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REVIEW ARTICLE

Growth in exclusively breastfed infants[☆]

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KEYWORDS

Growth;
Growth monitoring;
Exclusive
breastfeeding

Abstract

Objective: To address the growth of full-term children in the first 6 months of life in exclusive breastfeeding.

Source of data: A non-systematic review was carried out by searching the MEDLINE/PubMed, Web of Science, and Cochrane Library databases and the World Health Organization website for articles and documents on the growth of exclusively breastfed infants and their monitoring. Those documents considered to be the most relevant by the author were selected.

Data synthesis: Exclusively breastfed infants show differentiated growth when compared to formula-fed infants. Weight loss in the first four days of life is due more to loss of fat mass rather than lean mass, including body water, and is usually lower in exclusively breastfed infants. In turn, the time for recovery of the birth weight may be longer in these infants. Formula-fed infants gain weight and increase their BMI more rapidly in the first three to six months of life than infants in exclusive or predominant breastfeeding due to a progressive increase in lean mass. The World Health Organization growth curves, which use the growth pattern of breastfed children as their standard, are used to monitor growth.

Conclusions: Exclusively breastfed infants have differentiated growth when compared with formula-fed infants. This should be considered when monitoring the infant's growth. It should be emphasized that the growth pattern currently used as reference is that of the exclusively breastfed infant.

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PALAVRAS-CHAVE

Crescimento;
Monitoramento do
crescimento;
Amamentação
exclusiva

Crescimento da criança em amamentação exclusiva

Resumo

Objetivo: Abordar o crescimento da criança nascida a termo nos primeiros seis meses de vida em amamentação exclusiva.

Fonte dos dados: Foi feita revisão não sistemática tendo sido consultadas as bases de dados MEDLINE/PubMed, Web of Science, Cochrane Library e site da Organização Mundial da Saúde, em busca de artigos e documentos versando sobre o crescimento da criança em amamentação exclusiva e o seu monitoramento. Foram selecionados aqueles julgados mais relevantes pela autora.

Síntese dos dados: As crianças em amamentação exclusiva apresentam crescimento diferenciado quando comparadas com crianças alimentadas com fórmulas infantis. A perda de peso nos primeiros 4 dias de vida se deve mais à perda de massa gorda do que de massa magra, incluindo a água corporal, e costuma ser menor nas crianças amamentadas exclusivamente. Por outro lado, o tempo para a recuperação do peso de nascimento pode ser maior nessas crianças. As crianças alimentadas com fórmulas ganham peso e aumentam o seu IMC mais rapidamente nos primeiros 3 a 6 meses do que as crianças em amamentação exclusiva ou predominante, devido a um aumento progressivo da massa magra. Para o monitoramento do crescimento utilizam-se as curvas de crescimento da Organização Mundial da Saúde, que adota como padrão o crescimento das crianças amamentadas.

Conclusões: A criança em amamentação exclusiva apresenta crescimento diferenciado em comparação com as crianças alimentadas com fórmulas infantis. Isso deve ser levado em consideração durante o monitoramento do crescimento da criança. Ressalta-se que o padrão de crescimento adotado como referência atualmente é o da criança amamentada exclusivamente. © 2018 Sociedade Brasileira de Pediatria. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Infant growth monitoring in the beginning of life is of the utmost importance, as the growth behavior is closely related to the child's present and future health. However, the assessment about the adequacy of the infant's growth is strongly influenced by the reference charts used (growth curves). For health professionals to be able to adequately assess the growth of an exclusively breastfed infant, it is important that they be aware of some aspects of this growth and of monitoring tools.

This review article aimed to address the growth of exclusively breastfed infants born at term. The definition of exclusive breastfeeding used here is that by the World Health Organization: a child is considered to be exclusively breastfed when he/she receives only human milk, without any other type of food, including water.¹ As the recommended duration of exclusive breastfeeding is six months,² the focus will be on growth in the first six months of life.

The first part of the article addresses the body composition of the exclusively breastfed infant and makes some comparisons with that of the formula-fed infant. The second part focuses on the monitoring of the infant's growth, considering the reference population, the use of anthropometric indices in primary care and the differences in growth in the first six months according to the type of feeding.

Body composition

The human body consists of lean mass (fat-free and consisting of proteins, intra- and extracellular water, and bone mineral content) and fat mass (body fat). There are differences in body composition between exclusively breastfed and formula-fed infants. This difference may be involved in the protection breastfeeding offers against overweight and obesity throughout the individual's life.³ A recent meta-analysis concluded that exclusively breastfed infants have a 31% lower chance of later developing overweight and obesity.³ This protection is probably related to the differences in growth between breastfed and formula-fed infants.⁴⁻⁶ The feeding method in the beginning of life affects the development of body composition.⁷

Several studies have found that dairy formula-fed infants gain weight and increase their BMI more rapidly in the first six months of life than infants in exclusive or predominant breastfeeding.⁸⁻¹¹ It has been demonstrated that this excess of weight gain in formula-fed infants does not represent an excess of adiposity gain, as previously believed, but rather a progressive increase in lean mass.¹¹ This excess of lean mass can be explained by the fact that formula-fed infants consume more protein in the first six months⁶ of life than breastfed infants. A higher protein intake in the first year of life is associated with a greater increase in lean mass.¹²

Since the literature does not indicate any differences in the adiposity gain (fat mass) trajectory in the first

six months between exclusively breastfed and formula-fed infants,^{11,13–15} the hypothesis that the excess adiposity accumulated during this period is involved in the association between breastfeeding and lower risk of overweight and obesity in the future loses strength. Other hypotheses have been raised: differences in the consumption pattern of solid foods¹⁶; the effect of the baby bottle on self-regulation of food intake¹⁷; absence of exposure to bioactive substances that inhibit adipogenesis found in human milk¹⁸; differences in the distribution of fat deposits^{14,19}; and excess lean mass gain.¹¹

Regarding bone mass, a systematic review²⁰ retrieved only one study describing the association between bone mass and type of feeding in the first six months.²¹ That small-sample study showed no difference in bone mass at five months of life between exclusively breastfed and formula-fed infants.

The association between breastfeeding and a favorable intestinal microbiome to several child health outcomes is well established.^{22–24} More recently, researchers have concentrated their efforts in delineating the trajectory associating human milk composition, microbiota, and child growth.²⁵ There is some evidence suggesting that the microbiota composition is associated with weight gain and adiposity in young children.²⁶ A study using an animal model to assess the role of sialylated oligosaccharides found in human milk, and their effects on the favorable microbiome and infant growth, verified that the growth-promoting effect of these oligosaccharides does not appear to be due to direct changes in the host's metabolism, but through the modulation of the microbiota activity and a complex interaction network of the microbial community.²⁵ This is a very promising area of research that will certainly add new insights into the importance of breastfeeding and its association with the microbiome for child growth.

Growth monitoring

Growth monitoring begins in the intrauterine life and continues soon after birth, with the follow-up of the expected weight loss in the first days of life.

Weight loss after birth

Weight loss in the first four days of life of exclusively breastfed infants is more due to loss of fat mass than lean body mass, including body water.^{27,28} After the fourth or fifth day, the fat mass increases significantly, getting close to the values observed on the first day.

Weight loss and the time until birth weight recovery vary and depend on the nutrition the child receives. The mean weight loss in exclusively breastfed infants was 5% in a study carried out in the United States²⁹ and 6.3% in an Italian study.³⁰ The latter study observed that weight loss in exclusively breastfed infants was lower when compared with that formula-fed newborns ($7.5\% \pm 2.4\%$). The authors concluded that exclusive breastfeeding poses no increased risk for greater weight loss in the neonatal period. However, a study comparing weight loss in full-term exclusively breastfed infants to those receiving formula reported that the mean time to birth weight recovery in exclusively

breastfed infants was higher when compared to those who received formula (8.3 days vs. 6.5 days, respectively).³¹

Weight loss after birth is also influenced by the type of delivery, whether vaginal or cesarean section. A study carried out in California, United States, which included 161,471 healthy newborns with 36 weeks or more of gestational age, born between 2009 and 2013, found that 5% of infants born by vaginal delivery and more than 10% of those born by cesarean section lost 10% or more of their birth weight in the first 48 h of life.³² These differences were observed as early as in the first six hours after the birth and persisted throughout the first days. With the data obtained in this study, it was possible to construct a nomogram that may be useful in monitoring the newborn's weight loss after birth. This nomogram is available and takes into consideration the type of feeding, the type of delivery, and the child's days of life.³³

Another study, using a mathematical model to establish the peak weight loss after the birth of full-term newborns, found that the lowest weight, *i.e.*, the maximum inflection point of the weight curve of exclusively breastfed infants, was on the third day of life, at 52.3 h of life.³⁴

Growth monitoring

Reference population

In the 1980s and 1990s, several studies on the growth of infants receiving different diets were published.^{5,35,36} These studies indicated a differentiated growth in exclusively breastfed infants when compared with those who were formula-fed. Data from seven studies carried out in North America and Northern Europe, totaling 226 infants that were exclusively breastfed for at least four months and longitudinally followed-up, showed that the weight of breastfed infants increased more rapidly in the first two months of life and less rapidly from three to 12 months, in relation to the infants who served as references for the growth curves of the Centers for Disease Control and Prevention (CDC).⁵ These children also showed greater linear growth until four months of age.

The differentiated growth of breastfed infants in relation to those non-breastfed alerted researchers, healthcare professionals, and international organizations of a possible inadequacy of the growth curves used as reference – the curves of the National Center for Health Statistics (NCHS 1977),³⁷ adopted at that time by 100 countries, including Brazil, and the curves of the Centers for Disease Control and Prevention (CDC).³⁸ These curves, among other limitations, were predominantly based on formula-fed infants.³⁹ It was feared, at the time, that the use of these curves could be causing iatrogenic conditions by comparing the growth of exclusively breastfed infants with those of formula-fed children, since the rate of weight gain was lower in exclusively breastfed infants... after 2 months of life.

Considering this scenario, and starting from the premise that the children's growth in the first five years is more affected by living and feeding conditions than ethnic factors,^{40,41} the World Health Organization (WHO) decided to fund the creation of new curves to be adopted internationally.

The new WHO growth curves were made available worldwide in 2006⁴² and are currently adopted by more than 125 countries,⁴³ including Brazil. These curves are available in the Caderneta de Saúde da Criança⁴⁴ and on the WHO website.⁴⁵ They were created based on children from six countries of different continents: Brazil (Pelotas, Rio Grande do Sul), the United States (Davis, California), Norway (Oslo), Oman (Muscat), Ghana (Accra), and India (New Delhi). When creating the curves for the age group of 0 to 2 years, 903 children were followed-up, monitored at birth and at 21 visits: at weeks one, two, four, and six, monthly from two to 12 months, and every other month in the second year of life.⁴⁶

An unprecedented characteristic that adds significant value to the WHO's curves, in addition to its international representativeness, is that they are prescriptive, and not only descriptive; *i.e.*, to be included in the study, children had to meet certain criteria to ensure they had the minimum conditions to develop their growth potential. As a result, children in conditions of extreme vulnerability were excluded. The adopted criteria were the following: absence of economic, environmental, or individual restrictions to ideal growth; full-term birth; single birth; absence of major perinatal morbidity; non-smoking mothers; and exclusive or predominant breastfeeding for at least four months (recommendation at the time of the study) and total duration of breastfeeding for at least 12 months.⁴⁶ Children in exclusive and predominant breastfeeding (mother's milk and water-based liquids: water, tea, and juice) were grouped because their growth was found to be similar. Using breastfed infants as the reference for optimum growth established maternal breastfeeding as the infant feeding standard for optimal growth.

Indices and cut-off points used

An index is the combination of more than one measurement. They are important because they allow interpreting and grouping measurements.

In order to monitor children's growth, the WHO recommends the following indices: weight-for-age (W/A); length or height-for-age (L/A or H/A); weight-for-length or weight-for-height (W/L or W/H) or body mass index-for-age (BMI/A), in addition to birth weight.

The W/A index expresses the body mass for the child's chronological age. Its advantages comprise the fact that it is easily measured and the high sensitivity of weight to variations in the children's health and nutrition status. It is the most sensitive index to monitor growth in the first year of life. However, the use of this index alone has some limitations, especially for children older than 1 year. As it does not use the length or height measurement, it is not possible to identify whether the growth deviation has started in the past or whether it is recent. Therefore, this index should be used together with other indices.⁴⁷

The L/A index reflects the child's linear growth. A deficit in this index indicates a long-term process that may express a past problem or a problem that was initiated in the past, but which persists in the present. After six months of age, it is considered a better parameter for evaluating growth than weight alone.⁴⁷ It reflects the quality of life of a population and is an excellent prognostic indicator. Height at 2 years of age is considered the best predictor of human capital. A

deficit in this index at this age may affect future school performance, the individual's economic productivity, and even affect the birth weight of the descendants.⁴⁸

The BMI/A (weight/length² or weight/height²) expresses the association between weight and length or height of the individual. It is the indicator that can distinguish whether the growth deficit problem is a past or current issue. BMI is a good indicator of adiposity and excess weight, and is closely related to other parameters, such as skinfolds, densitometry, and electromagnetic bioimpedance.⁴⁹ There is evidence that a high BMI in children younger than 2 years increases the risk of obesity in adolescence and adulthood.^{50,51} Its use is recommended since birth.

The anthropometric indices may be expressed as a *percentage* of the reference values, *percentile* used in relation to the reference values, and *standard deviations* (SD) or *Z-scores*, which indicate the number of SDs below or above the median of the reference population, the exact position of the child in relation to the reference population. The WHO has recommended the use of standard deviations, with a cut-off point for the identification of growth deviations $\pm 2SD$ in relation to the mean. According to WHO, for the age group of 0 to 2 years, SDs between $>+1$ and $\leq +2$ indicates overweight risk; between ≥ 2 and ≤ 3 indicates overweight; and >3 , obesity.⁵²

Serial measurements allowing the construction of an index curve are more useful than comparing a single measurement with the reference, allowing early interventions in the presence of a rapid change in the upward or downward trend of a horizontal plot or a plot that crosses a Z-score line.

To better monitor the child's growth, use of different indices is recommended; the risk should be interpreted based on the location of the measurement point in relation to the mean and the velocity of some change in the curves.

Comparison of the anthropometric indices of exclusively breastfed infants with formula-fed infants

The study of the new WHO growth curves confirmed that the growth of exclusively breastfed infants (children included in the WHO curve) is different from that of infants who were predominantly formula-fed (children included in the NCHS and CDC curves). The mean weight of the children included in the WHO study was higher than that of children in the NCHC curve up to about six months of age, but the weight gain velocity was lower after two months in breastfed infants.⁴ The same is observed when comparing children in the WHO curve with those in the CDC curves.⁵³ As for the length, it was similar between exclusively breastfed infants and those who were predominantly formula-fed, although the variability in the measurements is lower in breastfed infants. These differences justify the use of growth curves of exclusively breastfed infants (new WHO curves), since exclusive breastfeeding is considered the gold standard for infant feeding in the first six months of life.

Conclusions

The growth of exclusively breastfed infants is different from those who were predominantly formula-fed, as shown by the differences between the new WHO growth curves and

the older curves constructed with infants predominantly fed with formula. This difference manifests as early as soon after birth – breastfed infants lose less weight in the first three to four days of life – and it continues during the first six months.

Overall, the mean weight of exclusively breastfed infants is higher than that of infants predominantly fed with formula until about six months of age, but the weight gain velocity is lower after two months in breastfed infants, *i.e.*, formula-fed infants gain weight and increase their BMI more rapidly in the first six months when compared to infants in exclusive or predominant breastfeeding. This behavior may give the false impression that breastfed children do not grow adequately, if the NCHS or CDC curves are used. Considering that the currently adopted growth pattern is that of exclusively breastfed infants, the adoption of the new WHO growth curves for monitoring children's growth has been recommended worldwide.

Conflicts of interest

The author declares no conflicts of interest.

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