean daily consumption of cow's milk was significantly higher in the former (756 ml, range 200-1500) than in the latter group (253 ml, range 0-1000). Children with chronic constipation and anal fissure were breastfed for a significantly shorter period (5.8 months, range 0-18) than the other children (10.1 months, range 2-24).

Breastfeeding how

Rea MF. Rethinking breastfeeding in Brazil: how we have reached 10 months of duration. *Cad Saúde Pública* 2003;19 suppl.1:37-45

In 1975, only one out of two Brazilian women breastfed until the 2nd or 3rd month; however, in 1999, a survey indicated that one out of two Brazilian mothers breastfed for 10 months. This increase over the course of 25 years can be viewed as a success. However, many activities could be better organized, coordinated and corrected when errors occur. Various relevant decisions have been made by international health agencies during this period, in addition to studies on breastfeeding that have reoriented practice. The study reviews the history of the Brazilian national programme to promote breastfeeding, focusing on an analysis of the influence of international policies during four periods: 1975-1981 (when little was done), 1981-1986 (media campaigns), 1986-1996 (breastfeeding-friendly policies), and 1996-2002 (planning and human resources training activities backed by policies to protect breastfeeding). One challenge for the future is to continue to promote exclusive breastfeeding for 6 months, taking specific population groups into account. Another challenge is to prevent future deaths from both infectious diseases and non-communicable diseases by further improving breastfeeding rates and duration.

Prepared by the **Geneva Infant Feeding Association (GIFA)**, a member of the **International Baby Food Action Network (IBFAN)**.

Editors: *Marina Ferreira Rea, Adriano Cattaneo, Robert Peck and Elaine Petitot-Côté* revised and edited the text. Editorial: *Rafael Perez-Escamilla*. For copies of *Breastfeeding Briefs* please make request to GIFA, Av. de la Paix 11, 1202 Geneva, Switzerland. Fax: +41-22-798 44 43, e-mail: info@gifa.org, or to UNICEF country offices. Available also in French, Spanish, Portuguese and Arabic. A contribution of CHF 20.-- for a subscription to organisations in industrialised countries is gratefully accepted and can be sent by international postal order to account no. 12-17653-5