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# NUTRITIONAL DEFICIENCIES AND GROWTH DELAYS IN CHILDREN UNDER FIVE ATTENDING PUBLIC HEALTH CLINICS IN LOW-INCOME AREAS

*Original Article*

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## ABSTRACT

**Background:** Undernutrition remains a leading cause of growth impairments among children under five, particularly in low-income regions. Micronutrient deficiencies, such as anemia and zinc deficiency, contribute significantly to stunting and wasting, further exacerbated by poverty, poor feeding practices, and limited access to healthcare. South Punjab, a socioeconomically challenged region in Pakistan, continues to report high rates of child malnutrition, yet limited community-based data exist to guide interventions.

**Objective:** To examine the association between nutritional deficiencies and growth impairments among children under five attending public health clinics in low-income areas of South Punjab.

**Methods:** A cross-sectional study was conducted from May to September 2023 across selected public health clinics. A total of 355 children aged 6–59 months were enrolled through systematic random sampling. Data were collected via structured caregiver interviews, anthropometric assessments (height-for-age, weight-for-age, weight-for-height, and MUAC), and biochemical tests (hemoglobin and serum zinc levels). Growth status was evaluated using WHO Child Growth Standards. Logistic regression was performed to identify factors independently associated with stunting, adjusting for sociodemographic confounders.

**Results:** Stunting was observed in 34.4% of children, wasting in 25.1%, and underweight status in 29.6%. Anemia and zinc deficiency were present in 47.3% and 39.2% of participants, respectively. Multivariable analysis showed that anemia (AOR 2.14; 95% CI: 1.35–3.39), low MUAC (AOR 1.89; 95% CI: 1.17–3.06), zinc deficiency (AOR 1.74; 95% CI: 1.04–2.91), and low household income (AOR 1.96; 95% CI: 1.15–3.33) were independently associated with stunting.

**Conclusion:** Nutritional deficiencies are strongly linked to growth delays in under-five children living in underserved settings. Routine nutritional screening and targeted supplementation should be prioritized within public health strategies to improve child health outcomes.

**Keywords:** Anemia, Child Nutritional Status, Growth Disorders, Malnutrition, Micronutrient Deficiencies, Public Health, Stunting.

## INTRODUCTION

In many low-income settings, the first years of a child's life unfold under the shadow of nutritional inadequacy and socioeconomic hardship (1). These early years—crucial for physical, cognitive, and emotional development—are often marked by chronic undernutrition, which can lead to irreversible growth delays (2). Among children under five, who represent one of the most nutritionally vulnerable groups, growth impairments such as stunting and wasting are not only alarmingly prevalent but also deeply intertwined with poor dietary intake, recurrent infections, and systemic poverty (3). This study sets out to explore this relationship by examining the link between nutritional deficiencies and growth delays among children attending public health clinics in underserved communities (4). A child's growth trajectory is closely tied to their nutritional status, particularly during the first 1,000 days of life (5). Malnutrition—manifesting in forms such as underweight, wasting, stunting, and micronutrient deficiencies—can leave a lasting imprint on a child's health and developmental potential (6). Evidence from multiple studies confirms that children living in poverty-stricken areas are disproportionately affected (7). In a large-scale study conducted in rural China, nearly half of the children surveyed were found to be anaemic, and significant proportions showed developmental delays in both cognitive and psychomotor domains, with strong associations between low haemoglobin levels and impaired development (8).

Similarly, a cross-sectional analysis of slum-dwelling children under five reported that socioeconomic disadvantages—such as large family size, food insecurity, and poor environmental hygiene—were core contributors to poor nutritional status and delayed growth (9). These children not only had higher rates of stunting and underweight but also showed more frequent infections and slower developmental progress (10). Comparable patterns have been observed in Brazil's urban low-income settlements, where intra-community disparities further compound the problem, leaving certain subgroups of children—especially males, those with low birth weight, or those not breastfed—at a higher risk of stunted growth (11). Further insights come from international comparative research which highlights the compounded risk of undernutrition among children already exhibiting cognitive delays (12). Across 47 low- and middle-income countries, children with cognitive impairments were more than twice as likely to be severely underweight or stunted compared to their peers without such delays (13). Household income level emerged as the most consistent predictor of undernutrition among these children (14). This indicates a reinforcing cycle, where undernutrition leads to developmental deficits, which in turn make children more susceptible to further nutritional neglect (15). The biochemical footprint of nutritional deficiency is equally telling. In a study from Paris, children with marginal growth delays had significantly lower serum levels of albumin, zinc, and insulin-like growth factor-I, all of which are essential markers of nutritional adequacy and physical growth. These findings suggest that even "healthy"-appearing children from low-income backgrounds may be suffering from subclinical malnutrition, leading to cumulative deficits in both height and weight gain over time. Environmental and behavioral factors further exacerbate this issue. Feeding practices such as lack of breastfeeding, poor dietary diversity, and unresponsive caregiver-child interactions during meals have all been associated with suboptimal nutritional outcomes. Responsive feeding, although gaining traction as a potential protective factor, still lacks sufficient intervention-based evidence in low-resource settings, though some studies suggest it may promote better dietary intake and food acceptance among infants (16).

Despite increasing global awareness, interventions remain unevenly distributed, often bypassing the poorest families who stand to benefit the most (17). Community-based programs, such as the Massachusetts Growth and Nutrition Program, have demonstrated significant improvements in anthropometric measures through multidisciplinary interventions—yet such models are rarely implemented at scale in low-income nations. This underscores the urgency of developing scalable, culturally tailored strategies that integrate health services, nutritional education, and social support systems (17). Given the strong and consistent link between nutritional inadequacy and impaired growth outcomes, especially among children in under-resourced communities, the stakes for early intervention are high. Beyond the immediate health implications, poor growth in early childhood is a well-established predictor of poor educational achievement, lower productivity in adulthood, and the perpetuation of poverty across generations (18). This study therefore seeks to contribute to this critical discourse by examining the prevalence and nature of nutritional deficiencies and their relationship to growth delays in children under five who attend public health clinics in low-income areas. By focusing on this underserved population through a cross-sectional lens, the study aims to identify not only the nutritional gaps but also the socio-environmental patterns that may drive them. The ultimate objective is to generate actionable insights that can inform policy interventions and healthcare practices targeting vulnerable child populations in similar settings.

 

## METHODS

This cross-sectional study was conducted over a six-month period from May 2023 to September 2023 in selected public health clinics situated in low-income, underserved areas of South Punjab, Pakistan. The primary aim was to investigate the association between nutritional deficiencies and growth impairments in children under the age of five. Given the socioeconomic and infrastructural disparities within this region, the study was designed to capture a representative picture of pediatric nutritional and growth status in resource-constrained settings. To ensure adequate power for detecting a statistically significant relationship between nutritional status and growth outcomes, the sample size was calculated using standard prevalence estimation formulas for cross-sectional studies. Assuming a 30% prevalence of stunting based on regional public health reports, a confidence level of 95%, and a margin of error of 5%, the minimum required sample size was estimated at 323 children. To account for potential non-responses and data loss, a 10% buffer was added, resulting in a final target sample size of 355 children. A multistage sampling technique was employed, starting with the purposive selection of public health clinics serving the most socioeconomically disadvantaged populations. Within each clinic, systematic random sampling was used to recruit participants.

Children aged between 6 months and 59 months who were attending outpatient services at selected clinics were considered eligible. Inclusion criteria comprised children whose caregivers consented to participate and who had no known chronic or congenital conditions that independently affect growth (e.g., cerebral palsy, congenital heart disease). Exclusion criteria included children who were acutely ill at the time of examination or those with incomplete clinical records or anthropometric data. Written informed consent was obtained from the parents or primary caregivers after explaining the purpose, procedures, and voluntary nature of the study in the local language. Data collection involved structured caregiver interviews, anthropometric measurements, and clinical assessments. A pretested, interviewer-administered questionnaire was used to collect demographic data (child's age, sex, family size, parental education, and income), feeding history (breastfeeding practices, dietary diversity, meal frequency), and recent morbidity episodes. Nutritional status was assessed using both anthropometric and biochemical indicators. Standardized protocols were followed to measure weight (using digital baby scales, ±100g accuracy), height/length (using length boards or stadiometers, ±0.1cm), and mid-upper arm circumference (MUAC) using non-stretchable MUAC tapes. All anthropometric measurements were taken in triplicate and averaged for accuracy. Growth impairments were evaluated using WHO Child Growth Standards. Stunting was defined as height-for-age Z-score (HAZ) < -2 SD, wasting as weight-for-height Z-score (WHZ) < -2 SD, and underweight as weight-for-age Z-score (WAZ) < -2 SD. Nutritional deficiencies were assessed through capillary blood sampling to measure hemoglobin levels for anemia and serum zinc using atomic absorption spectrometry. Hemoglobin levels below 11.0 g/dL were considered indicative of anemia. Additional assessments for vitamin A and D were not performed due to budget constraints.

The primary outcome was the presence of growth impairment (stunting, wasting, or underweight), and the main exposure variable was nutritional deficiency (as indicated by anemia or low MUAC). Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were reported as means and standard deviations, while categorical variables were expressed as frequencies and percentages. To test for associations between nutritional deficiencies and growth outcomes, chi-square tests were applied for categorical variables. Independent samples t-tests were used to compare means of continuous variables between children with and without growth impairments. For multivariable analysis, binary logistic regression was employed to adjust for potential confounders such as age, gender, maternal education, and household income. The outcome variable for the regression model was stunting (yes/no), and adjusted odds ratios (AORs) with 95% confidence intervals were reported. Prior to applying parametric tests, data distribution was assessed for normality using Shapiro-Wilk tests and visual inspection of histograms and Q-Q plots. Since the data met assumptions of normal distribution, no transformation was required. Data were entered and managed using EpiData version 3.1 and analyzed using SPSS version 26. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant. To ensure data quality, double data entry was conducted, and periodic audits were carried out by the principal investigator. Calibration of equipment was performed weekly, and inter-rater reliability among data collectors was maintained through ongoing training and supervision. The methodological approach in this study ensures a robust analysis of the relationship between poor nutrition and growth delay, considering both anthropometric and biochemical parameters within a statistically sound framework. This strategy allows for reproducibility in similar low-resource settings and contributes valuable insights to targeted pediatric health interventions in South Punjab.

## RESULTS

Among the 355 children enrolled in the study, the mean age was 28.6 ± 15.2 months, with a slightly higher representation of males (53.5%). A significant proportion of households reported monthly incomes below PKR 25,000 (67.9%), and the majority of mothers had

 

no education beyond primary school (77.7%). Exclusive breastfeeding for less than six months was noted in 60.0% of the sample population. Anthropometric assessment revealed that 34.4% of children were stunted (HAZ < -2 SD), 25.1% were wasted (WHZ < -2 SD), and 29.6% were underweight (WAZ < -2 SD). Additionally, 27.3% of children presented with a mid-upper arm circumference (MUAC) less than 12.5 cm, indicative of acute malnutrition. The prevalence of stunting increased notably with child age, whereas wasting was more common in younger children.

Biochemical analysis showed that 47.3% of the children were anaemic (Hb < 11.0 g/dL). Serum zinc deficiency was identified in 39.2% of cases. These deficiencies often co-occurred, and the majority of affected children had either one or both deficiencies, with only 13.5% of the total sample free from both anemia and zinc deficiency. Figure 1 visually represents the prevalence of growth impairments, while Figure 2 illustrates the distribution of major nutritional deficiencies. Logistic regression analysis was conducted to identify factors independently associated with stunting. Children with anemia had more than twice the odds of being stunted compared to non-anemic children (AOR: 2.14, 95% CI: 1.35–3.39, p = 0.001). Similarly, low MUAC values were significantly associated with stunting (AOR: 1.89, 95% CI: 1.17–3.06, p = 0.009). Zinc deficiency also emerged as a significant risk factor (AOR: 1.74, 95% CI: 1.04–2.91, p = 0.035). In terms of socio-economic influence, children from households earning less than PKR 25,000 monthly were significantly more likely to be stunted (AOR: 1.96, 95% CI: 1.15–3.33, p = 0.014).

No significant gender differences were found in the rates of undernutrition, but children above the age of 36 months exhibited a higher likelihood of stunting and anemia. There was also a notable association between early cessation of breastfeeding and higher rates of both wasting and underweight status, although this was not statistically tested in the final regression model. The results collectively demonstrate a high burden of both nutritional deficiencies and growth impairments among children attending public health clinics in low-income areas of South Punjab. The tables and charts provided illustrate the magnitude of these outcomes and their associations with key nutritional and socioeconomic variables

**Table 1: Demographic Characteristics**

| Demographics | Value |
|---|---|
| Age (months), mean Â± SD | 28.6 Â± 15.2 |
| Gender (Male), n (%) | 190 (53.5%) |
| Household income < PKR 25,000, n (%) | 241 (67.9%) |
| Mother's education (Primary or below), n (%) | 276 (77.7%) |
| Exclusive breastfeeding <6 months, n (%) | 213 (60.0%) |

**Table 2: Anthropometric Indicators**

| Indicator | Frequency, n (%) |
|---|---|
| Stunting (HAZ < -2 SD) | 122 (34.4%) |
| Wasting (WHZ < -2 SD) | 89 (25.1%) |
| Underweight (WAZ < -2 SD) | 105 (29.6%) |
| MUAC < 12.5 cm | 97 (27.3%) |

**Table 3: Biochemical Nutritional Deficiencies**

| Indicator | Frequency, n (%) |
|---|---|
| Anemia (Hb < 11.0 g/dL) | 168 (47.3%) |
| Serum Zinc Deficiency | 139 (39.2%) |

**Table 4: Logistic Regression Analysis for Stunting**

| Variable | Adjusted OR (95% CI) | p-value |
|---|---|---|
| Anemia | 2.14 (1.35–3.39) | 0.001 |
| Low MUAC | 1.89 (1.17–3.06) | 0.009 |
| Zinc Deficiency | 1.74 (1.04–2.91) | 0.035 |
| Household Income < PKR 25,000 | 1.96 (1.15–3.33) | 0.014 |

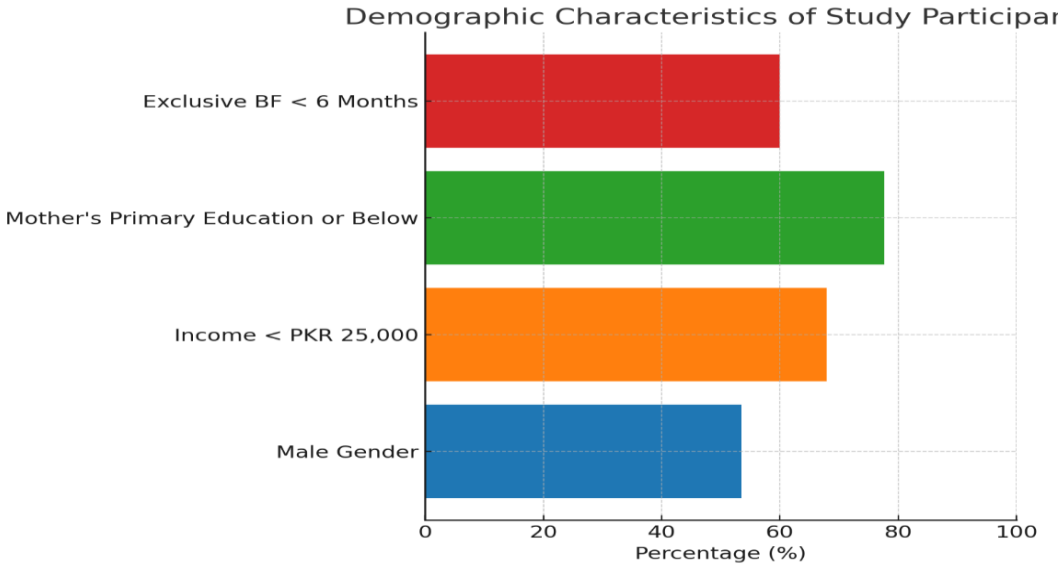


*Figure 1 Demographic Characteristics of Study Participants*

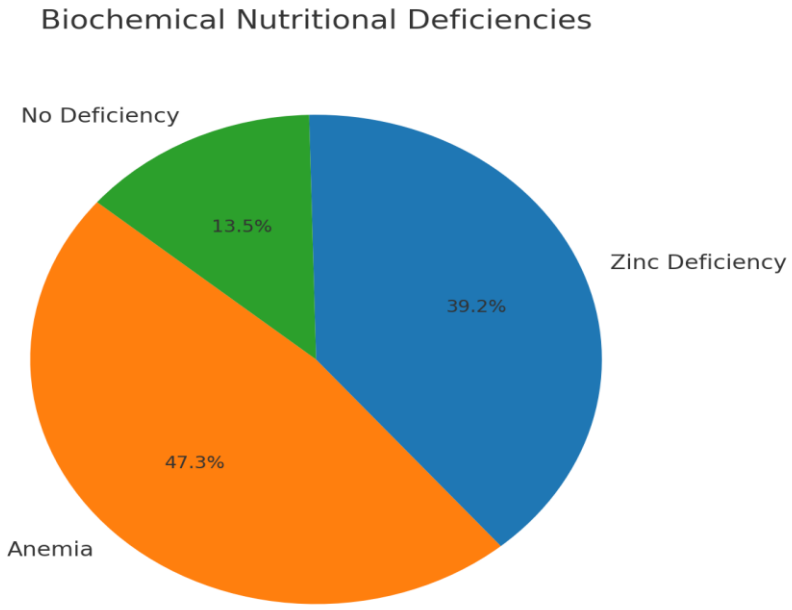


*Figure 2 Biochemical Nutritional Deficiencies*

 

## DISCUSSION

The findings of this study emphasize the substantial burden of nutritional deficiencies and growth delays among children under five years residing in low-income areas of South Punjab. These outcomes are consistent with previous research conducted in similar low-resource environments, reinforcing the interconnected nature of poverty, undernutrition, and developmental setbacks during early childhood (19). The observed prevalence of stunting (34.4%), wasting (25.1%), and underweight status (29.6%) underscores the persistent challenge of chronic and acute malnutrition in this population. These figures align with global estimates reported by UNICEF, which note that in 2021, approximately 22% of children under five globally were stunted, with a higher concentration in South Asia and Sub-Saharan Africa. Moreover, the anemia rate of 47.3% observed in this study mirrors findings from rural China, where Luo et al. found nearly half of infants aged 6–12 months were anemic, with strong associations between low hemoglobin levels and delayed cognitive and motor development (20). Zinc deficiency, noted in 39.2% of participants, also emerged as a significant contributor to growth retardation, consistent with findings by Almahmoud et al. (2024) in a Kuwaiti cohort of children with chronic illness, where micronutrient deficiencies were strongly linked to stunting and low weight-for-age scores. These biochemical deficits, when coupled with anthropometric impairments, reflect a complex interplay of inadequate dietary intake, poor absorption, and frequent infections that commonly afflict children in impoverished households (21).

Importantly, the regression analysis demonstrated that anemia, low MUAC, and zinc deficiency were all independently associated with increased odds of stunting, even after adjusting for socio-demographic variables. This finding supports similar conclusions from Emerson et al. (2019), who noted that children with cognitive delays in low-income countries were significantly more likely to be exposed to undernutrition, particularly when household wealth was limited (22). The socioeconomic dimension was particularly striking in this study, as children from households earning less than PKR 25,000 per month had nearly twice the odds of being stunted. This aligns with Sharma's (2011) evaluation of slum children in India, where low income, poor environmental sanitation, and inadequate maternal education were identified as key predictors of poor growth outcomes (23). One notable strength of this study lies in its use of both anthropometric and biochemical tools to comprehensively assess nutritional status, offering a nuanced understanding of malnutrition beyond simple weight and height metrics. The inclusion of validated WHO growth standards and laboratory-confirmed micronutrient deficiencies enhances the reliability of the findings and allows for meaningful comparisons with global data (24). Nevertheless, several limitations must be acknowledged. The cross-sectional design limits causal inference, and the reliance on clinic-based sampling may introduce selection bias, potentially excluding children with limited access to healthcare services. Additionally, the study did not assess other critical micronutrients such as vitamin A, iodine, or iron-binding capacity, which could further elucidate the complexity of nutritional deprivation. Also, dietary intake was self-reported by caregivers, introducing potential recall bias. These methodological constraints, while inherent to many field-based studies in low-resource settings, warrant careful consideration when generalizing results (25).

Despite these limitations, the study contributes significantly to the growing body of literature highlighting the urgent need for targeted nutritional interventions in underserved communities. It reaffirms the importance of integrated child health strategies that address not only food access but also maternal education, poverty alleviation, and micronutrient supplementation. Future research should explore longitudinal patterns of nutritional recovery and growth in response to specific community-based interventions, particularly those involving micronutrient fortification, cash transfer programs, or maternal behavior change initiatives. A deeper examination of feeding practices, infection history, and maternal nutritional status could offer additional insight into the intergenerational nature of malnutrition. Moreover, randomized controlled trials are needed to test the efficacy of integrated models of care that combine clinical, nutritional, and social support for young children in resource-constrained environments (26). In summary, this study reinforces the deep-rooted association between nutritional deficiencies and growth impairments in children under five living in low-income settings (27). The data underline the critical importance of early identification, targeted supplementation, and policy-level investment in maternal-child health to break the cycle of poverty and undernutrition (28).

## CONCLUSION

This study highlights the significant association between nutritional deficiencies—particularly anemia and zinc deficiency—and growth impairments such as stunting and wasting among children under five in low-income areas of South Punjab. The findings underscore the urgent need for integrated nutritional screening, targeted supplementation, and socioeconomic support within primary healthcare settings to combat early childhood undernutrition and its long-term consequences on health and development.

 

**AUTHOR CONTRIBUTION**

| Author | Contribution |
|---|---|
| Uswa Laraib Amjad | Substantial Contribution to study design, analysis, acquisition of Data<br>Manuscript Writing<br>Has given Final Approval of the version to be published |
| Ajeet Kumar / Sahil | Substantial Contribution to study design, acquisition and interpretation of Data<br>Critical Review and Manuscript Writing<br>Has given Final Approval of the version to be published |
| Amir Muhammad* | Substantial Contribution to acquisition and interpretation of Data<br>Has given Final Approval of the version to be published |
| Musab Bin Zubair | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |
| Sumble Ali Khan | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |
| Hafsa Malik | Hafsa Malik Substantial Contribution to study design and Data Analysis<br>Has given Final Approval of the version to be published |
| Maheen Rafique | Contributed to study concept and Data collection<br>Has given Final Approval of the version to be published |
| Vaneeza Iftikhar | Writing - Review & Editing, Assistance with Data Curation |

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