Research Paper

Health Disparities in Developmental Status of One-year-old Neonates With Low and Normal Birth Weight: A Comparative Study

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ABSTRACT

Background and Purpose: Low birth weight (LBW) neonates usually experience delays in developing gross and fine motor skills. Studies in Iran reveal a prevalence of growth retardation ranging from 7% to 26.3% among Iranian children. Recognizing the significance of complications associated with LBW, this study aims to scrutinize the developmental status of LBW infants at one year of age and juxtapose it with that of normal birth weight (NBW) neonates.

Materials and Methods: This retrospective cohort study involved 105 one-year-old children in Shirvan City, Iran. Participants were selected through a census, and their information was extracted from the SIB system (the integrated health record system). Data collection utilized the 12-month version of the ages and stages questionnaire (ASQ) and a demographic questionnaire. Statistical analyses, including the t-test, Pearson correlation coefficient, and linear regression, were performed using SPSS software, version 26.

Results: The ASQ questionnaire revealed that the dimensions of problem-solving and individual-social skills had the lowest and highest mean scores, respectively. A comparison of developmental domains between the two groups did not yield any significant differences. However, when considering gender, a noteworthy relationship emerged in both groups, particularly in communication and gross motor skills, as well as individual-social development and problem-solving.

Conclusion: Noteworthy disparities were identified between LBW and NBW infants at birth, encompassing factors such as breastfeeding and maternal educational levels. Consequently, public health policies should prioritize initiatives to enhance mothers' and infants' health and nutritional well-being before and during pregnancy and early childhood.

Keywords: Low birth weight, Ages and stages questionnaire, Developmental status

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Introduction

Low birth weight (LBW), defined as a birth weight below 2500 g, stands out as a critical global health concern and a leading cause of mortality [1]. It is a primary indicator of neonatal complications during infancy and childhood [2]. The predominant culprits behind LBW differ between industrialized and developing nations, with premature birth and intrauterine growth retardation being the primary causes, respectively [1].

Globally, an estimated rate of 15% to 20% of all births, exceeding 20 million annually, falls into the LBW category [3]. The prevalence of LBW varies across different regions: 13% in developing countries, 9% in the United States, 6% in East Asia and the Pacific, 13% in sub-Saharan Africa, and notably, 28% in South Asia [3]. Given that a substantial percentage of LBW infants worldwide are born in South Asia, Asians emerge as one of the most vulnerable populations to LBW and its ensuing health implications. Despite significant reductions in the prevalence of LBW in low- and middle-income countries due to concerted efforts, LBW continues to be a critical public health priority [4].

In recent decades, scientific progress has extended the survival of LBW infants. However, this enhanced survival comes at the cost of an increased likelihood of encountering LBW-related complications, leading to a rise in complications such as cerebral palsy, seizures, hydrocephaly, blindness, deafness, and cognitive disorders in children [5]. Various studies indicate that LBW infants experience physiological and psychosocial challenges two to three times higher than their counterparts [1]. These infants are prone to delays in developing gross and fine motor skills [6]. As they reach school age, they exhibit poorer physical development, cognitive function, and school performance. These complications persist into adulthood, imposing significant economic, emotional, and social burdens on society, healthcare systems, and families [1, 7].

A paramount approach to fostering economic and social development in nations is to invest in the physical and mental well-being of children, recognizing them as the true assets of the country. The environment significantly shapes the developmental status, underscoring the crucial role of early interventions and diagnosis. Achieving this goal necessitates developmental monitoring and screening [8]. Conducting developmental screening for children at the age of one can uncover potential issues that, when addressed through early interventions, can positively influence the child's future well-being [9].

Regrettably, despite numerous studies focusing on premature and LBW infants globally, the growth process and potential developmental issues of such infants in Iran have been explored minimally. Consequently, there is a pressing need for preventive measures to assess and formulate appropriate plans in this domain. Considering this imperative, we have chosen to study LBW babies' developmental status. The aim is to contribute to the establishment of an improved developmental and rehabilitation program for these infants in the future. Recognizing the significance of LBW complications, our study was designed to investigate the developmental status of LBW babies at one year of age, drawing comparisons with normal birth weight (NBW) neonates in Shirvan City, Iran.

Materials and Methods

This retrospective cohort study involved 105 girls and boys under the care of comprehensive urban health centers in Shirvan, all of whom reached the age of one from March to February 2017. The subjects were selected through a census from these health centers, and their information was extracted from the SIB (the integrated health system) system of health centers. The inclusion criterion was age 12 months when completing the questionnaire, and the study focused on children without congenital abnormalities.

Data collection involved the completion of the ages and stages questionnaire (ASQ) by the mothers of two groups of children: Those with birth weights below 2500 g (LBW) and those with birth weights above 2500 g (NBW), as recorded in the SIB system. Demographic information was gathered by directly contacting the mothers after obtaining their consent for participation. Before data collection, parents received comprehensive information regarding the research objectives and protocols, with assurances that the recorded data in the questionnaires would remain confidential and be utilized solely for research purposes.

The ASQ is a globally recognized standard for assessing children's developmental status across various age groups. With reported reliability and validity at 93%, this questionnaire has demonstrated its effectiveness as a screening tool in different pediatric populations [10]. The study employed a set of instruments comprising a questionnaire for demographic characteristics alongside the ASQ. The demographic characteristics questionnaire encompassed two sections detailing the baby's and mother's attributes and was structured based on previous research. The mother's characteristics section

collected information such as age, gestational age, delivery route, education, occupation, household dimension, and pregnancy complications (gestational diabetes, hypertension, nausea, and vomiting frequency, pregnancy-related problems, hypothyroidism, preeclampsia, etc.). The baby's characteristics section gathered data on gender, birth weight, birth height, birth head circumference, and birth rank. The ASQ questionnaire, featuring 19 questionnaires tailored to different age groups spanning 4 to 60 months, stands out as a valuable tool for screening children's development and is completed by parents.

This research focused on 1-year-old children, so the 12-month version of the ASQ was employed. This questionnaire comprises 30 queries categorized into five sections: Communication, gross motor skills, fine motor skills, individual-social development, and problem-solving. The phrases about the child's development within each section were articulated in straightforward language and sequenced from simpler to more complex activities.

Descriptive statistics were utilized for data summarization, including mean, standard deviation, and frequency percentage. Inferential statistical analyses, such as the t-test, chi-square test, Pearson correlation coefficient, and linear regression, were employed to explore relationships between variables using SPSS software, version 26.

Results

In this study, the range of birth weights spanned from 1640 to 4525 g. Among the participants, 18 children (17.1%) with a birth weight below 2500 g were categorized as the LBW group, while 87 (82.9%) fell into the NBW category. The LBW group exhibited a mean birth weight of 2177.7±275.6 g. The mean age of mothers at delivery for both groups was 26.7±6.7 years, with 61.1% having educational degrees below a diploma. In contrast, the NBW group had a mean birth weight of 3386.2±843.5 g, a mean maternal age at delivery of 27.9±6.8 years, and 29.9% of mothers had an education below a diploma. Further demographic details for the LBW and NBW groups are presented in Table 1.

Table 1. Comparative analysis of parents' demographic characteristics concerning neonates' birth weight

Variables		Mean±SD/No. (%)		P
		LBW	NBW	
Mother's age at pregnancy (y)		26.7±6.7	27.9±6.8	0.48
Mother's job	Employed	3(16.7)	18(20.7)	0.68
	Housewife	15(83.3)	69(79.3)	
Mother's education	Lower than diploma	11(61.1)	26(29.9)	0012
	Higher than diploma	7(38.9)	61(70.1)	
Type of delivery	Cesarean	6(33.3)	36(41.4)	0.52
	Natural	12(66.7)	51(58.6)	
Neonate's gender	Male	10(55.6)	46(52.9)	0.83
	Female	8(44.4)	41(47.1)	
Feeding	Breast milk	6(33.3)	62(71.3)	0.006
	Formula	3(16.7)	9(10.3)	
	Both	9(50)	16(18.4)	
Pregnancy complications	Present	2(11.1)	11(12.6)	0.88
	Absent	16(88.9)	76(87.3)	
NICU admission	Yes	3(16.7)	13(4.9)	0.88
	No	15(83.3)	74(85)	

Abbreviations: NBW: Normal birth weight; LBW: Low birth weight; NICU: Neonatal intensive care unit.

Table 2. Comparative analysis of individual characteristics between normal- and low-birth-weight neonates

Variables	Mean±SD		P
	LBW	NBW	
Birth weight (kg)	2.1±0.27	3.3±0.84	<0.001
Birth height (cm)	45.5±2.8	51.1±5.9	<0.001
Birth head circumference (cm)	32.7±1.2	34.2±1.5	<0.001
Weight at 12 months (kg)	9.7±1.4	10.6±1.5	0.02

NBW: Normal birth weight; LBW: Low birth weight.

The chi-square test results revealed significant associations between the mother's education, nutrition, and the newborn's birth weight. Specifically, a higher proportion of mothers with education beyond a diploma and a more frequent practice of breastfeeding during delivery were observed among those who gave birth to NBW babies. Table 2 provides a detailed comparison of the characteristics between NBW and LBW children.

In the present study, the dimensions of problem-solving and individual-social skills yielded the lowest and highest mean scores on ASQ, respectively. Table 3 displays the mean scores of developmental domains for both LBW and NBW children across genders.

This study explored the correlation between scores in various ASQ dimensions and quantitative variables such as birth weight, birth height, birth head circumference, weight at one year, birth rank, household size, and mother's age at delivery. No significant relationships were observed between different developmental dimensions and these variables, except for a noteworthy correlation between the gross motor skills section and birth rank (r=0.24, P=0.01). Additionally, no significant associations were found between different developmental domains and the mother's gender, occupation, and education.

This study employed a regression model to discern factors influencing infant growth and mitigate the confounding effects of other variables. The findings indicat-

Table 3. Developmental outcomes in 1-year-old boys and girls

Developmental Domain	Mean±SD					
	All children		Boys		Girls	
	LBW	NBW	LBW	NBW	LBW	NBW
Communication establishment	55.5±6.3	55±8.2	54.8±6.7	56.5±4.1	53.1±11.6	56.2±5.9
P	0.76		0.03		0.009	
Gross motor skills	56.3±6.3	56.9±6.4	54.5±7.6	57.7±5.7	56.1±7.1	58.7±3.5
P	0.72		0.04		0.04	
Fine motor skills	54.5±10.3	58.05±7.1	54.4±9.9	57±9.4	54.5±10.8	59.3±1.7
P	0.16		0.35		0.006	
Individual-social skills	56.6±5.1	56.7±7.1	56.6±7.1	58±4.2	55±5.9	56.8±7.2
P	0.96		0.23		0.97	
Problem-solving	54.7±7.1	56.8±6.5	55.9±7.9	56±7.3	53.1±7.03	57.9±4.3
P	0.21		0.92		0.04	

NBW: Normal birth weight; LBW: Low birth weight.

ed that, even after controlling for confounding factors, the mother's age at delivery exhibited an inverse correlation with establishing a communication dimension (B=-0.23, P=0.03). Furthermore, a direct and significant relationship was identified between the fine motor skills dimension and head circumference (B=3.12, P=0.03) in infants with birth weights below 2500 g.

Discussion

Based on our research, 18 children (17.1%) among the 105 infants were found to have low birth weight. The most and least affected developmental domains were individual social skills and problem-solving abilities. Interestingly, our study did not reveal a significant association between LBW and NBW with developmental domains. However, noteworthy findings indicate a significant correlation between male gender and communication and gross motor skills and between female gender and communication, gross motor skills, individual-social development, and problem-solving abilities.

In our current investigation, notable distinctions emerged in the growth patterns of children with low birth weight (LBW <2500 g) compared to those with normal birth weight (NBW >2500 g) at the age of one year, as well as in their birth weight, height, and head circumference. Analyzing the demographic characteristics of the parents in both groups revealed that infants with a birth weight below 2500 g were less frequently breastfed than those with a higher birth weight. Moreover, mothers of NBW infants exhibited significantly higher educational levels than mothers of LBW babies. These findings can be elucidated by the diverse array of macronutrients, micronutrients, immunoglobulins, cytokines, growth factors, hormones, and antimicrobial agents present in breast milk, which confer numerous health benefits to LBW infants. A meta-analysis conducted by Godah et al. underscored the considerable protective effect of maternal education against the risk of giving birth to LBW babies [11]. Consequently, ensuring access to education for girls and women can play a pivotal role in enhancing birth outcomes and diminishing the incidence of LBW births.

When assessing the rate of developmental retardation in the two groups, it was observed that the most significant and least pronounced delays were associated with the individual-social and problem-solving domains, respectively. A study by Dehghani et al. indicated that, in their research, the highest and lowest developmental delays were linked to gross motor skills and communication dimensions, respectively [12]. Conversely, Zareipour et al., who focused on children aged 6-18 months, found that the highest and lowest developmental delays were associated with the areas of communication and gross motor skills, respectively [13], contradicting the outcomes of our study. This disparity in findings can be attributed to the distinct age ranges investigated in these studies.

In our study, a comparison of developmental domains between the two groups showed no significant differences. Additionally, we did not observe any significant relationship between birth weight status and various developmental domains. However, Zareipour et al. found a significant association between gender and problem-solving, gross motor skills, and communication [13]. Furthermore, Donald et al. reported significant differences between genders in all developmental areas except for gross motor skills [14], which does not align with our findings.

This study investigated the correlation between various developmental domains within each gender. The findings revealed a noteworthy association between the male gender and communication and gross motor skills domains. Similarly, a significant relationship was observed between the female gender and the domains of communication, gross motor skills, individual-social development, and problem-solving.

In this study, a notable correlation was observed between the domain of gross motor skills and the birth rank. According to Zareipour's study in northwest Iran, developmental delays in male children were more pronounced than in female children, particularly in problem-solving, gross movements, and communication. Similarly, Hediger et al. reported that developmental delays in fine motor skills, gross motor skills, and social domains were significantly more prevalent in males [15]. Akbari's study also indicated a significant correlation between male gender and growth delay in children [16]. However, other studies reported no association between gender and developmental delays, revealing results inconsistent with our study [17, 18].

Subsequently, we employed a regression model to discern the factors impacting the growth and development of infants while mitigating the confounding effects of other variables. Following adjustments for potential confounders, a significant inverse correlation surfaced between the mother's age at delivery and the communication domain. Additionally, a direct and significant correlation was identified between the domain of fine movements and head circumference at birth in LBW

children. In their study, Ritchie et al. identified gestational age, congenital cerebral abnormalities, and family socio-economic status as predictors of children's social development [19]. Similarly, Noohjah et al. found a significant correlation between the mother's age at delivery and the area of motor development [20]. However, our study revealed a distinct result, showing a significant and inverse relationship between the mother's age at delivery and the communication domain.

Similar to our findings, Dareh et al. reported no significant relationships between various developmental areas and the variables of birth weight and gender [21]. In line with a study by Afraz et al., we observed that birth rank and mother's education had no significant relationship with different developmental areas [22]. Additionally, consistent with Karami et al. [23], we found no significant relationship between the type of feeding and developmental areas.

The distinctive feature of the present study lies in its exploration of the developmental status of infants at the age of one year, specifically comparing those with LBW and NBW in a region where such a comparison had not been previously conducted. This unique approach allows for a nuanced understanding of developmental differences in infants within this particular geographical context, considering the inherent variations that different regions may exhibit.

An acknowledged limitation of our study is its restriction to LBW and NBW children exclusively in urban health centers. Furthermore, the study did not evaluate certain influential factors, such as the mother's nutritional status during pregnancy. Given the significance of our findings and the increasing global emphasis on early childhood development, it is recommended that population-based studies that directly measure the developmental outcomes of LBW children be undertaken. This approach would provide a broader and more comprehensive understanding of the factors influencing developmental outcomes in diverse settings.

Conclusion

The study findings underscore directing public health policies toward mothers' and infants' health and nutritional well-being both before and during pregnancy and early childhood. The emphasis on maternal and child health is crucial for promoting positive developmental outcomes and overall well-being.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the North Khorasan University of Medical Sciences (Code: IR.NKUMS.REC.1399.027).

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Authors contributions

Conceptualization and study design: Abed Neshan; Data analysis: Andishe Hamedi; Data interpretation: Elham Hamedi and Andishe Hamedi; Writing the original draft: Elham Hamedi; Review, editing and supervision: Akram Mousavi and Andishe Hamedi.

Conflict of interest

The authors declared no conflict of interest.

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