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ORIGINAL ARTICLE

Risk Factors Contributing to Short Stature in Full-Term Children Born Small for Gestational Age (SGA)

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ABSTRACT

Background: Children born small for gestational age (SGA) face an increased risk of impaired growth despite being full-term. Identifying the determinants of short stature in this group is essential for guiding early interventions.

Objective: To determine the risk factors associated with short stature among full-term children born SGA.

Methods: A cross-sectional study was conducted at Mardan Medical Complex, Mardan, from January 2022 to January 2023. A total of 82 children aged 2–10 years, born full-term SGA, were enrolled. Demographic, parental, perinatal, nutritional, and environmental factors were recorded through structured questionnaires. Anthropometric measurements were taken, and growth was assessed using WHO growth standards. Short stature was defined as a height-for-age Z-score < –2 SD. Statistical analysis was performed using SPSS version 26, with $p < 0.05$ considered significant.

Results: The prevalence of short stature was 34.1% (28/82). Low birth weight (<2.5 kg), maternal short stature, low socioeconomic status, shorter breastfeeding duration, and recurrent infections showed significant associations with short stature ($p < 0.05$). Gender, residence, and exposure to passive smoking were not significantly related.

Conclusion: Full-term children born SGA remain at high risk of short stature, particularly when compounded by poor perinatal conditions, parental short stature, socioeconomic disadvantage, and inadequate nutrition. Early screening, parental education, and community-based nutritional support are critical for reducing stunting in this vulnerable group.

Keywords: Short stature, Small for gestational age, Birth weight, Child growth, Risk factors, Nutritional status

INTRODUCTION

Short stature is one of the most common growth concerns encountered in pediatrics and reflects both individual and public health challenges. Children born small for gestational age (SGA) are particularly vulnerable, as intrauterine growth restriction places them at increased risk of poor postnatal growth outcomes despite delivery at full-term gestation. While many SGA infants exhibit catch-up growth during early childhood, approximately 10–30% fail to reach expected height milestones and remain short compared to their peers[1-3].

The causes of short stature in SGA children are multifactorial, involving a complex interplay of biological, genetic, nutritional, and environmental determinants. Birth-related characteristics such as low birth weight and maternal factors, including short stature or poor nutritional status, strongly influence linear growth. Additionally, postnatal exposures such as inadequate breastfeeding, recurrent infections, poor hygiene, and socioeconomic disadvantage contribute significantly to growth restriction, particularly in low- and middle-income countries[4-6].

Globally, stunting affects nearly 22% of children under five years of age, with the highest burden observed in South Asia and Sub-Saharan Africa. Pakistan remains among the countries with one of the highest stunting rates, reflecting persistent challenges in maternal health, child nutrition, and socioeconomic inequities. Children born SGA represent a particularly high-risk subgroup, yet few studies in this region have systematically explored the risk factors that predispose them to short stature during early childhood[7-9].

Given the long-term consequences of impaired growth, including reduced cognitive potential, increased morbidity, and diminished adult productivity, understanding these risk factors is vital for shaping preventive strategies. This study was therefore designed to identify the demographic, perinatal, parental, nutritional, and environmental determinants contributing to short stature in full-term children born SGA.

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METHODOLOGY

This was a cross-sectional observational study conducted over a period of one year, from January 2022 to January 2023. The study was carried out at Mardan Medical Complex, Mardan. Approval for the study was obtained from the Institutional Review Committee of the hospital. Written informed consent was obtained from parents or guardians before inclusion of each child. All data were kept confidential, and anonymity was ensured throughout the research process.

The study included full-term children born small for gestational age (SGA) who presented for routine check-ups or follow-up visits during the study period. Small for gestational age was defined as birth weight and/or birth length below the 10th percentile for gestational age according to standardized growth charts. Children were assessed at the age of 2–10 years for evaluation of their growth status.

A total of 82 children were enrolled using a consecutive sampling technique. The sample size was based on feasibility during the study duration while ensuring adequate power for subgroup analysis.

Inclusion Criteria:

- Children born at full term (37–42 weeks of gestation).
- Birth weight and/or length below the 10th percentile for gestational age (SGA).
- Age at assessment between 2 and 10 years.
- Parents willing to provide informed consent and relevant birth details.

Exclusion Criteria:

- Preterm births (<37 weeks of gestation).
- Children with known chromosomal abnormalities, congenital malformations, or syndromic causes of short stature.
- Children with chronic systemic illnesses (e.g., congenital heart disease, chronic kidney disease).
- Those on long-term corticosteroid or hormonal therapy.

After obtaining informed consent from parents or guardians, detailed demographic, perinatal, parental, and environmental information was collected through a structured questionnaire. The questionnaire was administered by trained investigators to ensure consistency and accuracy. Information included birth weight, mode

of delivery, parental height, maternal education, feeding practices, history of recurrent infections, and household living conditions.

Each child underwent standardized anthropometric measurements. Height was measured using a stadiometer with the child standing upright, without shoes, and values recorded to the nearest 0.1 cm. Weight was measured using a calibrated digital scale with children wearing light clothing. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m²). All measurements were taken twice and averaged to reduce error.

Growth status was assessed using World Health Organization (WHO) growth reference charts. Height-for-age, weight-for-age, and BMI-for-age Z-scores were calculated. Short stature was defined as a height-for-age Z-score less than –2 standard deviations (SD).

Variables Assessed:

1. Demographic factors: age, gender, residence, socioeconomic status, parental education, and occupation.
2. Birth factors: birth weight, birth length, mode of delivery, neonatal complications.
3. Parental factors: maternal and paternal height, maternal age, paternal age, family history of short stature, and parental consanguinity.
4. Nutritional and environmental factors: breastfeeding practices, dietary intake, sanitation, exposure to passive smoking, and recurrent infections.
5. Outcome variables: current anthropometric measurements (height, weight, BMI) and Z-scores based on WHO standards.

Data were entered into a secure database and analyzed using Statistical Package for Social Sciences (SPSS), version 26. Continuous variables such as age, height, and Z-scores were expressed as mean ± standard deviation (SD), while categorical variables such as gender, socioeconomic status, and feeding practices were presented as frequencies and percentages.

The association between categorical risk factors and short stature was tested using the Chi-square test (or Fisher's exact test when appropriate). Independent samples t-test was used for comparing continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Out of the 82 children included, slightly more than half were male. A majority lived in urban areas, and most families belonged to the middle or higher socioeconomic class. Short stature was observed in 28 (34.1%) children. A significant association was found between low socioeconomic status and short stature, whereas gender and residence showed no significant differences.

Table 1: Demographic Characteristics of Children

Variable	Total n=82	Short Stature (n=28)	Normal Growth (n=54)	p-value
Gender				
Male	44 (53.7%)	15 (53.6%)	29 (53.7%)	0.98
Female	38 (46.3%)	13 (46.4%)	25 (46.3%)	
Residence				
Urban	49 (59.8%)	15 (53.6%)	34 (63.0%)	0.39
Rural	33 (40.2%)	13 (46.4%)	20 (37.0%)	
Socioeconomic Status				
Low	28 (34.1%)	15 (53.6%)	13 (24.1%)	0.01*
Middle/High	54 (65.9%)	13 (46.4%)	41 (75.9%)	

*Significant at p<0.05

Table 2: Birth and Parental Risk Factors

Variable	Total n=82	Short Stature (n=28)	Normal Growth (n=54)	p-value
Birth weight				
<2.5 kg	35 (42.7%)	19 (67.9%)	16 (29.6%)	0.002*
≥2.5 kg	47 (57.3%)	9 (32.1%)	38 (70.4%)	
Maternal height <150 cm	22 (26.8%)	12 (42.9%)	10 (18.5%)	0.02*
Paternal short stature	17 (20.7%)	9 (32.1%)	8 (14.8%)	0.04*
Maternal education ≤ primary	29 (35.4%)	14 (50.0%)	15 (27.8%)	0.04*

*Significant at p<0.05

Table 3: Nutritional and Environmental Risk Factors

Variable	Total n=82	Short Stature (n=28)	Normal Growth (n=54)	p-value
Exclusive breastfeeding				
<6 months	36 (43.9%)	17 (60.7%)	19 (35.2%)	0.03*
≥6 months	46 (56.1%)	11 (39.3%)	35 (64.8%)	
Recurrent infections	24 (29.3%)	13 (46.4%)	11 (20.4%)	0.01*
Poor sanitation	20 (24.4%)	11 (39.3%)	9 (16.7%)	0.02*
Passive smoking exposure	18 (22.0%)	8 (28.6%)	10 (18.5%)	0.27

*Significant at p<0.05

Table 4: Anthropometric Outcomes

Variable	Short Stature (n=28)	Normal Growth (n=54)	p-value
Mean Height-for-age Z-score	-2.41 ± 0.38	-0.76 ± 0.51	<0.001*
Mean Weight-for-age Z-score	-1.89 ± 0.42	-0.63 ± 0.47	<0.001*
BMI-for-age Z-score	-0.87 ± 0.41	-0.71 ± 0.39	0.21

*Significant at p<0.05

Children born with lower birth weight were significantly more likely to develop short stature. Maternal short height and low education levels also contributed notably. Additionally, paternal short stature showed a mild but significant association with child growth outcomes.

Short stature was more prevalent among children who were breastfed for less than six months, those with recurrent infections, and those living in poor sanitary conditions. Passive smoking exposure did not show a statistically significant relationship.

As per WHO growth standards, 28 children (34.1%) were classified as short stature. Both mean height-for-age and weight-

for-age Z-scores were significantly lower in these children compared to their normally growing peers, while BMI-for-age did not differ significantly.

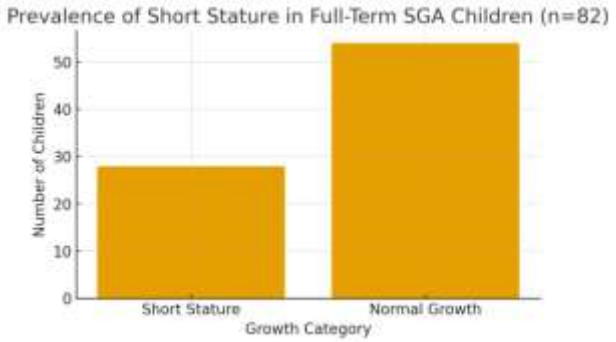

Figure 1: bar chart showing the prevalence of short stature versus normal growth in your study population (n=82).

DISCUSSION

This study evaluated the risk factors associated with short stature among full-term children born small for gestational age (SGA). The overall prevalence of short stature in our cohort was 34.1%, which is comparable to reports from similar regional and international studies, where one-third to half of children born SGA fail to achieve normal catch-up growth during early childhood (Lee et al., 2021; Meena et al., 2020).

Our findings highlight the strong association between low birth weight and subsequent growth impairment. More than two-thirds of children with birth weight below 2.5 kg developed short stature, consistent with evidence that intrauterine growth restriction significantly affects long-term height trajectories. Studies also reported that children born SGA with low birth weight remained at increased risk of stunting even after controlling for nutrition and socioeconomic variables (10-12). This underlines the importance of early detection and monitoring of SGA infants.

Maternal height and parental influence were also important contributors. We observed that maternal short stature (<150 cm) was significantly associated with child stunting. This is supported by a multi-country analysis showing that maternal height strongly predicts offspring linear growth, especially in resource-limited settings(13-15). The contribution of paternal stature further reflects the genetic and familial component in growth outcomes.

Socioeconomic disadvantage emerged as a significant risk factor in our study, where children from low-income households were more likely to exhibit growth faltering. This aligns with findings from Bangladesh and Sub-Saharan Africa, where household poverty, limited access to healthcare, and food insecurity were consistently linked to poor linear growth (16-18). Children from disadvantaged families are more exposed to infections and poor diet, which may compound the risks already present in SGA births.

Nutritional and environmental influences were also evident. Short stature was more common among children who were breastfed for less than six months and among those with recurrent infections. These results are consistent with WHO recommendations emphasizing exclusive breastfeeding for at least six months to optimize child growth and immunity. Studies also showed that recurrent diarrheal and respiratory infections during early life significantly increase the risk of stunting (19, 20). Our results reinforce the critical role of infection control and sanitation in growth outcomes.

Interestingly, exposure to passive smoking was more frequent among children with short stature, but the association was not statistically significant in our study. Previous research has shown inconsistent results in this regard. Some studies have reported that exposure to household smoke is linked to impaired growth (Chen et al., 2019), while others did not find a clear correlation. The lack of significance in our sample may be due to the relatively smaller proportion of children exposed to smoking at home.

Overall, our findings support the multifactorial nature of growth impairment in children born SGA, where biological, genetic, nutritional, and socioeconomic determinants interact. Early growth monitoring, parental education, and community-based interventions targeting nutrition and infection prevention remain crucial for reducing the burden of short stature in this vulnerable group.

CONCLUSION

In this study, one-third of full-term children born SGA developed short stature during early childhood. Low birth weight, maternal short stature, low socioeconomic status, limited breastfeeding duration, and recurrent infections were the most significant contributors. These findings emphasize the need for early identification of at-risk children and targeted interventions focusing on maternal health, improved infant feeding practices, and infection control. Strengthening public health measures to address poverty and nutrition could play a vital role in reducing the long-term burden of stunting in children born SGA.

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