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Effect of gestational age on growth of low birth weight infant: retrospective cohort study

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ABSTRACT

Introduction: Growth is essential in children, especially in the first two years of life. History of low birth weight (LBW) and gestational age are known to be several factors that influence growth and relate to growth retardation. This study aims to analyze the effect of gestational age on the growth of LBW infants.

Methods: An observational analytical study design with a retrospective cohort approach and quantitative study methods was conducted in September 2023. Subjects were gathered by simple random sampling. Twenty-four preterm infants and 24 full-term infants born from September 2021 to September 2022 who met the inclusion criteria were followed up. Subjects were weighed on a scale, and the results were plotted on the World Health Organization (WHO) weight-for-age growth chart. The plotted results are presented as a Z-score, which can be further categorized into two groups: severely underweight and underweight (growth not achieved), along with normal and risk of overweight (growth achieved).

Result: Of the 48 subjects, the majority were male (66.67%), aged between 12-15 months (39,6%), born by cesarean section (83.3%), and had a history of exclusive breastfeeding (64.6%). Most subjects with a history of full-term and preterm LBW were in the normal category (70.8% and 75%, respectively). The result showed full-term LBW infants have 1.75 times greater risk of not achieving growth than preterm LBW with RR 1.750 (95%CI 0.588 to 5.207).

Conclusion: Gestational age affects growth, with full-term infants at more risk of not achieving growth.

Keywords: gestational age; growth; low birth weight; full-term; preterm.
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INTRODUCTION

Monitoring growth in children aged 1-2 years is essential because the first phase of rapid growth occurs in this age range, and failure to grow in the first two years of life is associated with a decrease in height in adulthood.[1] One of the problems with children's growth is stunting, which is the result of long-term malnutrition disrupting growth and development. Stunting results in below-average physical growth, impaired cognitive development, and vulnerability to disease. If not immediately detected and treated, stunting can cause a decline in the quality of human resources in a country. LBW is the dominant risk factor causing stunting.[2]

Low Birth Weight (LBW) babies are born with a weight of less than 2500 grams without assessing the gestation period. LBW can be caused by preterm birth (< 37 weeks) or full-term (37-42 weeks) which the growth of the fetus in the uterus is retarded. Until now, LBW is one of the health problems considered to be the cause of increased morbidity and mortality rates during the neonatal period. Globally, there are around 15 -20% of babies born with LBW out of 20 million births per year.[3] Based on 56.6% of toddlers with birth weight records in Indonesia, LBW cases were recorded at around 6.2%, and in West Java province, it was 6.32%.[4] Data on the incidence of LBW in the city of Depok in 2020 was 0.63%, and in 2021, it was 0.65%, which shows an increase of 0.02%.[5,6] Apart from being at high risk of morbidity and mortality, LBW babies are also more susceptible to growth disorders. The results of a previous study conducted in Korea showed that a significant number of babies with a history of low birth weight could not keep up with growth.[7]

The differences in the body composition between full-term or small-for-gestational age (SGA) and preterm babies also can contribute to growth because the full-term babies that experience intrauterine growth restriction (IUGR) have placental insufficiency, which disrupts the distribution of oxygen and nutrients. Compared to babies without IUGR, the SGA ones have significantly decreased fat mass (FM) and fat-free mass (FFM). This shortfall may limit the significant gain in fetal weight that often happens at this age.[8] Inadequate growth during pregnancy and early childhood can permanently reduce fat-free mass.[9] Furthermore, to adapt to the uterine environment, fetuses with IUGR go through various hemodynamic and metabolic changes that may result in long-term modifications to the structure and function of several organ systems.[10] As a result, growth may vary between full-term and preterm babies.

Therefore, this study aims to compare the growth between LBW infants who were born at full-term and preterm at Permata Hospital, Depok.

METHODS

This study used an observational analytical study design with a retrospective cohort approach and quantitative study methods. In September 2023, the study was conducted at Permata Hospital in Sawangan, Depok City, West Java, Indonesia. LBW infants born at Permata Hospital between September 2021 and September 2022, whose parents or guardians gave permission, in good health, and without any congenital abnormalities were included. The exclusion criteria in the study were absent at the time of the study. Forty eight LBW infants were selected using a simple random sampling method. All the LBW infants were followed up until September 2023. The subjects were divided into two groups: full-term LBW and preterm LBW. The sample calculation were conducted using the two-proportion difference hypothesis test formula, which yielded a minimum requirement of 22 subjects per group. With the estimated dropout probability of 10%, the adjusted sample for each group was determined to be 24 subjects, resulting in a total sample size of 48 participants. The corrected age was applied to the preterm LBW group. Study instruments included weight scales, the WHO weight-for-age growth chart, the maternal and child health handbook, and questionnaires.

We gathered information regarding the subject's gender, age, birth history, and history of exclusive breastfeeding prior to the measurement. The weight was measured using the neonatal weight scale at Permata Hospital, and the results were plotted on the WHO weight-for-age growth chart. The Z-score from the growth chart classified the outcomes as severely underweight, underweight, normal, and risk of overweight.

The data was analyzed using a relative risk test. Data testing was carried out using IBM SPSS Statistics for Windows Version 25.0.

RESULTS

There were 221 newborns (13%) with low birth weight out of 1701 babies born at Permata Depok Hospital between September 2021 and September 2022. From 221 data of LBW infants born from September 2021 to September 2022 at Permata Depok Hospital, 24 subjects in the full-term LBW group and 24 subjects in the preterm LBW group were obtained randomly. The study conducted in September 2023 used 48 subjects that met the study criteria.

The characteristics of subjects are shown in Table 1. The gender of subjects who met the inclusion criteria was dominated by male (66.7%), in the age range of 12-15 months (39.6%), born by cesarean section (83.3%), and had a history of exclusive breastfeeding (64.6%). Most of the full-term LBW was found in the growth achieved category (70.8%). This result was also found in preterm LBW, where the majority of the results were in the normal category (87,5%).

The relative risk for unachieved growth in full-term LBW infants is 1.750. Full-term LBW infants are 1.75 times more likely to experience unachieved growth than those who have preterm LBW (Table 2).

Table 1. The characteristics of subjects

Characteristic	N=48
Gender, n (%)	
Male	32 (66,7)
Female	16 (33.3)
Age, n (%)	
12-15 months	19 (39.6)
16-18 months	11 (22.9)
19-21 months	8 (16.7)
22-24 months	10 (20.8)
Birth History, n (%)	
Normal delivery	8 (16.7)
Cesarean section	40 (83.3)
Exclusive breastfeeding, n (%)	
Yes	31 (64.6)
No	17 (35.4)

DISCUSSION

Growth is a quantitative change that can be observed physically in children. Several factors, such as nutritional intake, genetics, hormones, stress, and the environment can influence growth in children.[11] Apart from that, the body composition difference between full-term babies undergoing intrauterine growth restriction (IUGR) or small for gestational age (SGA) babies and preterm babies may result in growth differences. This is affected by placental disruption; in the meantime, fetal growth depends on the placenta's blood vessel formation, oxygen delivery, and endocrine control of cellular growth.[12] IUGR fetuses have a disproportionately low fat mass compared to their lean mass.[8] Poor fetal growth will cause them to have limited lean body mass and metabolic capability.[13] Other than that, preterm newborns are known to often have less than ideal growth, with many being discharged at lower weight, head circumference, and length percentiles than when they were delivered.[14] Preterm newborns are susceptible to cumulative protein and energy shortages that lead to extra-uterine growth restriction (EUGR) during the neonatal stay and after discharge, regardless of growth restriction at birth.[15]

In September 2023, 48 subjects were

Table 2. Growth distribution of LBW infants

Gestational age	Growth (N=48)		Total	RR (95% CI)
	Not achieved	Achieved		
Full-term, n (%)	7 (29.2%)	17 (70.8%)	24	1.750 (0.588 to 5.207)
Preterm, n (%)	3 (12.5%)	21 (87.5%)	24	

included in this study. Majority of the subjects in the full-term and preterm group were in growth achieved category (70.8% and 87,5%, respectively). Growth achieved is closely related to catch-up growth. Catch-up growth is a process that occurs naturally, influenced by the child's age, and results in babies with low birth weight reaching normal weight.[16] Babies who experience growth retardation after birth, especially preterm babies, must catch up with growth in weight, body length, and head circumference. According to a previous study, preterm babies have a critical "window of opportunity" for growth rate within two to three months of the corrected age. This window of opportunity will significantly impact the babies' future growth and development. In their first year of life, preterm babies should achieve growth close to full-term babies. Efforts to catch up on growth begin during the first month of life and often reach normal growth targets within the first two years of life.[7]

All the nutrients essential for growth and development are included in breast milk, so international guidelines recommend that exclusive breastfeeding be given to babies for the first six months.[17] Children who receive exclusive breast milk can have better body immunity to avoid the risk of infections such as diarrhea that results in decreased appetite and suboptimal absorption of nutrients, which can cause the nutrients to be insufficient to support healthy growth.[18] For low birth weight babies, breast milk is the best nutrition source since it can guard against future health issues.[19] In addition, babies who receive exclusive breast milk can have their nutritional needs met to support normal growth in terms of weight and height.[20] The majority of subjects (64.6%) in this study had exclusive breastfeeding history. According to this study, 12 of the 24 participants in the preterm LBW group and 19 of the 24 subjects in the full-term LBW group, respectively, obtained exclusive breastfeeding. This result is lower than the coverage rate for babies receiving exclusive breastfeeding in Depok in 2021 (73.6%) and 2022 (74%).[5,21] This can be caused by several problems, such as physical problems in the mother due to lack of nutritional intake, psychological issues or pressure, delayed initiation of early breastfeeding, the mother's job, and the mother's educational status.[22]

Premature babies often need additional sources of nutrition and calories that can be provided by formula milk, especially when breast milk is insufficient. This can be shown from this study that 16 out of the 24 subjects in the preterm LBW group consumed formula milk. Babies fed formula milk have higher plasma insulin levels than breastfed babies, so this will stimulate fat accumulation and early development of adipocytes.[23] In addition, higher protein intake from formula milk can accelerate weight gain.[24] While formula milk feeding has been linked to faster newborn growth rates, breast milk was associated with better body composition recovery and low-fat mass accretion.[19]

In this study, the full-term LBW group had more growth not achieved results. Full-term LBW have a 1.75 times greater risk of experiencing unachieved growth compared to preterm LBW. This condition can be caused by babies with full-term low birth weight during the gestation period experiencing stunted fetal growth or intrauterine retardation, which continues until the baby is born and has a negative impact that affects its growth as it ages.[20]

When newborns have intrauterine growth restriction (IUGR), their metabolism changes significantly. Preterm infants born small-for-gestational age (SGA) have faster metabolic rates, increased energy expenditure, and diminished fat absorption in the first month of life. This is typically attributed to inadequate placental nutrition.[25] Infants born with restricted growth exhibit a distinct body composition compared to those born with normal intrauterine growth. Prolonged intrauterine malnutrition that persists after birth may lead to specific outcomes, as early postnatal undernutrition coupled with subsequent rapid growth is a risk factor for nutrition-related chronic disorders in adulthood.[26]

The fetus relies on the placenta to get nutrients, including amino acids, essential for its growth and development. The total fetal amino acids and total fetal α-amino nitrogen levels are decreased in IUGR than in AGA fetuses. This is primarily due to lower levels of important amino acids, notably branched-chain amino acids like leucine, valine, and isoleucine. Furthermore, the drop in maternal plasma amino acid concentrations during normal pregnancy does not occur in IUGR pregnancies, resulting in lower fetal-maternal amino acid concentration disparities for most amino acids.[27]

Protein synthesis typically occurs significantly higher than protein intake, indicating that body proteins undergo continuous degradation and resynthesis, a process known as protein turnover. For lean body mass to increase, the rate of protein synthesis must surpass that of protein breakdown, leading to a net gain in protein. In preterm infants, protein stores are often depleted shortly after birth, contributing to postnatal growth restriction and increasing demand for nutrients to facilitate catch-up growth.[27] The risk of LBW is higher in female babies than in male babies.[28,29] This could be attributed to male babies' birth weight being heavier than female babies.[30] The difference in weight seen after 28 weeks of gestation is thought to be caused by stimulation of androgenic hormones or the role of the Y chromosome, which contains genetic material involved in the growth of male fetuses.[29] Despite previous studies, the population in Permata Hospital, Depok predominantly male. Therefore, the majority of LBW infants in this study, both full-term and preterm, were found to be male (66.7%).

Of the 48 samples with 24 full-term LBW subjects and 24 preterm LBW subjects, seven participants in the full-term LBW group and three participants in the preterm LBW group in this study failed to catch up with growth. The development of growth failure is highly influenced by parental factors. A previous study showed that better socioeconomic position and adherence to feeding standards were associated with higher maternal education.[31] Parent educational status can reduce growth failure, in general. The other factor is the mother's employment status; children of working mothers experience a higher rate of growth failure than children of mothers who work at home.[32] Growth failure also can caused by malnutrition. The World

Health Organization (WHO) defines malnutrition as deficiencies or excesses in nutrient intake, imbalance of essential nutrients, or impaired nutrient utilization. Inadequate intake, the most frequent reason for growth failure, can result from insufficient food supply or consumption. Inadequate intake may result from incorrect formula mixing or challenges with breastfeeding.[33] Further research can be carried out using larger samples, cohort design, frequent monitoring over a predetermined duration, and including the parental factors and feeding history.

Some limitations of this study include time constraints, difficulty in contacting patients, and not including other risk factors that could influence growth.

CONCLUSION

It was concluded that gestational age affects growth, with full-term infants more at risk of not achieving growth.

DISCLOSURES

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Ethical Clearance

The study protocol has been approved by the Pembangunan Nasional "Veteran" Jakarta University Research Ethics Committee with number 336/VII/2023/KEPK.

Conflict of Interest

None declared.

Author Contribution

All authors contributed to all processes in this research, including concept, design, monitoring, data collection and analysis, preparation, and approval of this manuscript for publication.

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REFERENCES

1. de Onis M, Branca F. Childhood stunting: a global perspective. Matern Child Nutr. 2016;12:12–26.
2. Rahayu A, Yulidasari F, Putri AO, Rahman F. Riwayat Berat Badan Lahir dengan Kejadian Stunting pada Anak Usia Bawah Dua Tahun. Kesmas: National Public Health Journal. 2015;10(2):67.
3. World Health Organization. Global Nutrition Targets 2025 Low Birth Weight Policy Brief. 2014.
4. Riset Kesehatan Dasar (Riskesdas). Laporan Nasional Riskesdas 2018. Jakarta; 2019.
5. Dinas Kesehatan Kota Depok Tahun 2022. Profil Kesehatan Kota Depok Tahun 2021. 2022.
6. Dinas Kesehatan Kota Depok Tahun 2021. Profil Kesehatan Kota Depok Tahun 2020. 2021.
7. Jin Yoon S, Lim J, Ho Han J, Eun Shin J, Min Lee S, Seon Eun H, et al. Identification of Growth Patterns in Low Birth Weight Infants from Birth to 5 Years of Age: Nationwide Korean Cohort Study. J Environ Res Public Health. 2021;18:1206.
8. Priante E, Verlato G, Giordano G, Stocchero M, Visentin S, Mardegan V, et al. Intrauterine Growth Restriction: New Insight from the Metabolomic Approach. Metabolites. 2019;9(11):267.
9. Manapurath R, Gadapani B, Pereira-da-Silva L. Body Composition of Infants Born with Intrauterine Growth Restriction: A Systematic Review and Meta-Analysis. Nutrients. 2022;14(5):1085.
10. Calek E, Binder J, Palmrich P, Eibensteiner F, Thajer A, Kainz T, et al. Effects of Intrauterine Growth Restriction (IUGR) on Growth and Body Composition Compared to Constitutionally Small Infants. Nutrients. 2023;15(19).
11. Hilaire M, Andrianou XD, Lenglet A, Ariti C, Charles K, Buitenhuis S, et al. Growth and neurodevelopment in low birth weight versus normal birth weight infants from birth to 24 months, born in an obstetric emergency hospital in Haiti, a prospective cohort study. BMC Pediatr. 2021;21(1).
12. Cho WK, Suh B-K. Catch-up growth and catch-up fat in children born small for gestational age. Korean J Pediatr. 2016;59(1):1.
13. Larsson A, Ottosson P, Törnqvist C, Olhager E. Body composition and growth in full-term small for gestational age and large for gestational age Swedish infants assessed with air displacement plethysmography at birth and at 3-4 months of age. PLoS One. 2019;14(5).
14. Ong KK, Kennedy K, Castañeda-Gutiérrez E, Forsyth S, Godfrey KM, Koletzko B, et al. Postnatal growth in preterm infants and later health outcomes: a systematic review. Acta Paediatr. 2015;104(10):974–86.
15. Raaijmakers A, Allegaert K. Catch-Up Growth in Former Preterm Neonates: No Time to Waste. Nutrients. 2016;8(12):817.
16. Patandianan E, Umboh A, Warouw S. Hubungan Status Gizi dan Berat Lahir pada Anak Usia 2-3 Tahun. Jurnal e-Clinic (eCl). 2015;3(1).
17. Rizka Kumala H, Purnomo W. Hubungan ASI Eksklusif dengan Perkembangan Balita yang Memiliki Riwayat Berat Badan Lahir Rendah (BBLR) di Puskesmas Tanah Kali Kedinding Surabaya. Vol. 8, Media Gizi Kesmas. Halaman; 2019.
18. Bahar N. Hubungan ASI Eksklusif dan Bayi Berat Lahir Rendah dengan Stunting. Jurnal Ilmiah Obsgin. 2021;
19. Juharji H, Albalawi K, Aldwaighri M, Almalki A, Alshiti H, Kattan W, et al. Impact of Breastfeeding on Low Birthweight Infants, Weight Disorders in Infants, and Child Development. Cureus. 2022;
20. Badjuka BYM. The Correlation between Low Birth Weight and Stunting in 24-59 Month Children in Haya-Haya Village, Western Limboto Sub-District, Gorontalo Regency. Afiasi : Jurnal Kesehatan Masyarakat. 2020;5(1):23–32.
21. Dinas Kesehatan Kota Depok Tahun 2023. Profil Kesehatan Kota Depok Tahun 2022 [Internet]. 2023. Available from: www.dinkes.depok.go.id
22. Kadir NA. Menelusuri Akar Masalah Rendahnya Persentase Pemberian ASI Eksklusif di Indonesia. Jurnal Al Hikmah. 2014;XV.
23. Gnawali A. Prematurity and the Risk of Development of Childhood Obesity: Piecing Together the Pathophysiological Puzzle. A Literature Review. Cureus. 2021;
24. Fenton TR, Al-Wassia H, Premji SS, Sauve RS. Higher versus lower protein intake in formula-fed low birth weight infants. Cochrane Database of Systematic Reviews. 2020;2020(7).
25. Ramel SE, Brown LD, Georgieff MK. The Impact of Neonatal Illness on Nutritional Requirements: One Size Does Not Fit All. Curr Pediatr Rep. 2014;2(4):248–54.
26. Manapurath R, Gadapani B, Pereira-da-Silva L. Body Composition of Infants Born with Intrauterine Growth Restriction: A Systematic Review and Meta-Analysis. Nutrients. 2022;14(5):1085.
27. de Boo HA, Harding JE. Protein metabolism in preterm infants with particular reference to intrauterine growth restriction. Arch Dis Child Fetal Neonatal Ed. 2007;92(4):F315–9.
28. Mitao M, Philemon R, Obure J, Mmbaga BT, Msuya S, Mahande MJ. Risk factors and adverse perinatal outcome associated with low birth weight in Northern Tanzania: A registry-based retrospective cohort study. Asian Pacific Journal of Reproduction. 2016;5(1):75–9.
29. Hüseyin ÇH, Muazzez H, Yadigar P. A Study of Low Birth Weight Prevalence and Risk Factors Among Newborns In A Public-Hospital at Kilis, Turkey. Afr Health Sci. 2020;20(2):709–14.
30. Lee JK, Jang HL, Kang BH, Lee K-S, Choi Y-S, Shim KS, et al. Percentile Distributions of Birth Weight according to Gestational Ages in Korea (2010-2012). J Korean Med Sci. 2016;31(6):939.
31. Jiang S, Sung J, Sawhney R, Cai J, Xu H, Ng SK, et al. The determinants of growth failure in children under five in 25 low- and middle-income countries. J Glob Health. 2023;13:04077.
32. Ebrahimzadeh F, Hajizadeh E, Baghestani AR, Nazer MR. Effective Factors on the Rate of Growth Failure in Children below Two Years of Age: A Recurrent Events Model. Iran J Public Health. 2018;47(3):418–26.
33. Tang MN, Adolphe S, Rogers SR, Frank DA. Failure to Thrive or Growth Faltering: Medical, Developmental/Behavioral, Nutritional, and Social Dimensions. Pediatr Rev. 2021;42(11):590–603.