

# Breastfeeding: a natural defence against obesity?

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## Abstract

Today, obesity represents one of the most serious health problems facing both children and adults. Childhood obesity has several causes, including genetic factors, dietary habits, personal behaviours, and interaction of all of these. It often leads to adult obesity, which causes health problems including heart disease, diabetes, and even early death. Thus, many studies have investigated possible measures to prevent childhood obesity, and breastfeeding is considered an important early preventive intervention. Despite the fact that several milk formulas have been demonstrated to be safe and effective for feeding both term and premature infants, for its immunological and nutritional qualitative advantages, human milk is nowadays universally recognized as the optimal feeding choice for healthy, sick and preterm infants.

To date, it is however still unclear whether breastfeeding can prevent childhood obesity. In fact, literature data provide controversial results, probably due to several confounding factors, including maternal habits, age, level of education, lifestyle, race, parity, pregnancy complications, types of delivery, and infant health factors.

Thus, whether breastfeeding protects against obesity is still unclear. Further researches, by reducing the influence of confounding factors and improving the accuracy of the effect estimate, are needed to confirm the validity of the role of breastfeeding in reducing the risk of developing childhood overweight.

This review briefly summarizes what is known on the possible relationship between breastfeeding and prevention of obesity development.

## Keywords

Breastfeeding, human milk, overweight, obesity, adipokines, children.

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## Introduction

Childhood obesity is a global epidemic health problem and rising trends in overweight is apparent in both developed and developing countries [1]. Many strategies addressing prevention of childhood obesity and related risk of chronic diseases have been proposed, including breastfeeding, which is widely acknowledged as the ideal form of nutrition for infants [1].

Despite the fact that several milk formulas have been demonstrated to be safe and effective for feeding both term and premature infants [2], for its immunological and nutritional qualitative advantages, human milk (HM) is nowadays universally recognized as the optimal feeding choice for healthy, sick and preterm infants. Breast milk is uniquely suited to the human infant, and, as a dynamic, bioactive fluid, it changes in composition from colostrum to late lactation, and varies within feeds, diurnally, and between mothers [3]. It also confers neural, psychological, and developmental benefits [4].

Furthermore, breastfeeding has been shown to be protective against several illnesses, including upper and lower respiratory infections, atopic (asthma and eczema) and immunological (celiac disease) disorders, as well as overweight/obesity [3]. In particular, it has been reported that, although breastfed infants grow more rapidly during four months of life, at age 1 they gain weight less than formula fed babies [5, 6].

In light of these and similar results, it has been assumed that breastfeeding can prevent overweight. However, as obesity is considered a multifactorial disorder [7], whether breastfeeding can help to prevent obesity childhood is still unclear [8]. In fact, data from literature concerning a possible correlation between breastfeeding and overweight/obesity prevention provided controversial results, probably due to several confounding causes. These include: maternal body mass index (BMI), age, race/ethnicity, lifestyle, level of education, smoking, sedentary or physically activity, parity, types of delivery, pregnancy complications, and infant health factors [9].

## Possible effects of breastfeeding on weight gain regulation

Several hypothesis have been proposed to explain the protective role of breastfeeding against obesity.

Firstly, protein intake as well as energy metabolism are lower among breastfed subjects [10, 11]. Despite the fact that breast milk provides a moderate amount of calories and nutrients for the infant (e.g., protein, sugar, fat, and water) and also changes with time and mother's diet [3], the content of protein in formula feeding is approximately 1.6 times higher than baby's needs [12]. In particular, in longitudinal studies, a significant relationship was found between dietary protein intake at the age of 10 months and later BMI and distribution of body fat [13]. This confirms that a high intake of protein in early childhood might increase the risk of obesity in later life.

Secondly, studies revealed the presence, in human milk, of hormones (e.g., leptin, adiponectin, resistin, ghrelin) which, through early control of satiety, have a positive effect on the programming of energy balance regulation in childhood and adulthood, thereby protecting against later obesity [14].

In particular, leptin, an adipocyte-derived hormone also present in human milk, passes from breast-milk to infant blood and, by acting as a satiety signal, exerts both short- and long-term effects on energy balance and body weight regulation [15, 16]. The existence of leptin in breast milk might have a significant role in growth, food intake and regulation of satiety in infants during the early lactation period [17, 18].

Adiponectin, the most abundant adipose-specific protein, circulates in very high concentrations in human milk and levels are positively associated with insulin sensitivity and inversely related to the degree of adiposity [19]. An inverse relationship between adiponectin levels in milk and adiposity of the breastfed infant has been observed; this might be due to modulation of infant metabolism by milk adiponectin, and may be related to the observed protection against obesity from breastfeeding [20].

Resistin, a cytokine synthesized by adipocytes, correlates positively with hormone status (estradiol, progesterone, prolactin, thyroxine, triiodothyronine, cortisol, and leptin); thus, it may be involved in appetite regulation and in the metabolic balance of newborns [21, 22]. It has been reported that resistin has a significant role in

energy and glucose homeostasis, since it impairs the activation of AMP-activated protein kinase (AMPK) which is a key regulator of glucose uptake and skeletal muscle fatty acid metabolism [23]. Recently, a positive correlation between serum resistin level of breastfed infants and breast milk resistin levels has been founded [24].

Another component of human milk is ghrelin which, acting as an appetite-stimulatory signal and playing a role in short- and long-term regulation of food intake, influences the energy balance [25]. Ghrelin would appear to be involved in postnatal growth, and a positive correlation between ghrelin level in breast milk and infant weight gain has been observed [26]. However, serum ghrelin levels in formula fed infants is significantly higher compared to breastfed infants [27]. This finding might suggest that formula fed infants, who receive a higher amount of ghrelin, have a greater feeding stimulus than breastfed infants and a consequent increase in weight and growth rate.

Moreover, human milk, through both lipid and not lipid molecules, including epidermal growth factor and tumour necrosis factor  $\alpha$ , increases the growth factors synthesis which, in turns, inhibits preadipocyte differentiation [28].

Nevertheless, several other peptide/protein hormones have recently been identified in human breast milk, including obestatin, nesfatin, irisin, adropin, copeptin, pituitary adenylate cyclase-activating polypeptide, apelin, motilin and cholecystokinin, that may be involved in the mechanism of weight gain regulation [29].

It is known that breastfeeding can influence the prevalence of both underweight and overweight status in later life [30, 31]. For example, a major discharge of growth hormone, insulin-like growth factor 1 and insulin are present in the bloodstream of breastfed newborns, promoting a major fat deposition and an increased number of adipocytes [32].

In addition to biological mechanisms, breastfeeding also influences behavioural and physiological feeding patterns. Breastfed infants tend to better adjust the amount of human milk and calories they ingest, in comparison to formula fed infants, who are often obligate to finish a bottle even if satiated.

Finally, it has been reported that breastfeeding affects timing of solid food intake. Exclusive breastfeeding precludes inappropriate complementary feeding practices such as early introduction of complementary foods that could

lead to unhealthy weight gain [33]. Huh and colleagues found that early introduction of solids was associated with higher mean BMI at 3 years of age among formula fed infants, but not breastfed infants [34].

Moreover, it has been proposed that differences in dietary preferences between breast and formula fed infants could also justify breastfeeding-risk obesity association. Scholtens et al. [35] reported that, at 7 years of age, breastfed children for more than 16 weeks had a major intake of fruit and vegetables than formula fed newborns.

### **Breastfeeding and gain weight: state of art**

Evidence on breastfeeding and obesity are, to date, contradictory, probably due to several confounding variables which can influence body weight in children and contribute to overweight/obesity prevention. In 2004 and 2005, two meta-analyses reported that breastfeeding could help to prevent obesity childhood [36, 37]. Thereafter, through the meta-analyses of childhood risk factors for obesity, Wheng et al. [38] founded that breastfeeding infants had a 15% decrease in the odds of childhood overweight in comparison to bottle fed babies. In this paper, ten studies [30, 39-47], comparing the effects of breastfeeding and other types of nutrition during the first 12 months of life, were particularly analyzed. From the collected data the protective role of breastfeeding against overweight in childhood resulted unclear. In fact, 5 studies [30, 41, 44, 45, 47] reported a beneficial effect of breastfeeding against obesity, while the other 5 did not confirm the beneficial role [39, 40, 42, 43, 46]. Among the studies [39, 44, 48-50] which analyzed the possible influence of breastfeeding duration on childhood overweight, only one [39] reported a significant decrease in the OR of overweight at 2 years of age if infants who were breastfed for more than 6 months were compared with those breastfed for less than 3 months. With the same purpose, Yan et al. [51] conducted a meta-analysis, including 25 studies (10 studies cross-sectional surveys and 15 cohort studies) with a total of 226,508 participants. They investigated the association between breastfeeding duration (categorized as < 3 months, 3-5 months, 5-7 months and  $\geq$  7 months) and obesity. In detail, authors assessed that the risk of childhood obesity was lower in breastfed children by 22% compared with those who were never breastfed. Moreover, infants who were breastfed for more than 7 months

had significantly less likelihood to develop obesity, while in those breastfed for less than 3 months the obesity risk decreased of 10%. Authors conclude that breastfeeding is a significant protective factor against obesity in children, indicating also a breastfeeding dose-response effect.

Conversely, in a recent national survey enrolling 14,880 children, Djalalinia et al. [52] assessed that duration of breastfeeding, categorized into five groups of 0 months, < 6 months, 6-12 months, 12-18 months, and 18-24 months, had no significant association with anthropometric measures such as height, weight, blood pressure, and abdominal obesity. Compared to previous studies [39, 51], the authors also hypothesized that the controversies regarding the relationship between anthropometric measures and breastfeeding might result from the presence of several parameters, including ethnicity, age, maternal glucose tolerance, hormonal and body composition changes, acting as a confounding factors. Confirming this hypothesis, Assunção et al. [53] reported that, after adjusting for potential confounding parameters (e.g., anthropometric, socioeconomic, demographic, behavioural, and health-related factors), children, exposed to exclusive breastfeeding for more than 6 months, showed a lower prevalence of overweight in the second year of life.

In addition, several studies assessed that exclusive breastfeeding appears to have a stronger protective effect than breastfeeding combined with formula feeding [37, 45, 54, 55]. However, these results were not confirmed by the findings of several studies, in which the obesity risk was not found decreased in children breastfed for less than 4 months [49], for 4 months [56], for 6 months [50], for less than 12 months or major than 12 months [57] of age.

In conclusion, while the beneficial effects of breastfeeding children are well documented in several diseases [3], data that breastfeeding, also in a dose-dependent manner, might decrease risk of both short- and long-term obesity are controversial, showing both protective and null effects. These discrepancies may be related to the diverse enrolled populations (with unique genetic and environmental backgrounds), different sample sizes and absence/presence of confounding factors (e.g., maternal education, maternal age, maternal pre- and post-partum weight, parity, ethnicity, and delivery type). Further research, by reducing the influence of confounding factors and improving the accuracy

of the effect estimate, are needed to confirm the validity of the role of breastfeeding in reducing the risk of developing childhood overweight. In the mean time, breastfeeding, despite the rare results of its uncorrect management, including hypernatremic dehydration [58-60], still represents the most ancient and natural mode of feeding for the newborn, and should always be encouraged [61]. Moreover, the results of the abovementioned studies seem also to confirm that breastfeeding is not only nutritionally sound but economically beneficial as well [62], in particular, by reducing the sanitary costs related to obesity. On this regard, international data collected by the International Association for the Study of Obesity show that 36% of boys and 34% of girls are overweight or obese in Italy, compared with 23% of boys and 21% of girls, on average, in other countries [63]. This critical incidence causes an obesity cost equal to 2,500,000,000 euros/year. Nevertheless several programmes have been proposed to cut health expenditures, their health effects take a longer time. In fact, while the treatment for obesity is time-consuming and inconclusive, the prevention of obesity is the most effective solution [64]. Therefore, breastfeeding, through protective effect against obesity, could be also represent an effective prevention strategy.

### Declaration of interest

The Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The Authors declared that they did not receive any financial support.

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