We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300
Open access books available

171,000
International authors and editors

190M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Chapter

The Catch Up of Small for Gestational Age: Breast Milk Is It the Best?

Haythem Bachrouche

Abstract

Small for gestational age (SGA) is defined as a birth weight below the 10th percentile for gestational age. We can distinguish two categories of SGA: the first group is constitutionally programmed to be small despite a favorable maternal environment, the second group has a growth restriction due to a maternal condition leading to placental insufficiency. The burden of fetal growth-restricted (FGR) SGA is higher in resource-poor countries, and children born FGR SGA have a higher risk of mortality and morbidity during the neonatal period and beyond. To overcome this underweight and therefore the higher rate of early and late morbimortality, it seems logical that the weight gain in the first months of life (catch up phenomenon) have the optimal speed. Exclusive breastfeeding from birth until six months of age should be encouraged for all infants, including SGA infants, but the supplementation with standard formula or fortified formula until the 6th month of life is it not justified for an optimal catch up? Many authors believe that the "catch up" phenomenon would be the major etiological factors of obesity, cardiovascular disease, and metabolic syndrome in the future. It was demonstrated in many research that, SGA children who received fortified formula or standard formula whatever the reason, showed faster weight gain in the first months of life, which was related to increased body fat later in life. It was also revealed in several studies that, when exclusively breastfed, SGA achieved a catch-up growth slower, suggesting that the human milk can be the reference nutriment for healthy growth without nutritional impairment in children born SGA with effects adulthood.

Keywords: small for gestational age, breastfeeding, metabolic syndrome, overweight, standard formula, fortified formula

1. Introduction

Catch up growth (CUG) of small for gestational age (SGA) is a crucial determinant of short- and long-term health issues. Adequate nutrition and feedings practices during the early life are the key of an optimal growth rate.

Is exclusive breastfeeding from birth until six months of age (EBF) the best recommendation for preterm and term SGA? Would EBF be enough to prevent undernutrition and to achieve optimal CUG of theses infants? Would EBF reduce morbidity and mortality during early life and later in this high-risk population? We will try to answer to these questions in this chapter according to the latest scientific evidences to guide health professionals to early preventive strategies.

2. Who is the small for gestational age?

Small for gestational age (SGA) is defined as a birth weight below the 10th percentile for gestational age.

During intrauterine life, the fetus may be constitutionally programmed to be small despite a favorable environment. It can also undergo adverse maternal conditions causing a placental insufficiency and leading to intrauterine growth restriction (IUGR) without achieving his genetic potential growth.

We distinguish the premature SGA (PT SGA) and full-term SGA (FT SGA) according to gestational age.

SGA infants represent about 10% of live births in developed countries [1]. Few years ago, this prevalence can be variable for the same population due to a lack of consensus on the definitions used for SGA, as well as on the reference standards for growth in the world.

To overcome this uniformity and due to a lack of evidence-based and internationally applicable tools, the International Consortium for Fetal and Newborn Growth in the 21st Century (INTERGROWTH-21e) published in 2014 standards for weight, height and head circumference at birth. The aim of this initiative is to monitor fetal growth and to standardize growth assessment, in order to provide compelling evidence for maternal and newborn health programs [2].

These fetal and neonatal references complement the WHO growth standards published in 2006 and represent the most appropriate framework for monitoring growth during the first 5 years of life.

Indeed, the WHO growth standards take an approach regardless of ethnicity or location and based on breastfed infants as the normative model of growth under optimal conditions, contrary to previous growth references like 1977 NCHS and 2000 CDC based on formula fed infants [3].

This evolution of growth assessment tools led to better harmonization of research and so a better quality of studies' conclusions.

3. The challenge of SGA nutrition in the early life

It is well known that a low birth weight is linked to the risk of perinatal and infantile morbidity and mortality [4].

There are many causes of SGA. A constitutionally small infant born to a small mother and/or father is the commonest cause of SGA. The commonest pathological cause of SGA is placental dysfunction leading to suboptimal nutrition and intrauterine growth retardation (IUGR).

This stressful environment during fetal development can cause epigenetic changes, abnormal vascularization and aberrant endocrine regulation. These conditions observed particularly in SGA with IUGR increase the risk of diseases later in life.

Prematurity is an additional factor, and the PT SGA has more complications in short and long -term life.

Prenatal monitoring can reduce the prevalence of SGA. The regular follow-up of pregnant women is a recommended universal action as a front-line strategy to prevent noncommunicable diseases in adulthood by decreasing the incidence of SGA.

But we know that not only the intrauterine period, but also the postnatal nutrition and growth interfere with future health issues. Indeed, human growth is the result of an interaction between genetic, hormonal, nutritional and environmental factors.

Due to evidence that one of the main factors for modulating the growth pattern in infancy is nutrition and, therefore, feeding policies are very important for the prognosis of these infants in the early life and later. So, the efforts can be directed to defining optimal feeding patterns for SGA.

Not long ago, we thought that the delay of weight at the start of life must be recovered as soon as possible to prevent cognitive issues by promoting rapid catch-up growth especially for head circumference.

We have encouraged in the past mothers and health professionals to supplement additional calories to SGA by administering a nutrient enriched formula to promote quick weight gain.

But from studies by Singhal and his team revealing that accelerated gain in weight with the supply of nutrient and calorie dense formulas to SGA was associated with increased total body fat in childhood [5], many other studies confirmed that this practice might be deleterious to infant born SGA and that who grew more rapidly were more likely to be obese later and have a specific increased risk of cardiovascular and metabolic diseases. In order to minimize the programmed disease risk (due to IUGR) and to reach optimal post-natal growth, the nutrition pattern in the first months of life is a real challenge.

4. Research limitations and proposals for standardization

As we described above the lack of uniformity and the need of standardization in SGA and CUG definitions made very difficult to complete metanalysis and to draw a valuable scientific conclusion.

Conjointly, for ethical reasons we cannot conduct randomized double-blind studies evaluating exclusively breastfed infants vs. exclusively formula fed infants.

For these reasons, researches in the literature about SGA nutrition are sparse and difficult to conduct and most current evidence is based on limited studies with low to medium study quality.

But after the INTERGROWTH-21 initiative coming to complete the WHO child and adolescent growth standards (2006–2007) we can propose the following, to improve globally the quality of our studies and to obtain more interpretable results:

- that the cut-off of the 10th percentile is the definition of SGA;
- that to standardize the identification of infants born SGA we recommend that the INTERGROWTH-21 birth-weight for-gestational-age standards be used;
- that the definition of CUG is a change of >0.67 in z score representing a clinically significant response;

- that the WHO Growth Standards be used to calculate z scores [2];
- that rapid CUG be defined as a postnatal centile crossing defined in terms of an upward change in weight z score during 1 month [6];

By applying these proposals, future metanalysis of small cohort's studies can be possible, and so we can obtain a better scientific quality recommendation.

5. Nutrition of FT SGA in the first months of life

To overcome the underweight at birth of FT SGA and to minimize a higher risk of early and late morbimortality, it seems logical that the weight gain in the first months of life (catch up phenomenon) have the optimal speed.

Many authors believe that the catch-up phenomenon would be the major etiological factors of obesity, cardiovascular disease, and metabolic syndrome in the future.

The challenge is how to nurture these FT SGA and achieve balance between risk of malnutrition (causing cognitive development impairment) and accelerated growth without increasing the risk of chronic non-communicable diseases in the future [4].

Exclusive breastfeeding (EBF) from birth until six months of age is strongly recommended by WHO for all infants (FT SGA, PT SGA, LBW and preterm infants) [1] but the supplementation with standard formula or fortified formula until the 6th month of life is it not justified for an optimal catch up?

Levels of overweight and obesity has increased remarkably worldwide and many studies found that infants who were grew rapidly were more likely to be obese in childhood, adolescence and early adulthood than other infants [7].

The study by Singhal et al. showed that the increased caloric supply in SGA infants, especially protein, led to a rapid early growth with fat mass accumulation. In the other hand, the breastmilk apart his nutritional components, contains adipokines (leptin and adiponectin) that lead to better appetite regulation, helping to achieve a healthier weight gain [8].

This fact was consolidated by other studies. After 3 months of age the growth diverges markedly between breastfed and formula fed infants with a difference in average of 600–650 g at 12 months. Differences in length tend to be less pronounced [3] which does not affect the prognosis of the size later. Furthermore, infant formula lacks growth mediators found in human milk and slower weight gain of breastfed infants was not associated with nutritional impairment in infancy or shorter size in adulthood.

In low and medium incomes countries, we note a virtual absence of studies of CUG, and to our knowledge the only research done by Bachrouche et al. was interesting [9]. They compared 2 groups (17 EBF FT SGA vs. 13 formula fed FT SGA) and there was a significant difference in the mean of weight at the age of 6 months suggesting that standard formula provided a faster weight gain and that EBF until 6 months ensured a slower CUG.

Also, Zegher et al. in his cohort study found that breastfed FT SGA had a higher insulin sensivity, normal serum fasting glucose, IGF 1 and adiponectin levels and a lower BMI and fat mass when compared to formula fed FT SGA suggesting a reduced risk of diabetes and obesity in adulthood [4].

Likewise, FT SGA exclusively breastfed until 6 months matched their genetic growth trajectory slower without nutritional impairment.

In the other hand, in a systematic review it was evidenced that, SGA showed higher insulin resistance and higher risk of diabetes [10], and additional to such risk and according to the result of latest studies, the early introduction during the first months of life of infant formulas or any other supplementation may induce a rapid catch-up growth of SGA that is considered as one of major etiological factors of obesity, cardiovascular diseases and metabolic syndrome in adulthood for these infants.

For all that, breastfeeding seems to be the best choice for FT SGA to reach an optimal catch-up growth with the best outcomes and this nutrition recommendation can prevent obesity and cardiovascular and metabolic diseases in this high-risk population.

6. Nutrition of PT SGA in the first months of life

The nutritional management of SGA associated to prematurity is more difficult in view of this double risk factor of morbidity and mortality. Postnatal nutrition of PT SGA must be safe, help to achieve optimal growth but also minimize the potential risk for later ill-health.

International pediatric societies recommend that postnatal growth should be close to that of the utero growing fetus. In neonatal period, we often need to hospitalize PT SGA in NICU for reasons of care and the staff has sometimes to limit nutrient intake.

Once again, Exclusive breastfeeding from birth until 6 months of age, is strongly recommended by WHO in PT-SGA, LBW and preterm infants, but is EBF enough to fulfill the nutritional requirements of this infants?

Energy and nutrient intakes for preterm based on weight and age of birth have been developed and published by several groups and notably by WHO (**Table 1**). Also, ESPEGHAN recommends to apply an enhanced nutrient strategy after discharge from hospital up to 52nd week of GA to all growth-restricted VLBW infants. Indeed, the breast milk or pasteurized donor milk as a first alternative milk source over standard and preterm infant formula are recommended for preterm and SGA [1].

This strategy improves feeding tolerance, reduces delay to enteral feeding and lead to a lower incidence of necrotizing enterocolitis (NEC). The breast milk (BM) or donor BM is usually fortified to achieve intake recommendations by preferably human milk (HM) originated fortifier better than cow milk-based protein or preterm formula.

Limited studies with low to medium quality had compared HM to HM fortified and HM to formula. Overall, only human milk compared to formula intervention had a positive effect on morbidity among preterm infants while no interventions had any effect on mortality. The Bovine/cow milk supplementation had unfavorable effects on morbidity and mortality. In a systematic review, 3 studies compared HM and formula in ELBW. 2 studies did not observe any effect on growth, and only the study of Manea et al. reported that breast milk was more effective than formula at improving the weight of these infants [11].

The higher caloric and protein intake for premature infants in general and especially for PT SGA has as arguments the immediate metabolic risks, the avoidance of malnutrition and the promotion of a better neurocognitive prognosis. Hence, nutrient fortification of HM is now standard clinical practice for VLBW babies in many settings.

However, it is important to note that these recommended intakes are for guidance and in 45 of 46 studies (summarized in 6 reviews) faster infant growth has

	Birth to 7 days	Stabilization to Term	Term
Energy Requirements			
Energy kJ/kg (kcal/kg)	292–334 (70–80)	438–563 (105–135)	417–501 (100–120)
Macronutrients			
Carbohydrates (g/kg)	5.0–20.0	7.5–15.5	7.5–15.5
Protein (g/kg)	1.0–3.0	3.0–3.6	2.2
Fat (g/kg)	0.5–3.6	4.5–6.8	4.4–7.3
Micronutrients per day			
Vitamin A (IU/kg)	700–1500	700–1500	600–1400
Thiamin (mg/kg)	0.04–0.05	0.04–0.05	0.05
Riboflavin (mg/kg)	0.36–0.46	0.36–0.46	0.05
Niacin (NEe /5000 IU)	8.6	8.6	8.6
Vitamin B6 (mg/g of protein intake)	0.015	0.015	0.015
Folate (μg)	50	50	25
Vitamin B12 (μg)	0.15	0.15	0.15

Table 1.
WHO recommended daily energy and nutrient intakes at birth for preterm infants (>1.0 kg). Adapted from Edmond, Karen and Bahl, (2006).

been associated with later obesity in both high- and low-income countries, in infants preterm or at term and born with normal or low birth weight.

In addition, the argument put forward that poor growth in preterm expose to neurocognitive impairment remains unproven according to a recent review [12].

That is why we can suggest that BM without any fortification can be the best choice for the PT SGA in neonatal period, based on its immunological advantages, its better digestive tolerance, the possibility of early introduction and the possibility of reducing hospital stays. After discharge and with a close monitoring of growth in PT SGA, EBF until 6 months can be advised with the aim to achieve a catch up with a slow and progressive weight gain without any rapid acceleration exposing to the obesity and others diseases in adulthood. Although in a recent systematic review, involving over 10,000 VLBW infants, we have found much of the evidence for the association between growth outcomes and HM intake to be inconclusive, largely due to the quality of the evidence [13].

In summary, the concept of EBF for PT SGA can be adopted worldwide, if efforts will be directed to conduct high quality studies that can prove that BM is safer for these infants in early life and also preventive later from adult diseases by a slower growth in the first months of life.

7. Breast milk values and actions to do for a successful breastfeeding of SGA

The benefits of breastmilk are innumerable. All efforts, before conception, during pregnancy and in postpartum should be focused on the success of breastfeeding, especially for SGA.

The unimpeachable high qualities of human milk have been well studied and still remain an area of research.

Breastmilk confers many immunological, bioactive, psychological benefits for mothers and infants. It improves neurologic maturation, protects against NEC, diarrhea and infections, and reduce morbimortality in all infants and notably in SGA. Recently, a relationship between breastfeeding and epigenetic regulation has been found. A study found a significantly lower DNA methylation in children exclusively formula fed compared to children exclusively breastfed [14].

DNA methylation is considered as one of the main epigenetic mechanisms responsible for gene regulation and a potential biomarker of a variety of pathologies, including cancers, metabolic disorders, and cardiovascular diseases. EBF seems to be an epigenetic regulator and a protective nutritional feeding from diseases through the DNA methylation.

In view of this major importance of BM for maternal and child health, and especially for SGA who are at high risk of morbidity and mortality during childhood and after, all care strategies must support the breastfeeding of these infants.

Many measures are recommended: continuous Staff training, clear information for parents, creating neonatal units with kangaroo rooms, creating BM and donor BM banks, providing places for breastfeeding and breast pumping in hospitals, public places and at work. Also preferring cup-feeding when direct BM is not possible and early progressive feeding instead of delayed feeding for PT SGA are recommended. Follow-up by breastfeeding consultants should be encouraged for a better chance to overcome hardships to succeed an EBF of SGA until 6 months of life.

8. Conclusions

Human milk (HM) is the gold standard for feeding all infants. SGA are a high-risk population of obesity, cardiovascular diseases and metabolic syndrome later in life. The strategy of nutrition in the first months of life is crucial modulator to prevent health issues. EBF is associated with slower growth of SGA, however formula fed interventions can lead to a rapid catch-up growth linked to a higher risk of diseases in infancy and adulthood. Our nutrition strategies in view of recent data must avoid increased caloric supply in the early life and EBF until 6 moths of life would be preferred even for PT SGA.

Finally, breastfeeding seems to be the best choice for all SGA to reach an optimal catch-up speed with the best outcomes.

Acknowledgements

All the team of Pediatrics and Neonatology department of Mohamed Tlatli Hospital, Nabeul, Tunisia.

Conflict of interest

The author declares no conflict of interest.

IntechOpen

IntechOpen

Author details

Haythem Bachrouche
Medicine School of Tunis, Tunis El Manar University, Nabeul, Tunisia

*Address all correspondence to: haythem.bachrouche@gmail.com

IntechOpen

© 2023 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

[1] Carducci B, Bhutta Z. Care of the Growth Restricted Newborn. Best Practice & Research Clinical Obstetrics & Gynaecology. 2018;**49**:103-116. DOI: 10.1016/j.bpobgyn

[2] Campisi SC, Carbone SE, Zlotkin S. Catch-up growth in full-term small for gestational age infants: A systematic review. Advances in Nutrition. 2019;**10**(1):104-111. DOI: 10.1093/advances/nmy091

[3] Laurie A, Nommsen-Rivers KG, Dewey. Growth of breastfed infants. Breastfeeding Medicine. 2009;**4**(1):S45-S49. DOI: 10.1089=bfm.2009.0048

[4] Santiago ACT, Martins LP, da Cunha M, de Lima Costa. Cardiometabolic evaluation of small for gestational age children: Protective effect of breast milk. Nutrición Hospitalaria. 2021;**38**(1):36-42. DOI: 10.20960/nh.03267

[5] Singhal A, Kennedy K, Lanigan J. Nutrition in infancy and long-term risk of obesity: Evidence from 2 randomized controlled trials. The American Journal of Clinical Nutrition. 2010;**92**:1133-1144. DOI: 10.3945/ajcn.2010.29302

[6] Phillip M, Turck D, Shamir R, Koletzko B, editors. Nutrition and growth. In: Yearbook 2022. Vol. 125. World Review of Nutrition and Dietetics. Basel: Karger AG; 2022. pp. 138-155. DOI: 10.1159/000521798

[7] Baird J, Fisher D, Lucas P, Kleijnen J. Being big or growing fast: Systematic review of size and growth in infancy and later obesity. BMJ. 2005;**331**(7522):929. DOI: 10.1136/bmj.38586.411273.EO

[8] Santiago AC, Cunha LP, Vieira NS, Moreira LM, Oliveira PR, Lyra PP, et al. Breastfeeding in children born small for gestational age and future nutritional and metabolic outcomes: A systematic review. Jornal de Pediatria. 2019;**95**:264-274. DOI: 10.1016/j.jped.2018.06.013

[9] Bachrouche H, Aissa MY, Chraiet K. Catch up growth in infants born small for gestational age: Breastfeeding vs standard formula feeding in Tunisia. In: EAPS8-0619 E-Poster Viewing. Paris: EAPS 2018; 2018

[10] Martín-Calvo N, Goni L, Tur JA. Low birth weight and small for gestational age are associated with complications of childhood and adolescence obesity: Systematic review and meta-analysis. Obesity Reviews. 2022;**23**(S1):e13380. DOI: 10.1111/obr.13380

[11] Rana R, McGrath M, Gupta P. Feeding interventions for infants with growth failure in the first six months of life: A systematic review. Nutrients. 2020;**12**:2044. DOI: 10.3390/nu12072044

[12] Singhal A. Long-term adverse effects of early growth acceleration or catch-up growth. Annals of Nutrition & Metabolism. 2017;**70**:236-240. DOI: 10.1159/000464302

[13] Suganuma M, Rumbold AR, Miller J. A systematic review and meta-analysis of human Milk feeding and short-term growth in preterm and very low birth weight infants. Nutrients. 2021;**13**:2089. DOI: 10.3390/nu13062089

[14] Koletzko B, El Sharkawy M. Epigenetics, nutrition, and growth. In: Yearbook 2022. Vol. 125. Basel, Karger: World Rev Nutr Diet; 2022. pp. 64-80. DOI: 10.1159/000521777