Review

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Breastfeeding in SGA Neonates: "Does It Promote Healthier Growth Patterns?"

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Abstract

Background: Small for Gestational Age (SGA) neonates, characterized by birth weight and/or length below the 10th percentile for gestational age, face heightened risks of growth failure, or abnormal growth patterns along with and metabolic complications and developmental delays. Breastfeeding has been identified as a critical factor in promoting healthier growth and mitigating long-term health risks in both fullterm and preterm appropriate for gestational age (AGA) infants but similar studies in SGA infants are limited. **Aim:** This study reviewed the impact of breastfeeding on growth, and body composition in SGA neonates. **Patients and methods:** Using PubMed and Google Scholar 38 relevant studies, were identified, with 13 included in the final analysis, encompassing systematic reviews, randomized controlled trials, observational studies, and narrative reviews. **Results:** In preterm SGA neonates, exclusive human milk-based diets demonstrated superior outcomes compared to formula-based diets. Human milk promoted healthier catch-up growth without excessive fat accumulation along with reduced neonatal morbidities such as necrotizing enterocolitis, sepsis, and bronchopulmonary dysplasia. Advanced body composition methods, such as dual-energy X-ray absorptiometry (DXA), confirmed the protective metabolic benefits of human milk. Fortification strategies were found to enhance growth outcomes in donor milk-fed infants. For fullterm SGA neonates, exclusive breastfeeding for six months was associated with healthy catch-up growth without predisposing infants to obesity or excessive fat accumulation. Breastfed SGA infants exhibited normal or reduced adiposity, and favourable endocrine profiles. **Conclusion**: breastfeeding consistently emerged as a protective factor for SGA neonates, promoting healthier growth patterns. Further high-quality studies are needed to corroborate the observed patterns.

Keywords : SGA; preterm infant; breastfeeding; human milk; growth; obesity

Introduction

Small for Gestational Age (SGA)

Small for Gestational Age (SGA) is a term that refers to neonates born with a birth weight and/or birth length below -2 standard deviation scores (SDS) or the 10th percentile for gestational age and sex (1). The occurrence of SGA may result from a pathological process or may reflect constitutionally small fetuses (2). A term that should not be confused with SGA is IUGR (Intrauterine growth restriction) which refers to the state of fetus that is unable to achieve its growth potential due to an adverse intrauterine environment, based on serial fetal ultrasound measurements (1). Additionally, it is important to note that SGA neonates may be born either at term or preterm. Regardless of the gestational age, SGA infants represent a high-risk group for developmental delays and long-term adverse metabolic outcomes. Firstly, SGA newborns have a higher probability of complications such as sepsis and the need for mechanical ventilation, which are directly linked to poorer neurodevelopmental outcomes. Moreover, SGA newborns have a higher incidence of infections,

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including gastroenteritis and respiratory infections (3). As far as the long-term outcomes pertain, SGAs are at a higher risk of developing chronic diseases such as diabetes, hypertension, obesity, and cardiovascular disease. Longitudinal studies following SGA individuals into adulthood indicate that cognitive developmental challenges primarily manifest as poor academic performance in childhood, though differences in cognitive function appear to diminish in adulthood.

The outcomes described above are highly associated with catch-up growth in weight, length and head circumference during the first months of postnatal life which is also associated with lower insulin sensitivity, reduced HDL-cholesterol levels, elevated triglyceride concentrations, increased obesity risk, and early markers of atherosclerosis (4). Thus, postnatal growth patterns in these populations seems to be very important in short term and long-term.

Human Milk and Breastfeeding

Human milk is a complex biological fluid that contains all the essential nutrients and functional components that contribute to short-and long-term health positive outcomes. These include essential long-chain fatty acids, complex oligosaccharides, nucleotides, bioactive signaling proteins and hormones. Human milk provides the optimal nutrition for infants and is key to sustaining health and building the foundation for growth and cognitive development. The World Health Organization (WHO) recommends that infants should be exclusively breastfed for the first 6 months of life. (2)

Breastfeeding has numerous benefits for term neonates. It is important to highlight that, breastfeeding is associated with a decreased risk of obesity in childhood and adolescence, as well as a lower incidence of hypertension and high cholesterol in adulthood. Moreover, exclusive breastfeeding for a minimum duration of three months is associated with a reduced risk and severity of diarrhea and respiratory infections and when it is continued for at least six months it reduces additionally the likelihood of allergic diseases in infants who are genetically predisposed. Lastly, it is linked to a modest enhancement in cognitive development test performance (5) The protective mechanisms behind breastfeeding benefits stem from both milk composition and natural feeding patterns. Human milk provides balanced nutrients supporting optimal growth without excess weight gain, while delivering protective antibodies and immune factors (6). This slower, steadier growth reduces risks of early insulin resistance (7).

This evidence about the benefits of breastfeeding especially in regard growth is valid for full term normal weight newborns. As far as the SGA pertain, evidence about feeding practices' consequences is not well established because they are less likely to initiate and continue breastfeeding than other newborns. Especially the nutritional management of preterm small-for-gestational-age (SGA) neonates in regards their immediate and latter growth represents one of the most complex challenges in neonatal care. These infants, already compromised by intrauterine growth restriction and premature birth, present a unique dilemma where immediate nutritional interventions must balance short-term growth requirements against long-term developmental optimization.

A deeper understanding of the role of breastfeeding in SGAs in regard their early and later growth patterns will help to enhance outcomes in vulnerable populations, including term and premature SGA infants, which thus the low birthweight may have special dietary needs.

Methods

We searched Pubmed and Google Scholar for relevant studies on implementation of breastfeeding on both term and preterm SGA neonates in regard their growth. The following terms when used: "breastfeeding" or "human milk", and "SGA" or "IUGR" or "in utero growth restriction", or "in utero growth retardation" combined with the terms body weight, body composition, obesity up to June 2025.The initial literature search identified 38 relevant studies. The titles, and then abstracts of the retrieved articles, were scanned for relevance. We also reviewed the reference lists of the retrieved articles in search of other relevant articles that could have been missed in the initial search. Finally, 13 articles were included in this narrative review.

Preterm SGA Neonates and Breastfeeding

Fleig et al (8), have conducted a multicenter, retrospective cohort study in the US to compare the growth and neonatal outcomes of small for gestational age preterm infants who were fed either a cow's milk-based diet or an exclusive human milk-based diet. The study included 197 infants in the cow's milk-based diet group and 223 infants in the exclusive human milk-based diet group, with data collected from electronic medical records over approximately two years before and after the introduction of the exclusive human milk-based diet. Growth velocities and neonatal morbidities were compared between the cow's milk-based diet and human milk-based diet groups. The results indicated that SGA preterm infants who received a human milk-based diet showed improved length Z-scores at discharge compared to those fed a cow's milk-based diet. Despite initial concerns regarding growth in infants fed a human milk-based diet, SGA infants on this regimen achieved comparable growth outcomes to those in the cow's milk-based diet group, with some parameters indicating a trend toward improvement. Similarly, a single-center, longitudinal cohort study from US **(9)** evaluated the benefits of an exclusive human milk-based diet for premature infants (<37 weeks gestation). This study included 51 preterm neonates, comprising both 33 AGA and 18 SGA neonates, all of whom were fed exclusively with human milk. Assessments were conducted at 12–15 months corrected gestational age (visit 1) for anthropometric measurements, serum glucose, and non-fasting insulin, as well as at 18–22 months corrected gestational age (visit 2) for body composition analysis using dual-energy X-ray absorptiometry. This study indicated that premature infants fed exclusively with human milk exhibited improved long-term body composition and metabolic outcomes, with SGA infants demonstrating greater catch-up growth without increased adiposity or insulin resistance compared to appropriate for gestational age (AGA) infants at two years of age. Furthermore, very low birth weight infants who received an exclusive human milk-based diet indicated superior growth outcomes and a lower rate of postnatal growth failure at discharge.

According to the large study conducted by Belfort et al (10), in US which included 138,703 infants for diet-growth analysis and examined surviving infants born between 23 and 29 weeks of gestation or with a birth weight of 401–1500 grams from 2007 to 2016, human milk provided notable benefits for preterm neonates. The primary exposure variable was the enteral diet administered within 24 hours of discharge or transfer from the neonatal intensive care unit, categorized into three groups: exclusive human milk (8977), mixed feeding (65706), and exclusive formula feeding (64020). The main outcomes measured were weight gain and head growth, assessed through z-score changes from birth to discharge. Linear regression models were employed to estimate growth parameters while adjusting for confounders and clustering within hospitals. The study found that very preterm infants fed human milk (either unfortified or fortified) had slower weight gain and head growth compared to those fed infant formula. Among the SGA infants that was included in this study, absolute weight gain and head growth were faster than in AGA infants (for bottle fed infants, weight gain velocity was found to be 14.4 g/kg/d in SGA infants compared with 12.8 g/kg/d in AGA infants while in human milk fed infants, they were 13.9 and 12.43 in SGA and AGA respectively). The difference in growth between diet groups was similar.

A retrospective cohort study by Hofi et al (11), in Israel utilizing medical records from the Kaplan Medical Center NICU (2012–2018), examined the impact of breastfeeding on SGA preterm infants. The study included 80 infants, divided into two cohorts: those receiving fortified mother's own milk and those fed preterm formula. Anthropometric data including weight, length/height and head circumference at a corrected age of two years, were analyzed using statistical methods to compare growth outcomes. The measurements were converted to z-scores according to standardized age and sex, and changes in z-scores (Δ z-scores) were calculated from birth to discharge and from birth to the 2-year follow-up. The study found notable differences in growth outcomes between preterm formula and fortified mother's own milk for small for gestational age (SGA) preterm infants. At Discharge preterm formula -fed infants had smaller decreases in weight and length z-scores compared to mother's own milk -fed infants. mother's own milk -fed infants experienced a larger negative change in weight z-score (−0.47 vs. −0.25, P = 0.01) and length z-score (−0.63 vs. −0.27, P =

0.03). Moreover, preterm formula -fed infants showed a greater positive change in HC z-score (0.41 vs. 0.13, P = 0.04). Nearly half (47%) of mother's own milk -fed infants experienced poor length growth, compared to 22% of preterm formula-fed infants (P = 0.03). At 2-Year Corrected Age (CA): preterm formula -fed infants achieved significantly greater height catch-up growth (68% vs. 40%, P = 0.02) and a larger increase in height z-score (1.33 vs. 0.64, P = 0.02). Both groups showed similar increases in weight and HC z-scores, though preterm formula -fed infants had a higher proportion achieving HC catch-up growth (71% vs. 43%, P = 0.05). Overall, preterm formula-fed infants demonstrated better growth outcomes in weight, length, and HC at discharge and faster height catch-up growth at 2-year CA compared to mother's own milk -fed infants. The study indicates that mother's own milk -fed infants may require additional nutritional support to achieve optimal growth.

Bushati et al. (12) conducted a study in a 52-bed Level III Neonatal Intensive Care Unit in the USA to enhance feeding tolerance in 64 extremely low birth weight infants by implementing an exclusive human milk diet. Prior to exclusive human milk diet implementation, extremely low birthweight infants received human milk supplemented with bovine milk-based fortifiers. The historical cohort (n=49) received human milk with BOV-f, whereas the exclusive human milk diet cohort (n=15) was exclusively fed with human milk. Milk preparation and storage were centralized in a designated milk room, adhering to strict fortification protocols. Weight was measured daily and recorded in grams and weight percentiles and z-scores were calculated using the Fenton growth curves (13). Length was measured weekly, typically starting at 1 week of life, using a measuring tape or ideally a length board and linear growth was recorded in centimeters, growth velocities (centimeters per week), length percentiles, and z-scores based on the Fenton growth curves. Occipitofrontal Circumference (OFC) was measured at birth and weekly thereafter using a paper measuring tape. Head growth was recorded in centimeters, growth velocities (centimeters per week), and z-scores according to the Fenton growth curves. Z-scores were used to measure deviations from the mean growth parameter specific to gestational age and sex, based on the Fenton growth charts. According to those measuring methods, small-for-gestational-age (SGA) neonates receiving an exclusive human milk diet (EHMD) experienced slower weight gain and linear growth during hospitalization but a greater catch-up growth at 2 years of age without increased adiposity or insulin resistance compared to average-for-gestational-age infants. This suggests potential long-term metabolic benefits for SGA neonates. Regarding head growth, the study found no significant difference in occipitofrontal circumference parameters or OFC z-score changes between the EHMD cohort and the historical cohort during hospitalization. This indicates that head growth in SGA neonates may not be adversely affected by an EHMD.

Vesel et al. (14) conducted a multisite, prospective observational cohort study between September 2019 - January 2021, across 12 secondary and tertiary healthcare facilities in India, Malawi, and Tanzania. The study evaluated stable, 1114 moderately low-birth-weight infants (1.50 to <2.50 kg) enrolled at birth, with follow-up visits conducted over six months. Key variables included birth weight, type of low-birth-weight infants, lactation practices, feeding profiles, and growth outcomes at six months. Data were collected via maternal interviews, medical chart reviews, and anthropometric measurements. Weight was measured at birth and at each of the nine study visits with standard methods. Linear mixed-effects models and quasi-likelihood estimation approaches were employed for statistical analyses. The study reported that exclusive breastfeeding provided optimal nutrition and supported growth and development, with 43.8% of infants exclusively breastfed for six months. Human milk feeding was the predominant feeding method, with most infants fed directly from the breast. Lactation support was provided to 77.1% of mother-infant dyads, including guidance on proper latching, positioning, and human milk expression, highlighting the importance of structured lactation management in optimizing growth outcomes. Preterm SGA neonates of this study had 1.89 (95% CI 1.37 to 2.62) and 2.32 (95% CI 1.48 to 3.62) times higher risk of being underweight at 6 months in comparison with AGA neonates. Term-SGA infants had 2.33 (95% CI 1.77 to 3.08), 2.89 (95% CI 1.97 to 4.24) and 1.99 (95% CI 1.13 to 3.51) times higher risk of being underweight compared with preterm-AGA neonates.

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A retrospective analysis by Vizzari et al (15) examined late preterm infants (gestational age 34–36 weeks) born between 2009 and 2015. The study included 175 preterm infants with birth weights below the 10th percentile and excluded those with congenital abnormalities or severe medical conditions affecting growth. Data were collected from computerized medical charts and post discharge follow-up programs at 3, 6, 12, 24, and 36 months of corrected age. Logistic regression analysis identified variables associated with growth failure. The results indicated that infants receiving any human milk at discharge had a lower risk of failing to achieve catch-up growth in weight and length at 36 months. According to the study, breastfeeding was associated with improved metabolic and neurodevelopmental outcomes, with breastfed infants demonstrating a slower but more favourable growth trajectory compared to those receiving formula.

Fullterm SGA Neonates and Breastfeeding

A prospective study from Santiago et al (16) in Brazil, employing anthropometric measurements, body composition assessments, and cardiometabolic profiling in 20 term-born small-for-gestational-age (SGA) and 12 AGA children, tracked until preschool age, indicates that exclusive breastfeeding for the first six months may provide protective benefits against cardiometabolic risks in SGA children. The mean duration of exclusive breastfeeding was 180 days for both SGA and AGA groups. The findings indicate that exclusive breastfeeding during the initial six months promotes healthy and accelerated weight gain in SGA children, enabling them to achieve catch-up growth without predisposing them to overweight or obesity by preschool age. Specifically, exclusive breastfeeding for six months was significantly associated with catch-up growth in SGA children. The study revealed that SGA children who were exclusively breastfed exhibited a greater velocity of weight gain compared to their AGA counterparts. Notably, the maximum weight gain delta was 1.43 in the SGA cohort, compared to 0.55 in the AGA group ($p < 0.001$). Furthermore, 85% of SGA children successfully attained recovery in anthropometric parameters for age within the first six months, with catch-up growth being defined as an increase in z-score of ≥ 0.67. Despite experiencing initial accelerated weight gain, SGA children remained thinner and smaller than AGA children at preschool age, indicating that while exclusive breastfeeding facilitates early catch-up growth, it does not contribute to excessive weight gain or obesity in later childhood. In terms of body composition at preschool age, exclusively breastfed SGA children exhibited normal or reduced adiposity compared to AGA children, indicating that exclusive breastfeeding does not contribute to excessive fat accumulation and is thus favourable for long-term health. Additionally, the study found no significant differences in cardiometabolic risk factors, including fasting blood glucose, insulin levels, homeostasis model assessment of insulin resistance (HOMA-IR), and blood pressure, between SGA and AGA children at preschool age. The authors speculate that exclusive breastfeeding may mitigate the heightened risk of cardiometabolic diseases typically associated with SGA births. Importantly, none of the SGA children in this study were diagnosed with overweight or obesity at preschool age, implying that exclusive breastfeeding may exert a protective effect against these conditions.

Additionally, a study by Diaz et al in Spain (17) involving 117 term infants, including 63 AGA breastfed infants, 28 SGA breastfed infants, and 26 SGA formula-fed infants, explored the influence of breastfeeding versus formula feeding on circulating glucagon-like peptide-1 levels in SGA infants. The findings indicate that breastfeeding provides significant metabolic and endocrine advantages for SGA infants, potentially lowering their long-term risk of diabetes and other metabolic disorders. Anthropometric measurements, including weight and length, were recorded at birth and at four months, while body composition was evaluated using absorptiometry. According to the findings of the study, breastfeeding positively affects weight and length in SGA neonates. At four months SGA breastfed infants had an average weight of 6.3 kg, while SGA formula fed infants also had 6.3 kg but showed less favourable changes in BMI and ponderal index. At the same age additionally, SGA breastfed infants had an average length of 61.4 cm, which was slightly higher than the 61.1 cm observed in SGA-formula fed infants. Furthermore, a study, conducted at Queen Charlotte's & Chelsea Maternity Hospital in UK, employed magnetic resonance imaging (MRI) to assess adipose

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tissue content and distribution (18) and investigate the determinants of adiposity during preweaning postnatal growth in AGA and growth-restricted term infants. A total of 35 singleton infants were scanned within the first five days after birth, including 25 appropriate-for-gestational-age and 10 growth-restricted infants. Among them, 29 infants (21 AGA, 8 GR)—16 boys and 13 girls—underwent a second imaging session at six weeks old. Regarding feeding methods, 12 infants (9 AGA, 3 GR) were exclusively breastfed, 9 (6 AGA, 3 GR) were solely formula-fed, and 8 (6 AGA, 2 GR) received a combination of both breast milk and formula. According to the study, SGA infants exhibited complete catch-up in head growth and adiposity by six weeks, despite remaining lighter and shorter than AGA infants. The highest adiposity at six weeks that was observed in exclusively breastfed GR infants, indicated that breastfeeding supports improved fat deposition and metabolic health, potentially reducing the risk of obesity and related disorders later in life.

A cohort study of term SGA infants born between January 2006 and November 2015 in China (19), further substantiates the advantages of breastfeeding for term neonates. The study collected data on gestational age, birth weight, sex, gravidity, and parity at birth, as well as feeding patterns from 0 to 4 months. Parental characteristics, including weight, height, BMI, and educational background, were also recorded. The weight was measured using an electronic scale to the nearest 100 grams, **the length** in the supine position using a measurement bed to the nearest 0.1 cm and the height for children up to 3 years in a standing position using a measurement stadiometer. The author speculates that breastfeeding promotes optimal growth and development, including weight gain, by providing tailored nutrients and fostering better metabolic programming. However, the extremely rapid weight gain pattern of term SGA infants in the first 2 years of life may increase the risk of overweight/obesity at 2 to 5 years of age.

A cohort study in Spain investigating the impact of breastfeeding on body composition (by absorptiometry) and endocrine function in term SGA infants has further indicated the crucial role of human milk in fostering healthier growth patterns while mitigating the risk of future health complications (20).This study has followed infants who were exclusively breastfed or formula-fed for the first four months, with body composition assessments conducted at two weeks and four months of age. (72 AGA,46 BRF SGA,56 FOF SGA). The results indicated that SGA infants who were breastfed prioritized lean mass recovery over fat mass, a process that remained largely unaltered by early nutrition. However, breastfeeding facilitated balanced weight gain without leading to an excessive increase in fat mass, a risk commonly linked to formula feeding. Moreover, SGA infants exhibited normal levels of high-molecular-weight (HMW) adiponectin and insulin-like growth factor I (IGF-I) at four months, whereas formula-fed infants tended to have elevated levels of these biomarkers. Furthermore, breastfeeding was associated with a reduced risk of metabolic disorders, such as diabetes and hypertension, later in life—a particularly critical factor for SGA infants, who are inherently more susceptible to such conditions. Additionally, breastfeeding was associated with a lower likelihood of cardiovascular diseases in SGA infants, reinforcing its significance in reducing the inherent susceptibility of these children to such health issues.

Additionally, a study (7) evaluating the influence of early infancy feeding practices on fasting insulin levels in low birthweight neonates indicated benefits of exclusive breastfeeding for term SGA neonates. The study included 52 infants, 26 of whom received exclusive breast milk and 26 human milk fortifiers. Routine anthropometry and evaluation of health status was performed. The infants were followed up every 15 days up to three months. Statistical analyses indicated that exclusive breastfeeding was associated with slower and steadier weight gain, reducing the risk of early hyperinsulinemia and insulin resistance.

Discussion

The growth patterns of breastfed SGA infants as it has been shown in the few existing papers analysed in this review seems to lead in some conclusions that challenges conventional expectations about early nutrition and development. Santiago et al found that exclusively breastfed SGA infants demonstrate accelerated weight gain during their first six months compared to appropriately sized

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peers, yet they do not develop overweight or obesity later in childhood. This appears counterintuitive given the established association between rapid early weight gain and subsequent obesity risk. However, these breastfed SGA infants remained leaner at preschool age despite their initial rapid catch-up, with weight gain consisting primarily of lean muscle rather than adipose tissue, suggesting that breast milk may direct growth patterns differently than formula feeding (16).The metabolic benefits extend beyond anthropometric measures to encompass protective hormonal programming, as breastfed SGA infants maintain healthier hormone levels, particularly GLP-1, which regulates long-term blood sugar control (17). While formula-fed SGA infants often exhibit concerning elevations in growth hormones and fat-regulating proteins, breastfed counterparts maintain more physiological levels (20). By preschool age, breastfed SGA children demonstrate completely normalized blood pressure, glucose, and insulin levels, effectively eliminating the metabolic disadvantage associated with their birth status, with research suggesting extended protection against diabetes, hypertension, and cardiovascular disease (16,20).

Previous findings have implied that exclusive breastfeeding produces significantly lower BMI z-scores compared to expressed milk or formula feeding, revealing how natural feeding patterns drive metabolic advantages through the characteristic "breastfeeding paradox" of rapid initial growth followed by naturally moderated velocity (21-23). However, preterm SGA infants present a complex clinical challenge, as Belfort et al (10) demonstrated slower weight gain in human milk-fed infants (12.97 g/kg/day) with formula-fed counterparts showing superior discharge metrics including head circumference catch-up (71% vs. 43%, $P = 0.05$) (10,11). This creates an apparent paradox where the feeding strategy appearing suboptimal short-term may confer superior long-term advantages, though the marginally slower head growth warrants consideration given neurodevelopmental vulnerabilities (10).The implementation of breastfeeding paradigms have encountered significant clinical resistance from growth-focused monitoring systems developed for formula-fed populations, despite more recent growth charts (13)(24) better representing breastfed infants and evidence that lower percentile expectations increase breastfeeding rates(25,26). Slower growth trajectories in breastfed SGA infants may represent optimal metabolic programming rather than nutritional inadequacy, demanding clinical protocols that distinguish adaptive patterns from pathological failure while optimizing long-term outcomes for this vulnerable population.

Breastfeeding facilitates sophisticated biological programming optimizing long-term metabolic health through moderated weight gain patterns. Breastfed infants exhibit slower weight gain after two to three months, resulting in lower weight z-scores but superior body composition with reduced fat mass and enhanced lean tissue development (27,28,29). For SGA infants, natural breastfeeding facilitates initial catch-up growth when needed while transitioning to protective slower patterns that reduce obesity risk (27,30). Exclusive breastfeeding for six months significantly reduces excessive weight velocity through metabolic imprinting and appetite self-regulation development (31,32). This paradigm becomes essential for SGA infants who demonstrate heightened preferences for calorie-dense foods, as breastfeeding's self-regulatory mechanisms provide biological constraints against excessive intake patterns leading to pathological catch-up growth (33,34).

The fundamental distinction between natural breastfeeding and alternative feeding approaches lies in the infant's capacity for autonomous appetite regulation, which prioritizes metabolic health over maximum weight velocity. Infant-controlled feeding mechanisms enable SGA neonates to achieve appropriate catch-up growth through self-regulated intake based on physiological hunger and satiety signals, contrasting with externally imposed formula feeding schedules (35). This becomes particularly crucial for SGA infants, who demonstrate altered appetite regulation including impaired satiety signalling and enhanced orexigenic responses (36). Breastfeeding provides a protective framework accommodating these appetite irregularities while preventing metabolic consequences associated with uncontrolled growth acceleration.

The metabolic programming advantages of breastfeeding in SGA neonates extend beyond nutritional provision to encompass biological communication between maternal physiology and infant developmental needs. Human milk contains bioactive compounds including oligosaccharides, lactoferrin, immunoglobulins, growth factors, and cytokines that orchestrate infant metabolism, immune development, and growth patterns (37-39). The temporal variation in milk composition, with peak bioactive concentrations in colostrum followed by continued adaptation, suggests evolutionary programming responding to changing infant requirements. For SGA infants, this adaptive capacity becomes critical as their metabolic needs may deviate from population norms, necessitating individualized biochemical signaling that only fresh maternal milk may provide. The establishment of infant gut microbiome through milk-derived communities may affect metabolic health beyond nursing, influencing immune maturation and metabolic regulation (40,41).

Clinical support of breastfeeding in SGA neonates requires reconceptualizing growth monitoring paradigms that have undermined optimal feeding practices. Traditional growth references derived from formula-fed populations fail to recognize breastfed infants' distinct trajectory of rapid initial growth followed by naturally moderated weight gain (42). This pattern frequently triggers unnecessary interventions disrupting beneficial feeding relationships, particularly problematic for SGA infants whose growth may deviate further from norms (43).

The findings of the reviewed studies suggest that traditional neonatal nutrition approaches for preterm SGA infants might require reconsideration. Rather than pursuing aggressive growth targets through formula supplementation, data support prioritizing exclusive human milk feeding while accepting slower initial growth as potentially beneficial. This speculation demands support by appropriate monitoring protocols distinguishing appropriate slower growth from pathological failure (44, 45). Family counselling becomes critical, as parents often experience significant growth-related anxiety. Healthcare providers must communicate that slower initial growth represents an adaptive advantage rather than nutritional compromise, while maintaining vigilance for genuine growth failure (46). Future research should focus on optimal human milk fortification strategies maximizing both short-term growth and long-term metabolic outcomes.

Despite these encouraging findings, several methodological limitations must be acknowledged. The heterogeneity in study designs, varying definitions of exclusive human milk feeding, and differences in fortification strategies across studies complicate direct comparisons. Moreover, the observational nature of many studies introduces potential confounding variables, including maternal factors, socioeconomic status, and varying clinical practices that may influence outcomes beyond feeding type alone. The relatively small effect sizes observed in some studies raise questions about clinical significance, while Vesel et al reported that 43.8% of infants were exclusively breastfed for six months, though the study lacks detailed outcome data for long-term comparisons. Additionally, the generalizability of findings from highly controlled research settings to routine clinical practice remains uncertain (14). Caution remains warranted in interpreting these findings, as most evidence derives from observational studies that cannot definitively establish causation, and mothers who successfully breastfeed may provide unmeasured advantages. Nevertheless, the consistency of metabolic benefits across multiple investigations may suggest protective mechanisms underlying human milk feeding approaches.

It is concluded that of the present literature breast milk seems to be beneficial to both preterm and full term SGA infants in regard their growth patterns. Although the studies were limited in number and with several limitations discussed above the findings were consisted along the gestational age and age after birth. Supporting SGA populations requires sophisticated competencies distinguishing adaptive patterns from pathological failure. Implementation remains constrained by limited SGA-specific research (47), creating gaps when providers must balance long-term benefits against immediate growth concerns. Nuanced clinical judgment is required in distinguishing healthy catch-up growth from failure to thrive, while helping families understand that slower but sustained growth may offer superior long-term metabolic advantages.

Table 1. SGA Preterm infants: The table depicts the number of infants participating in each study, the duration of breastfeeding, the methodology used to analyze body mass and the main findings .

Study	Number of infants	Duration	Type of measurements	Growth findings	Other findings
Fleig et at	197 Cow milk based diet group, 223 Human milk	2 years before and after the introduction of the human milk diet	Weight, HC, weight gain velocity, head growth rate	Improved Z-scores	Reduction in necrotizing enterocolitis, lower incidence of late-onset sepsis
Visuthranukul et al	33 AGA, 18 SGA	22 months	Anthropometric measurements, serum glucose, non-fasting insulin, X-ray absorptiometry	Greater catch-up growth without increased adiposity or insulin resistance	Reduced risk of necrotic enterocolitis, bronchopulmonary dysplasia, retinopathy of prematurity, late-onset sepsis
Belford et al	138.703 infants born between 23-29 weeks	Until discharge of NICU	Weight, HC, weight gain velocity, head growth rate	Improved Z scores	Decline in severe morbidities among preterm infants
Hofi et al,	80 infants	Until 2 years	Weight, length/height, HC	Improved Z scores	Improved cognitive and developmental outcomes
Bushati et al	64 infants	5 months,7 months	Weight, length, occipitofrontal circumference, growth velocity	Lower risk of childhood obesity and metabolic diseases	Lower risk of necrotic enterocolitis, sepsis infections, enhanced neurodevelopmental and cognitive outcomes
Vesel et al	1114 low-birth-weight infants	6 months	Weight, length/height, HC Mid-Upper Arm	Exclusive breastfeeding provided optimal nutrition and	Need for consistent lactation support,

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			Circumference	supported growth and development	feeding difficulties
Vizzari et al	175 infants	36 months	Weight, length/height, HC	Lower risk of failing catch-up growth in weight at 36 months.	Improved metabolic and neurodevelop mental outcomes

HC=head circumference.

Table 2. SGA full term infants: The table depicts the number of infants participating in each study, the duration of breastfeeding, the methodology used to analyze body mass and the main findings .

Study	Number of infants	Duration of follow up	Type of measurements	Growth findings	Further findings
Santiago et al	20 SGA, 12 AGA	Until preschool age	Weight, height, head, neck and waist circumference, skinfolds	Catch-up growth without overweight or obesity by preschool age	Lower risk of cardiometabolic diseases
Díaz et al	63 AGA, 28 SGA Breastfed infants 26 SGA non breastfed	Until 4 months	Weight, length, body composition by absorptiometry	breastfeeding positively affects weight and length	Lower long-term risk of diabetes by preserving normal GLP-1 levels
Modi et al	25 AGA 10 GR	Until 6 weeks	MRI	SGA infants exhibited complete catch-up in head growth and adiposity by six weeks	Lower risk of obesity in exclusively breastfed infants
Li et al	296 SGA	Until 5 years	Weight, length, height	Breastfeeding promotes optimal growth and development	Immune system regulation, Healthy microbiome growth
Zegher et al	72 AGA 46 breasfed SGA 56 fortified formula *SGA*	4 months	Body composition assessments	Lean mass recovery over fat mass	Normal levels of high-molecular-weight adiponectin, growth factor I , reduced risk of diabetes hypertension

Gupta et al	26 SGA breastfed 26 SGA formula	Until 3 months	Routine anthropometr y	Slower and steadier weight gain,	Reduced risk of early hyperinsuline mia and insulin resistance

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