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Original Research Article

GROWTH STATUS AND ASSOCIATED FACTORS AMONG CHILDREN AGED 2–5 YEARS BORN WITH LOW BIRTH WEIGHT: A HOSPITAL-BASED CROSS-SECTIONAL STUDY

Palak Pandya[1], Krupa Modi[2], Hetal D Vora[3], Halak Vasavada[4]

[1]*Senior Resident, Department of Pediatrics, PDU Medical College, Rajkot, Gujarat, India.*
[2]*Consultant Paediatrician, Vinayak Children's Hospital, Ahmedabad, Gujarat, India.*
[3]*Professor, Department of Pediatrics, Smt N H L Municipal Medical College, Ahmedabad, Gujarat, India.*
[4]*Professor, Department of Pediatrics, Narendra Modi Medical College, Ahmedabad, Gujarat, India.*

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Corresponding Author:
Dr. Palak Pandya,
Senior Resident, Department of Pediatrics, PDU Medical College, Rajkot, Gujarat, India.
Email: palakpandya97@gmail.com

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ABSTRACT

Background: Children born with low birth weight remain vulnerable to impaired physical growth beyond infancy. Evidence describing multiple growth parameters and their associated factors during the preschool period is limited. This study assessed growth status among children aged 2–5 years born with low birth weight and examined factors associated with weight-for-age and height-for-age.

Materials and Methods: A hospital-based cross-sectional observational study was conducted among 83 children aged 2–5 years with documented birth weight <2500 g. Sociodemographic, perinatal, feeding and clinical information was collected using a structured case-record form. Weight, standing height, head circumference and mid-upper-arm circumference were measured. Weight-for-age, height-for-age and head circumference below the 3rd centile were classified as low. Bone age was assessed among children born small for gestational age. Associations were analysed using Pearson's chi-square or Fisher–Freeman–Halton exact test, as appropriate.

Results: Low weight-for-age was present in 45 (54.2%) children, impaired linear growth in 38 (45.8%), low head circumference in 11 (13.3%) and MUAC <11.5 cm in 3 (3.6%). Low weight-for-age was significantly associated with absence of exclusive breastfeeding, inappropriate complementary feeding and two or more hospitalizations during the first two years (all $p<0.001$), as well as maternal height ≤150 cm ($p=0.005$). Impaired linear growth was more frequent among small-for-gestational-age than appropriate-for-gestational-age children (60.0% vs 35.4%; $p=0.026$) and was associated with exclusive breastfeeding status ($p=0.036$), iron supplementation status ($p=0.007$) and maternal height ($p=0.004$). Among 35 small-for-gestational-age children, 3 (8.6%) had bone age lower than both chronological age and height age.

Conclusion: Growth impairment was frequent among preschool children born with low birth weight. Continued monitoring beyond infancy should emphasize linear growth in small-for-gestational-age children and identify modifiable feeding and illness-related factors.

Keywords: Low birth weight; preschool children; small for gestational age; weight-for-age; height-for-age; bone age.

INTRODUCTION

Low birth weight (LBW), defined as birth weight below 2500 g irrespective of gestational age, remains a major public health concern. It may result from prematurity, impaired fetal growth, or both and is associated with increased mortality and adverse growth and developmental outcomes. Globally, its prevalence declined only slightly from 15.0% in 2012 to 14.7% in 2020.[1]

Globally, the prevalence of low birth weight declined only marginally from 15.0% in 2012 to 14.7% in 2020. In 2020, approximately 19.8 million newborns nearly one in seven births had low birth weight, indicating insufficient progress toward the global target of a 30% reduction by 2030.[2]

Across successive NFHS rounds, India has shown substantial but incomplete improvement in childhood undernutrition. Stunting declined from 52.0% in NFHS-1 (1992–1993) to 45.5% in NFHS-2, increased to 48.0% in NFHS-3, and subsequently fell to 38.4% in NFHS-4, 35.5% in NFHS-5, and 29.3% in NFHS-6 (2023–2024). Underweight prevalence similarly declined from 53.4% to 47.0%, 42.5%, 35.8%, 32.1%, and 31.8%, respectively. Overall wasting fluctuated between 15.5% and 21.0% through NFHS-5, while NFHS-6 reported a reduction in severe wasting from 7.7% to 5.2%.[3]

Growth during early childhood reflects the combined influence of biological vulnerability and the child's postnatal environment. Children born with low birth weight begin life with reduced growth reserves, and those born small for gestational age or requiring prolonged neonatal care may remain particularly vulnerable to poor weight gain and impaired linear growth. Appropriate breastfeeding and complementary feeding, maternal nutrition and stature, socioeconomic conditions, recurrent illness, birth spacing, and access to timely health care can either support or limit postnatal catch-up growth. Consequently, growth outcomes among children born with low birth weight may vary considerably, even among those with similar birth weights.[4,5]

The preschool years therefore provide an important opportunity to identify persisting growth deficits after infancy. Reliance on body weight alone may overlook impaired linear growth, reduced head growth, or low muscle and fat stores.[6] Children born with low birth weight are at greater risk of stunting, underweight, and wasting than those born with normal birth weight. However, the extent of these problems varies across settings according to maternal, household, nutritional, and healthcare-related factors. Evidence describing growth among low-birth-weight children aged 2–5 years remains limited, despite the importance of this period for assessing recovery from early growth deficits.[7,8]

Low-birth-weight infants have higher neonatal mortality, and survivors remain vulnerable to impaired growth and later neurodevelopmental and metabolic consequences.[9,10] Among SGA children, a small subgroup may develop persistent short stature despite no obvious feeding, illness, or NICU-related factors; in this study, about 9% had delayed bone age and may warrant further evaluation, including IGF-1 and growth hormone assessment.[10,11]

Indian evidence has mainly come from national surveys, infant cohorts, or studies limited to small-for-gestational-age children. Therefore, the present study assessed growth and nutritional status among children aged 2–5 years born with low birth weight, compared appropriate- and small-for-gestational-age groups, examined factors associated with weight-for-age and height-for-age, and described the relationship among chronological age, height age, and bone age.

MATERIALS AND METHODS

Study design, study setting and study type: A hospital-based analytical cross-sectional study was conducted in the Department of Pediatrics, Smt. S.C.L. Municipal General Hospital, a tertiary-care teaching hospital affiliated with Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India, from November 2022 to March 2024.

Study participants: Children aged 2–5 years attending the pediatric outpatient or inpatient services were screened for eligibility. Children with a documented birth weight below 2,500 g in the Mamta card, neonatal discharge summary or hospital record were enrolled after parental consent. Children with cerebral palsy, global developmental delay, major congenital malformations or skeletal abnormalities affecting height measurement, including kyphosis, scoliosis and thoracic dystrophy, were excluded.

Sample size and sampling technique: The sample size was duration based, and all eligible children presenting during the 18-month study period were recruited, yielding a final sample of 83 participants. The recruitment process was consistent with consecutive sampling, although the thesis described the sampling as random in the statistical section.

Ethical considerations: The study commenced after approval of the study protocol by the Institutional Ethics Committee. Written informed consent was obtained from a parent or caregiver before enrolment, and confidentiality of participant information was maintained.

Data collection: Data were collected using a structured case-record form through caregiver interview, clinical examination and review of birth or hospital records. Variables included age, sex, socioeconomic class, gestational maturity, birth-weight category, appropriate- or small-for-gestational-age status, previous NICU admission, exclusive breastfeeding for six months, appropriate complementary feeding after six months, number of hospitalizations during the first two years, iron supplementation, clinical pallor and maternal height. Maternal height was categorized as ≤150 cm or >150 cm, and hospitalizations as ≥2 or <2. Weight was measured with minimal clothing on a zero-corrected weighing scale; standing height was measured using a stadiometer; head circumference was measured with a non-stretchable tape around the supraorbital ridges and maximum occipital prominence; and MUAC was measured at the midpoint between the acromion and olecranon. Anthropometric measurements were plotted on growth charts, and weight-for-age, height-for-age and head circumference below the 3rd centile were classified as low; MUAC ≤11.5 cm was classified as low. Bone age was assessed using a wrist radiograph and compared with chronological age and height age as CA > HA > BA, CA > HA = BA or CA = HA = BA.

Data Analysis: Data were entered and analysed using epi info CDC 7. Categorical variables were summarized as frequencies and percentages, and associations between growth outcomes and categorical study variables were assessed using the chi-square test. A two-sided p-value below 0.05 was considered statistically significant.

RESULTS

As shown in Table 1, most children were aged 2–3 years (42.2%), male (57.8%), from the lower socioeconomic class (79.6%), and born at term (85.5%). More than half had been appropriate for gestational age (57.8%) and previously admitted to the NICU (56.6%). Exclusive breastfeeding for six months and appropriate complementary feeding were reported in 49.4% and 47.0% of children, respectively.

Table 1: Baseline characteristics of children born with low birth weight (N=83)

Variables	**n (%)**
Age group	
• 2–3 years	35 (42.2)
• 3–4 years	21 (25.3)
• 4–5 years	27 (32.5)
Gender	
• Male	48 (57.8)
• Female	35 (42.2)
Socioeconomic status	
• Upper class	8 (9.6)
• Middle class	9 (10.8)
• Lower class	66 (79.6)
Gestational maturity	
• Term	71 (85.5)
• Preterm	12 (14.5)
Size for gestational age	
• Appropriate for gestational age (AGA)	48 (57.8)
• Small for gestational age (SGA)	35 (42.2)
Previous neonatal intensive care unit (NICU) admission	47 (56.6)
Exclusive breastfeeding for 6 months	41 (49.4)
Appropriate complementary feeding	39 (47.0)
≥2 hospitalizations during the first 2 years	43 (51.8)
Iron supplementation	55 (66.3)
Clinical pallor	39 (47.0)
Maternal height ≤ 150 cm	38 (45.8)

Table 2 shows that low weight-for-age was the most common growth impairment, affecting 54.2% of children, followed by impaired linear growth in 45.8%. Low head circumference was observed in 13.3%, whereas only 3.6% had MUAC below 11.5 cm.

Table 2: Growth status of children aged 2–5 years born with low birth weight (N=83)

Growth parameter and classification	**n (%)**
Weight-for-age <3rd centile — low weight-for-age	45 (54.2)
Height-for-age <3rd centile — impaired linear growth	38 (45.8)
Head circumference <3rd centile — low head circumference	11 (13.3)
MUAC <11.5 cm	3 (3.6)

MUAC, mid-upper-arm circumference

As demonstrated in Table 3, low weight-for-age was significantly more frequent among children who were not exclusively breastfed, did not receive appropriate complementary feeding, or had two or more hospitalizations during the first two years (all p<0.001). Maternal height ≤150 cm was also significantly associated with low weight-for-age (71.1% vs 40.0%; p=0.005). No significant association was observed with age, sex, gestational maturity, size for gestational age, socioeconomic status, NICU admission, iron supplementation, or clinical pallor.

Table 3: Factors Associated with Weight-for-Age Status among Children Born with Low Birth Weight (N=83)

Factors	WFA <3rd centile (n=45)	WFA ≥3rd centile (n=38)	P value*
Age group			
• 2–3 years	23 (65.7)	12 (34.3)	0.187
• 3–4 years	9 (42.9)	12 (57.1)	
• 4–5 years	13 (48.1)	14 (51.9)	
Gender			
• Male	27 (56.2)	21 (43.8)	0.663
• Female	18 (51.4)	17 (48.6)	
Gestational maturity			
• Term	40 (56.3)	31 (43.7)	0.345
• Preterm	5 (41.7)	7 (58.3)	
Size for gestational age			
• AGA	26 (54.2)	22 (45.8)	0.991
• SGA	19 (54.3)	16 (45.7)	
Socioeconomic status			
• Upper	2 (25.0)	6 (75.0)	0.189
• Middle	6 (66.7)	3 (33.3)	
• Lower	37 (56.1)	29 (43.9)	
Previous NICU admission			
• Yes	22 (46.8)	25 (53.2)	0.122
• No	23 (63.9)	13 (36.1)	
Exclusive breastfeeding for 6 months			
• Yes	11 (26.8)	30 (73.2)	<0.001
• No	34 (81.0)	8 (19.0)	
Appropriate complementary feeding			
• Yes	9 (23.1)	30 (76.9)	<0.001
• No	36 (81.8)	8 (18.2)	
Hospitalizations during first 2 years			
• ≥2	33 (76.7)	10 (23.3)	<0.001
• <2	12 (30.0)	28 (70.0)	
Iron supplementation			
• Yes	34 (61.8)	21 (38.2)	0.051
• No	11 (39.3)	17 (60.7)	
Clinical pallor			
• Yes	24 (61.5)	15 (38.5)	0.208
• No	21 (47.7)	23 (52.3)	
Maternal height			
• ≤150 cm	27 (71.1)	11 (28.9)	0.005
• >150 cm	18 (40.0)	27 (60.0)	

**P values were calculated using Pearson's chi-square test or Fisher–Freeman–Halton exact test, as appropriate.*

Table 4: Factors Associated with Height-for-Age Status among Children Born with Low Birth Weight (N=83)

Factors	HFA <3rd centile (n=38)	HFA ≥3rd centile (n=45)	P value*
Age group			
• 2–3 years	20 (57.1)	15 (42.9)	0.167
• 3–4 years	9 (42.9)	12 (57.1)	
• 4–5 years	9 (33.3)	18 (66.7)	
Gender			
• Male	24 (50.0)	24 (50.0)	0.367
• Female	14 (40.0)	21 (60.0)	
Gestational maturity			
• Term	33 (46.5)	38 (53.5)	0.757
• Preterm	5 (41.7)	7 (58.3)	
Size for gestational age			
• AGA	17 (35.4)	31 (64.6)	0.026
• SGA	21 (60.0)	14 (40.0)	
Socioeconomic status			
• Upper	3 (37.5)	5 (62.5)	0.124
• Middle	7 (77.8)	2 (22.2)	
• Lower	28 (42.4)	38 (57.6)	
Previous NICU admission			
• Yes	21 (44.7)	26 (55.3)	0.818
• No	17 (47.2)	19 (52.8)	
Exclusive breastfeeding for 6 months			
• Yes	14 (34.1)	27 (65.9)	0.036
• No	24 (57.1)	18 (42.9)	
Appropriate complementary feeding			
• Yes	15 (38.5)	24 (61.5)	0.208
• No	23 (52.3)	21 (47.7)	
Hospitalizations during first 2 years			
• ≥2	24 (55.8)	19 (44.2)	0.057
• <2	14 (35.0)	26 (65.0)	
Iron supplementation			
• Yes	31 (56.4)	24 (43.6)	0.007
• No	7 (25.0)	21 (75.0)	
Clinical pallor			
• Yes	16 (41.0)	23 (59.0)	0.413
• No	22 (50.0)	22 (50.0)	
Maternal height			
• ≤150 cm	24 (63.2)	14 (36.8)	0.004
• >150 cm	14 (31.1)	31 (68.9)	

**P values were calculated using Pearson's chi-square test or Fisher–Freeman–Halton exact test, as appropriate.*

Table 4 demonstrates that impaired linear growth was more common among SGA than AGA children (60.0% vs 35.4%; p=0.026). It was also significantly associated with absence of exclusive breastfeeding (p=0.036), iron supplementation status (p=0.007), and maternal height ≤150 cm (63.2% vs 31.1%; p=0.004). Other demographic, feeding, neonatal, and clinical factors did not show statistically significant associations with height-for-age status.

Table 5: Relationship between Chronological Age, Height Age and Bone Age Among SGA Children (n=35)

Age relationship	n (%)
CA > HA > BA	3 (8.6)
CA > HA = BA	26 (74.3)
CA = HA = BA	6 (17.1)
Total	**35 (100.0)**

BA, bone age; CA, chronological age; HA, height age; SGA, small for gestational age.

Among the 35 SGA children, Table 5 shows that 74.3% had height age and bone age below chronological age but equal to each other. Chronological age, height age, and bone age were equivalent in 17.1%, while 8.6% had bone age lower than both chronological age and height age.

DISCUSSION

Growth during the preschool years reflects the combined influence of intrauterine growth, early nutrition, illness and familial factors. Children born with low birth weight remain vulnerable to persistent deficits in weight and linear growth, making continued assessment beyond infancy important.

The main finding of this study was that growth impairment remained common during the preschool years among children born with low birth weight. Low weight-for-age affected 54.2% of children and impaired linear growth affected 45.8%, whereas low head circumference and MUAC <11.5 cm was much less frequent. This pattern suggests that attained weight and height were the growth dimensions most commonly affected. These findings are consistent with Jana et al,[12] who reported a greater burden of undernutrition among Indian children born with low birth weight than among those with normal birth weight.

Size for gestational age had a clearer relationship with height than with weight. Impaired linear growth was significantly more frequent among SGA children than AGA children (60.0% vs 35.4%; p=0.026), while weight-for-age status was almost identical in the two groups. Similar persistence of poorer stature among SGA children was reported by Khadilkar et al,[13] and Hendrix et al,[14] The present findings therefore suggest that intrauterine growth restriction may have a more lasting influence on linear growth, whereas preschool weight may be more strongly modified by postnatal feeding and illness.

Feeding practices showed important associations with growth. Children who had not been exclusively breastfed for six months had markedly higher proportions of low weight-for-age and impaired linear growth. Vizzari et al,[15] similarly observed that human-milk feeding supported postnatal weight and length recovery among late-preterm SGA infants. Appropriate complementary feeding was strongly associated with weight-for-age but not with height-for-age, possibly because body weight responds more rapidly than stature to current energy and nutrient intake. However, feeding history was recorded retrospectively and without detailed assessment of dietary diversity, frequency or nutrient adequacy; therefore, these associations should not be interpreted as causal.

Maternal height emerged as an important correlate of both weight and stature. Low weight-for-age and impaired linear growth were considerably more frequent among children whose mothers were ≤150 cm tall. This agrees with Sinha et al,[16] who reported a higher risk of poor linear growth among low-birth-weight infants born to short-stature mothers. Maternal height may reflect both inherited growth potential and the accumulated effects of maternal nutrition and health across generations, making it a useful clinical marker for identifying children who require closer growth monitoring.

The significant association between iron supplementation and impaired height-for-age requires cautious interpretation. Children who had received iron supplementation showed a higher frequency of low height-for-age, but the cross-sectional design cannot establish that supplementation contributed to poor growth. More vulnerable or anaemic children may have been preferentially prescribed iron, producing confounding by indication. Dose, duration, adherence and laboratory-confirmed anaemia were not available, while clinical pallor itself was not significantly associated with either weight-for-age or height-for-age.

Among SGA children, most had height age and bone age below chronological age but equal to each other, whereas 8.6% had bone age lower than both chronological age and height age. Khadilkar et al,[12] have shown that the relationship among chronological, height and bone age is influenced by nutritional and developmental status. The smaller subgroup with disproportionate bone-age delay may warrant longitudinal assessment of height velocity and clinical evaluation; however, bone-age delay alone is insufficient to diagnose growth hormone deficiency. The international SGA guideline,[17] and the findings of Prasad et al,[18] support endocrine evaluation only when persistent short stature and abnormal growth velocity fulfil established auxological criteria.

This study adds useful preschool-age evidence by evaluating several growth dimensions among both AGA and SGA children born with low birth weight. Its strengths include documented birth weight, simultaneous assessment of weight, height, head circumference and MUAC, and skeletal-age evaluation among SGA children. The hospital-based cross-sectional design, modest sample size, absence of a normal-birth-weight comparison group, caregiver recall, use of unadjusted analyses and classification by the 3rd centile limit causal interpretation and generalizability. Taken together, the findings indicate that postnatal feeding, recurrent illness, maternal stature and SGA status should all be considered during continued growth surveillance beyond infancy.

CONCLUSION

Growth impairment remained common among children aged 2–5 years born with low birth weight, particularly among SGA children, those with suboptimal feeding practices, recurrent hospitalizations and shorter maternal stature. Regular monitoring of both weight and height should therefore continue beyond infancy, with reinforcement of exclusive breastfeeding, timely complementary feeding and early treatment of childhood illnesses; children with persistent short stature, poor height velocity or disproportionate bone-age delay should undergo further specialist evaluation.

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