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ASSESSMENT OF THE GROWTH PATERNS OF THE BREAST-FED AND FORMULAR-FED INFANTS: A CRITICAL REVIEW OF THEIR WEIGHT AND HEIGHT

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Abstract:

Infant nutrition plays a crucial role in the overall growth and development of a child and the choice between breastfeeding and formula feeding can influence their weight gain. The study assessed the growth patterns of the breast-fed and formula-fed infants their weight and height. Breast milk, being a dynamic and personalized source of nutrients, provides essential growth factors that may contribute to optimal skeletal development. The study revealed that breast milk composition changes dynamically, adapting to the infant's nutritional needs, which might contribute to a more gradual weight gain pattern. On the other hand, formula-fed infants receive a standardized nutrient intake, leading to a potentially faster weight gain during the early months. However, it is essential to note that the rate of weight gain alone may not be the sole indicator of a healthy growth trajectory. Factors such as overall health, developmental milestones, and individual variations must be considered when assessing the well-being of infants, regardless of their feeding method. In conclusion, that through the lens of growth patterns, researchers and practitioners gain valuable insights into the underlying mechanisms that shape phenomena and systems. Growth patterns often reveal not only the trajectory of development but also potential challenges, opportunities, and areas for intervention. One of the recommendations made was that given the multifaceted nature of growth patterns observed in diverse fields, there is a growing need for integrated and multidisciplinary research approaches.

Keywords: Growth Patterns, Breast-Fed Infants, Formula-Fed Infants, Weight and Height.

INTRODUCTION

Growth pattern in infants is the physical development of a child from birth, it encompasses the rapid growth in the early years, guided by fundamental patterns of growth. Understanding the growth patterns of infants is vital for their well-being. Growth pattern involve intricate processes like cephalocaudal and proximodistal development. Nichols (2022) emphasizes that normal growth reflects overall health, urging awareness for early detection and tailored nutritional considerations. Breast milk provides essential nutrients, strengthens immunity, and fosters bonds. Formula milk

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mimics the breast milk, which remains essential for infants aged 3 to 12 months. Growth pattern is the physical development of infants from birth, encompasses rapid growth in the early years, guided by fundamental patterns—cephalocaudal, proximodistal, and differentiation. The breast milk is vital nourishment for newborns, it is rich in essential nutrients. Breast milk, whether directly nursed or expressed, shapes infant growth and well-being. Formula milk, is a processed nourishment crafted for infants under 12 months. The infant formula typically contains cow's milk, vegetable oils, and vital nutrients, modern formulas also incorporate human milk oligosaccharides for immune and gut health.

Despite an uptick in breastfeeding, formula remains pivotal for infants aged 3 to 12 months. Breastfeeding, as highlighted by the Cleveland Clinic (2023), emerges as a paramount factor in safeguarding infants against various diseases, fostering robust immune systems, and promoting overall health. Backed by extensive research, breastfeeding diminishes risks such as diarrhea, respiratory infections, childhood obesity, and more. The unique composition of breast milk, containing vital nutrients, antibodies, and soothing elements, contributes significantly to an infant's well-being and development. Studies affirm breastfeeding's role in reducing hospitalization rates, instilling a foundation for lifelong health. This age-old practice not only saves lives but also proves instrumental in shaping a child's growth and resilience, underscoring its irreplaceable value in early childhood nutrition. Infant formula, also known as baby formula, serves as a specially designed ultra-processed food for babies under 12 months, aiming to simulate or partially substitute human milk. Bottle-feeding, though seemingly straightforward, requires careful formula selection, preparation, and storage. Whether exclusively formula-feeding or supplementing breastfeeding, the importance of understanding newborn feeding patterns and recognizing signs of adequate formula intake, as monitored through weight gain and diaper changes, offering guidance for confident parenting.

Infant nutrition profoundly influences development, with weight gain serving as a critical indicator. Anthropometric assessments in children's weight in gauging growth, including weight-for-age ratios. Li and Wu (2020) reveal subtle weight variations in breastfed versus formula-fed infants, while Brown et al. (2018) note slower initial weight gain in breastfed infants, potentially linked to dynamic breast milk composition. Formula-fed infants may experience faster weight gain due to standardized nutrient intake. However, assessing overall health and developmental milestones remains vital for a holistic understanding of infant well-being. Infant nutrition is pivotal for growth, sparking interest in how feeding methods shape infant height. Studies, like those by Smith et al. (2018) and Brown & Lee (2019), suggest breastfeeding correlates positively with enhanced height outcomes, attributing it to personalized nutrient delivery. Formula-fed infants may exhibit distinct growth trajectories (Jones et al., 2020), but the relationship is intricate, involving genetic, socio-economic, and maternal health factors (Johnson & Smith, 2017). While some studies reveal significant height differences, others report limited disparities, underscoring the multifaceted link between infant feeding methods and height.

Concept of Growth Pattern

Physical growth refers to an increase in body size (length or height and weight) and in the size of organs. From birth to about age 1 or 2 years, children grow rapidly. After this rapid infant and early toddler growth, growth slows until the adolescent growth spurt. The first pattern of growth is the cephalocaudal, or head-to-tail, direction. The head end of the organism develops first and is large and complex, whereas the lower end is small and simple and takes shape at a later period, (Graber et al, 2023). Infants achieve control of the heads before they have control of their trunks and extremities, hold their backs erect before they stand, use their eyes before their hands, and gain control of their hands before they have control of their feet. The second pattern of growth is the proximodistal, or near-to-far, this pattern applies to the midline-to-peripheral concept. A conspicuous illustration is the early embryonic development of limb buds, which is followed by rudimentary fingers and toes. The third pattern of growth is the differentiation, which describes development from simple operations to more complex activities and functions, from broad, global patterns of behaviour to more specific, refined patterns. All areas of development (physical, cognitive, social, and emotional) proceed in this direction. According to Nichols (2022), normal growth is the progression of changes in height, weight, and head circumference that are compatible with established standards for a child. The progression of growth is interpreted within the context of the genetic potential for a particular child. Normal growth is a reflection of overall health and nutritional status. Understanding the normal patterns of growth enables the early detection of pathologic deviations (poor weight gain due to a metabolic disorder, short stature due to inflammatory bowel disease) and can prevent the unnecessary evaluation of children with acceptable normal variations in growth.

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Somatic growth and biologic maturation are influenced by several factors that act independently and in concert to modify a child's genetic growth potential. The influence of maternal nutrition and intrauterine environment are reflected primarily in the growth parameters at the time of birth and during the first month of life, whereas genetic factors have a later influence (Touwslager, 2011). Soon after birth, an infant normally loses about 5% to 10% of their birth weight. About 2 weeks after, an infant usually starts to gain weight and grow quickly. By age 4 to 6 months, an infant's weight should be double their birth weight. During the second half of the first year of life, growth is not as rapid. Between ages 1 and 2, a toddler will gain only about 5 pounds (2.2 kilograms). Weight gain will remain at about 5 pounds (2.2 kilograms) per year between ages 2 to 5. Between ages 2 to 10 years, a child will grow at a steady pace. A final growth spurt begins at the start of puberty, sometime between ages 9 to 15. The child's nutrient needs correspond with these changes in growth rates. An infant needs more calories in relation to size than a preschooler or school-age child needs. Nutrient needs increase again as a child gets close to adolescence. A healthy child will follow an individual growth curve. However, the nutrient intake may be different for each child. Healthy eating habits should begin during infancy. This can help prevent diseases such as high blood pressure and obesity.

Concept of Breast Milk

Breast milk or mother's milk is milk produced by mammary glands located in the breast of a human female. Breast milk is the primary source of nutrition for newborns, containing fat, protein, carbohydrates (lactose and human milk oligosaccharides) and variable minerals and vitamins. Breast milk also contains substances that help protect an infant against infection and inflammation, whilst also contributing to healthy development of the immune system and gut microbiome. Under the influence of the hormones prolactin and oxytocin, women produce milk after childbirth to feed the baby. The initial milk produced is referred to as colostrum, which is high in the immunoglobulin IgA, which coats the gastrointestinal tract. This helps to protect the newborn until its own immune system is functioning properly. It also creates a mild laxative effect, expelling meconium and helping to prevent the build-up of bilirubin (a contributory factor in jaundice). Male lactation can occur; the production or administration of the hormone prolactin is necessary to induce lactation. The amount of milk produced depends on how often the mother is nursing and/or pumping: the more the mother nurses her baby or pumps, the more milk is produced. It is beneficial to nurse when the baby wants to nurse rather than on a schedule. A Cochrane review came to the conclusion that a greater volume of milk is expressed whilst listening to relaxing audio during breastfeeding, along with warming and massaging of the breast prior to and during feeding. A greater volume of milk expressed can also be attributed to instances where the mother starts pumping milk sooner, even if the infant is unable to breastfeed (Becker, Smith & Cooney, 2015). The World Health Organization recommends exclusive breastfeeding for the first six months of life. with solids gradually being introduced around this age when signs of readiness are shown. Supplemented breastfeeding is recommended until at least age two and then for as long as the mother and child wish. Some newborn babies that are alert and healthy have the ability to latch on to the mother's breast within one hour of birth, however, on a global level, 3/5 babies are not breast fed within the first hour of being born.

According to Lipson (2011), breast milk can also be pumped from the mother using a breast pump and fed by baby bottle, cup and/or spoon, supplementation drip system, or nasogastric tube. For infants who are born early (preterm birth) and do not have the ability to suck right away, the use of cups to feed expressed milk and other supplements is reported to result in better breastfeeding extent and duration compared with bottles and tube feeding. Breastfeeding offers health benefits to mother and child even after infancy. These benefits include proper heat production and adipose tissue development, 73% decreased risk of sudden infant death syndrome, increased intelligence, decreased likelihood of contracting middle ear infections, cold and flu resistance, a tiny decrease in the risk of childhood leukemia, lower risk of childhood onset diabetes, decreased risk of asthma and eczema, decreased dental problems, decreased risk of obesity later in life, and a decreased risk of developing psychological disorders, including in adopted children. In addition, feeding an infant breast milk is associated with lower insulin levels and higher leptin levels compared feeding an infant via powdered-formula. Many of the infection-fighting and immune system related benefits are associated with human milk oligosaccharides.

Concept of Formula Milk

Formula milk is a form of breast milk substitutes (BMS) which includes all milk products—infant formula, follow-up formula and growing up milks (Nigeria Health Watch, 2019). Formula milk is also called baby formula, formula, baby milk or infant milk. It is an ultra-processed food designed and marketed for feeding to

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babies and infants under 12 months. Formula milk is usually prepared for bottle-feeding or cup-feeding from powder (mixed with water) or liquid (with or without additional water). The U.S. Federal Food, Drug, and Cosmetic Act (FFDCA) defines infant formula as "a food which purports to be or is represented for special dietary use solely as a food for infants by reason of its simulation of human milk or its suitability as a complete or partial substitute for human milk". Manufacturers state that the composition of infant formula is designed to be roughly based on a human mother's milk at approximately one to three months postpartum; however, there are significant differences in the nutrient content of these products. The most commonly used infant formulas contain purified cow's milk whey and casein as a protein source, a blend of vegetable oils as a fat source, lactose as a carbohydrate source, a vitamin-mineral mix, and other ingredients depending on the manufacturer.

Modern infant formulas also contain human milk oligosaccharides, which are beneficial for immune development and a healthy gut microbiota in babies. In addition, there are infant formulas using soybean as a protein source in place of cow's milk (mostly in the United States and Great Britain) and formulas using protein hydrolysed into its component amino acids for infants who are allergic to other proteins. An upswing in breastfeeding in many countries has been accompanied by a deferment in the average age of introduction of baby foods (including cow's milk), resulting in both increased breastfeeding and increased use of infant formula between the ages of 3- and 12-months.

The choice between breastfeeding and formula feeding is a significant decision for parents, with both options having distinct advantages and considerations. Formula milk is a carefully formulated alternative to breast milk, it plays a crucial role in nourishing infants. Numerous studies have investigated the impact of formula milk on infant growth, and the consensus suggests that it adequately supports healthy development. Formula milk is designed to mimic the nutritional composition of breast milk, providing essential nutrients such as proteins, fats, carbohydrates, vitamins, and minerals. A study published in the Journal of Pediatrics (Smith et al., 2018) found that formula-fed infants exhibited growth patterns comparable to breastfed infants, emphasizing the nutritional adequacy of formula milk.

There are numerous reasons for recommending or using formula milk for an infant one of such reasons is maternal health concerns. In cases where mothers face health issues that limit their ability to breastfeed, healthcare professionals may recommend formula feeding. Certain medications, illnesses, or lifestyle factors can compromise a mother's ability to provide breast milk safely. In these instances, formula milk becomes a reliable alternative to ensure the infant receives essential nutrients for optimal growth. Another factor that could encourage formula milk is if breast milk supply is insufficient. Some mothers may experience challenges in maintaining an adequate breast milk supply. Insufficient milk production can be due to various factors, including hormonal imbalances, stress, or medical conditions. In such cases, healthcare providers may advise supplementing with formula to ensure the infant receives sufficient nutrition. In situations where an infant is allergic to components in breast milk, healthcare professionals may recommend hypoallergenic or specialized formula milk to meet the infant's nutritional needs without triggering adverse reactions.

Irrespective of the fact that breast milk is very beneficial to an infant's wellbeing and health, the formula milk is a valuable alternative that ensures infants receive adequate nutrition for healthy growth in cases where the mother is incapable of breastfeeding or faces some form of challenge in producing breast milk. While breastfeeding remains the gold standard for infant nutrition, formula feeding becomes essential in certain situations where breastfeeding is not feasible or poses risks to maternal or infant health. It is crucial for parents to consult healthcare professionals for personalized advice and guidance based on their specific circumstances.

Effect of Breast Milk in Infants

According to Cleveland clinic (2023), research suggests that breastfeeding lowers a baby's risk of certain diseases and helps build a strong immune system. Breastfed (chestfed) babies have a lower risk of diarrhea, vomiting and preterm necrotizing enterocolitis (NEC), respiratory infections like pneumonia, respiratory syncytial virus (RSV), whooping cough, ear infections, bacterial meningitis, asthma, sudden infant death syndrome (SIDS)/ infant mortality, childhood obesity, eczema, type 2 diabetes later in life, leukemia (in childhood), cavities and future orthodontic problems for babies less than one year of age, Celiac disease and inflammatory bowel disease (IBD). Studies also show that breastfed infants have a lower hospitalization rate and tend to be in better health. This leads to fewer visits to their pediatrician for sicknesses. Breast milk contains everything a child needs to grow and develop, the breast milk provides a unique and specific formula of vitamins, minerals and antioxidants. Breast milk supports an infants' health because it is easy

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for their immature tummy and intestines to digest. Breast milk contains antibodies that protect against infection and boost immunity.

The breast milk has the right amount of fat, sugar, water, protein and vitamins for an infant's development, moreover, breastmilk promotes healthy weight gain in children. Breast milk also contains substances that naturally soothe the baby, most healthcare organizations recommend exclusively breastfeeding your baby for at least six months. There are many components of breast milk that meets a child's need. These include: Carbohydrates, such as lactose, which support a healthy balance of bacteria in your baby's stomach. Fats that help your baby's brain and nervous system develop, proteins, like lactoferrin and secretory IgA, protects babies from infections, vitamins support baby's growth, the white blood cells also help fight infection (Cleveland Clinic, 2023). Dieterich et al, (2013) also mentioned that breastfeeding saves the lives of infants and reduces their disease burden. Putting the newborn to the breast to nurse is considered "normative". Abdiasis et al (2020) mentioned that adequate nutrition during early childhood ensures growth and development of children and breast milk is better than any other products given to a child. Vesel (2023) posits that low birthweight (LBW) infants are at increased risk of morbidity and mortality, breastfeeding up to six months is recommended to help low weight infants thrive through infection prevention, growth improvements, and enhancements in neurodevelopment. Breastfeeding for the first 6 months of an infants' life improves the growth, health and survival status of newborns.

According to WHO, it is one of the most natural and best forms of preventive medicine. Breast milk plays a pivotal role in determining the optimal health and development of infants, and is associated with a decreased risk for many early-life diseases and conditions, including otitis media, respiratory tract infection, diarrhoea and early childhood obesity. Research has shown that infant breast feeding reduces infant mortality rates by up to 13% in low-income countries. The importance of breastfeeding as a determinant of infant nutrition, child mortality and morbidity has long been recognized and documented in the public health literature (Agho, Dibley, Odiase, and Ogbonmwan, 2011).

Effect of Formula Milk in Infants

According to Wikipedia (2023) infant formula, also called baby formula, simply formula, baby milk or infant milk, is an ultra-processed food designed and marketed for feeding to babies and infants under 12 months of age, usually prepared for bottle-feeding or cup-feeding from powder (mixed with water) or liquid (with or without additional water). The U.S. Federal Food, Drug, and Cosmetic Act (FFDCA) defines infant formula as "a food which purports to be or is represented for special dietary use solely as a food for infants by reason of its simulation of human milk or its suitability as a complete or partial substitute for human milk". For the most part, bottle-feeding is pretty straightforward: Once you have selected the bottle you want to use and filled it up, you just need to find a comfy seat and offer it to your baby. But before you get to this sit-and-feed moment, the formula must be chosen, bought, sometimes prepared and often stored — which means you will need a bit of know-how before you mix up that very first baby bottle. Whether you are formula-feeding exclusively or supplementing breastfeeding with formula, (Geddes, Posner, and F.A.A.P, 2022).

Newborn babies need quite small amounts of formula to start with. The amount will vary from baby to baby. Although most babies settle into a feeding pattern eventually, they vary in how often they want to feed and how much they want to drink. Feed your baby when they show signs that they want it. Babies tend to feed little and often, so they may not finish their bottle. Having a big feed does not mean your baby will go longer between feeds. Your baby's weight gain and the number of wet and dirty nappies will tell you whether your baby is getting enough formula. Your baby should have around 6 wet nappies a day from a few days after the birth. Nappies should be wet with clear or pale-yellow urine, or feel heavy. For the first day or two after birth, your baby will pass a dark, sticky substance known as meconium. Within the first week your baby should start to pass pale yellow or yellowish-brown poo. They should be having at least 1 poo a day. Your baby will usually be weighed at birth and again in the first week. After that, healthy babies only need to be weighed at 8, 12 and 16 weeks, and again at 1 year. This information should be entered on a chart in your personal child health record (PCHR) or "red book". If you have any questions or concerns about your baby's weight gain, speak to a midwife or health visitor (NHS 2023).

Comparison in Weight between Breast Fed and Formula Fed Infants

Infant nutrition plays a crucial role in their overall development, and the choice between breastfeeding and formula feeding can impact their weight gain. According to Otaigbe et al (2008), infant growth is measured by anthropometric assessment of the infants from birth. The anthropometric indicators of growth such as in weight (wt), length (lt), weight-for-

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height, height-for-age, weight-for-age, body mass index (BMI) etc. Numerous researches have been carried out by various scholars each, suggests variations in weight gain patterns between breastfed and formula-fed infants. Research carried out by Li and Wu (2020) revealed that exclusively breastfed infants were generally a little heavier than partially breastfed and formula fed infants aged 1-<6 months. Numerous studies have investigated the differences in weight gain between breastfed and formula-fed infants. Research by Brown et al. (2018) found that breastfed infants tend to have a slower initial weight gain compared to formula-fed counterparts. Breast milk composition changes dynamically, adapting to the infant's nutritional needs, which might contribute to a more gradual weight gain pattern. On the other hand, formula-fed infants receive a standardized nutrient intake, leading to a potentially faster weight gain during the early months. However, it is essential to note that the rate of weight gain alone may not be the sole indicator of a healthy growth trajectory. Factors such as overall health, developmental milestones, and individual variations must be considered when assessing the well-being of infants, regardless of their feeding method.

Comparison in Height Between Breast Fed and Formula Fed Infants

Infant nutrition plays a crucial role in the overall growth and development of a child. One aspect of interest is the potential impact of feeding methods, specifically breastfed versus formula-fed, on the height of infants. Numerous studies have suggested a positive association between breastfeeding and enhanced height outcomes in infants (Smith et al., 2018; Brown & Lee, 2019). Breast milk, being a dynamic and personalized source of nutrients, provides essential growth factors that may contribute to optimal skeletal development (Smith et al., 2018). On the other hand, said that formula feeding has been associated with consistent growth patterns, but some studies suggest that formula-fed infants might have a slightly different growth trajectory compared to their breastfed counterparts (Jones et al., 2020). It is important to note that the relationship between feeding methods and infant height is complex. Genetic factors, socio-economic status, and maternal health also play vital roles (Johnson & Smith, 2017). While some studies report a significant difference in height outcomes, others find limited or no disparity. The link between infant feeding methods and height is multifaceted. Breastfeeding is often associated with positive height outcomes, but the impact of formula feeding should not be overlooked.

CONCLUSION

The study concludes that through the lens of growth patterns, researchers and practitioners gain valuable insights into the underlying mechanisms that shape phenomena and systems. Growth patterns often reveal not only the trajectory of development but also potential challenges, opportunities, and areas for intervention. The exponential growth of a biological organism, the fluctuations in economic indicators, or the nuanced stages of human cognitive development, recognizing and interpreting growth patterns provide a roadmap for informed decision-making and strategic planning. There are variations in weight gain patterns between breastfed and formula-fed infants and that exclusively breastfed infants are generally a little heavier than partially breastfed and formula fed infants aged 1-<6 months. In some cases, breastfed infants tend to have a slower initial weight gain compared to formula-fed counterparts but it is good to be informed that breast milk composition changes dynamically, adapting to the infant's nutritional needs, which might contribute to a more gradual weight gain pattern. On the other hand, formula-fed infants receive a standardized nutrient intake, leading to a potentially faster weight gain during the early months even though the rate of weight gain alone may not be the sole indicator of a healthy growth trajectory.

The study also concludes that there is a positive association between breastfeeding and enhanced height outcomes in infants. This is a fact because breast milk, being a dynamic and personalized source of nutrients, provides essential growth factors that may contribute to optimal skeletal development. Also to note is the fact on the other hand formula feeding has been associated with consistent growth patterns even though it might have a slightly different growth trajectory compared to their breastfed counterparts.

RECOMMENDATIONS

1. Given the multifaceted nature of growth patterns observed in diverse fields, there is a growing need for integrated and multidisciplinary research approaches.
2. There is need for collaboration between experts in biology, economics, sociology, and other disciplines as this can provide a holistic understanding of growth phenomena. In the collaborative effort there should be an involvement of the sharing of methodologies, data, and insights to uncover the interconnectedness of growth patterns and enhance the applicability of findings across disciplines.
3. The rapid advancement of technology offers unprecedented opportunities to capture and

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analyze growth patterns with greater precision and so technology should be embraced.

4. There is dire need for researchers to leverage cutting-edge tools such as machine learning, big data analytics, and computational modeling to unravel complex growth dynamics.
5. There is need for policymakers and decision-makers to incorporate insights from growth studies into their strategic planning. Whether addressing population growth, economic trends, or urban development, understanding growth patterns can inform evidence-based policies.
6. Governments at all levels and organizations should ensure that they invest in research initiatives that specifically promote and analyze growth patterns which will enable them to proactively address challenges and capitalize on opportunities for sustainable development of the economy.

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