

Original Article in Psychology

Socioeconomic determinants of child health in urban slums of Bangladesh: A cross-sectional analysis of BMI and associations with parental education, poverty, occupation, and maternal age at birth

Sharmistha ROY^{1,5*}, Ashis Kumar BISWAS², Provakar ROY³, Jinuk PURKAYASTHA⁴, Nirmeen Refat KHAN⁵, Manoj SHARMA^{1,6}

Affiliations:

¹Department of Social and Behavioral Health. School of Public Health. University of Nevada, Las Vegas, USA. E-mail: roys5@unlv.nevada.edu. **ORCID:** 0009-0000-2691-938X

²Department of Epidemiology and Biostatistics. School of Public Health. University of Nevada, Las Vegas, USA. E-mail: biswaa1@unlv.nevada.edu **ORCID:** 0000-0003-1386-0838

³Upazila Health Complex, Tahirpur, Sunamganj, Bangladesh. E-mail: royprovakar991@gmail.com

⁴Jointapur Upazila Family Planning Office, Sylhet, Bangladesh. E-mail: purkayasthajinuk@gmail.com

⁵Department of Community Medicine, NIPSOM, Dhaka. E-mail- nirmeenkhan1971@gmail.com

⁶Department of Internal Medicine. Kirk Kerkorian School of Medicine at UNLV. University of Nevada, Las Vegas, USA. manoj.sharma@unlv.edu. **ORCID:** 0000-0002-4624-2414

Abstract

Background: Malnutrition in children is still a significant public health concern in Bangladesh, especially for underprivileged groups living in tea garden communities and urban slums. Socioeconomic factors, including maternal age at childbirth, parental education, family income, and parental occupation, have a significant influence on child nutritional outcomes. Socioeconomic factors, including maternal age at childbirth, parental education, family income, and parental occupation, have a significant influence on nutritional outcomes for children.

Objective: The purpose of this study was to determine the body mass index (BMI) distribution among children aged 1 to 5 in several tea garden areas in Sylhet, Bangladesh, and to investigate the relationships between BMI and important socioeconomic variables.

Methods: A cross-sectional survey was conducted in 2023 among 330 children residing in the tea gardens of Daldali, Lakkatura, and Malnicherra. Standardized WHO methods were employed to obtain anthropometric measures, and structured interviews with parents were conducted to gather socioeconomic data. Python was used to perform statistical analyses, including group comparisons, descriptive statistics, and correlation evaluations, to examine the relationships between socioeconomic factors and BMI.

Results: The mean BMI of participating children was 15.16 kg/m² (SD 3.85), indicating a high prevalence of undernutrition, alongside a small proportion exhibiting overweight status. Over 80% of households reported monthly incomes of less than 7,000 BDT, and approximately half of the mothers had no formal education. Higher parental education levels and household income were positively associated with child BMI. Furthermore, children of non-working mothers had somewhat higher BMIs, which may indicate a connection to more time spent providing care. Lower BMI values in children were linked to early maternal age at childbirth, which is common in this group.

Discussion: The findings highlight how intersecting socioeconomic factors impact child nutrition. Combating undernutrition in Bangladesh requires addressing poverty, promoting maternal education, and ensuring stable livelihoods.

Take-home message: Undernutrition is common among young children in Sylhet's tea-garden communities. Low income, limited maternal education, and early childbirth are key predictors of

poor growth. In contrast, educated, better-paid parents and caregiving mothers support healthier BMI. Addressing malnutrition requires integrated efforts in poverty reduction, maternal education, and sustainable livelihoods.

Keywords: Child malnutrition, Socioeconomic Factors, determinants, Body Mass Index, Poverty.

Cite this paper as: Roy S, Biswas AK, Roy P, Purkayastha J, Khan NR, Sharma M. Socioeconomic determinants of child health in urban slums of Bangladesh: A cross-sectional analysis of BMI and associations with parental education, poverty, occupation, and maternal age at birth. *J Health Soc Sci*. 2025;10(3):277-291. Doi: 10.19204/2025/SCCN3

Received: 10 May 2025; Accepted 12 August 2025; Published: 15 September 2025

INTRODUCTION

Malnutrition remains a critical public-health emergency. In 2024, about 150 million children under five were stunted, 42.8 million were wasted, and 35.5 million were overweight, together representing more than one in five children worldwide [1-3]. Undernutrition alone is implicated in roughly 45 % of all child deaths, while poor or imbalanced diets place almost one-quarter of the world's children at risk of irreversible developmental harm [2,4]. Although the global prevalence of stunting has fallen from 39.6 % in 1990 to 23.2 % in 2015, wasting has remained stubbornly high, and childhood overweight is rising, especially in low- and middle-income countries [2,4].

Bangladesh has achieved steady but uneven progress. Stunting declined from 51% in 2004 to 28% in 2022, while wasting has remained relatively stable at around 9%, and underweight remains at approximately 22% [1,5]. Urban-rural and regional gaps persist. Slum children in Dhaka face stunting rates exceeding 40 %, and Sylhet Division reports 36–43 % stunting, especially in tea-garden communities [1,6]. Over half of urban residents now reside in informal settlements that lack access to safe water, sanitation, and reliable health services [3].

Child nutrition is tightly linked to parental education, household income, parental occupation, and maternal age at childbirth [5,7]. Nearly one-fifth of Bangladeshis still live below the national poverty line, with even higher poverty in slums and tea gardens [8]. Mothers working long hours in informal jobs, limited schooling, and high teenage pregnancy rates (28 % of women aged 20–24 gave birth before 18) all worsen nutritional outcomes [9,10].

The body-mass index (BMI) is a practical composite indicator for children aged 1–5 years, capturing both wasting and emerging overweight in resource-constrained settings [11,12]. Analyzing BMI alongside socio-economic variables reveals how poverty translates into undernutrition and where interventions, such as poverty reduction, girls' education, delayed motherhood, and improved livelihoods, can be targeted most effectively.

Study objectives

The tea garden communities in Bangladesh are a combination of several vulnerabilities, including low parental education, early marriage and childbearing, deep-seated poverty, and reliance on precarious informal labor. Although numerous studies have been conducted on the nutrition of children in both rural and urban areas, a significant information gap remains regarding children living in semi-urban tea garden villages. The few existing studies focus predominantly on stunting or wasting, with minimal exploration of BMI as a composite indicator or the complex interplay of socioeconomic determinants.

The study aimed to evaluate the influence of maternal age at childbirth, parental education, occupation, and income on the BMI and health condition of the child, combining anthropometric measurements with a thorough socioeconomic profile. Global demands for multi-sectoral data to inform the formulation of effective policies and interventions align with this integrated approach [1], [2]. In addition, this study aims to fill these gaps by focusing on three major tea garden areas in Sylhet Sadar Upazila: Daldali, Malnicherra, and Lakkatura. Moreover, it aimed to investigate how parental

education, income, maternal age at childbirth, occupation, and their collective influence on child BMI and health status, by integrating anthropometric assessments with detailed socioeconomic profiling. This integrated approach aligns with global calls for multi-sectoral data to guide effective policy and intervention design [1,2].

The specific objectives of this study were:

1. To describe the distribution of BMI among children aged 1-5 years in selected tea garden communities in Sylhet.
2. To examine associations between child BMI and key socioeconomic factors, including parental education, parental occupation, household income, and maternal age at childbirth.

METHODS

Study design and setting

This cross-sectional study was conducted to assess the nutritional status of children aged 1 to 5 years residing in selected tea garden communities of Sylhet, Bangladesh. The study took place in 2023 within three specific tea gardens: Daldali, Lakkatura, and Malnicherra, located in Sylhet Sadar Upazila. These sites were purposefully selected due to their accessibility and representativeness of tea garden populations in northeastern Bangladesh, an area characterized by long-standing socioeconomic marginalization and health inequities.

Study population and sampling

The target population consisted of children aged 12 to 60 months residing permanently within the selected tea garden communities. Inclusion criteria required children to fall within this age range and have guardians willing to provide informed consent. Exclusion criteria included children with severe medical disorders affecting growth, those outside the age range, and families unwilling to participate.

The sample size was initially calculated to be 384, using Cochran's formula with a 5% margin of error and an assumed prevalence of 50% for malnutrition to maximize variability. However, due to time and logistical constraints, the final sample comprised 330 children. Participants were recruited through purposive sampling with assistance from local health workers and community leaders to ensure community trust and facilitate household engagement.

Data collection

Data collection was conducted through face-to-face interviews with parents or primary caregivers using a pretested, semi-structured questionnaire developed based on existing validated tools used in child nutrition surveys in Bangladesh. The questionnaire captured demographic details, family composition, parental education and occupation, household income, maternal age at childbirth, and child feeding and health practices.

Anthropometric measurements included weight, height, and mid-upper arm circumference (MUAC). Weight was measured to the nearest 0.1 kg using a calibrated digital scale; height was measured to the nearest 0.1 cm using a portable stadiometer, and MUAC was measured using a non-stretchable measuring tape. All measurements were conducted according to WHO standardized protocols to ensure accuracy and reproducibility. Caregivers were advised on the appropriate clothing and positioning for children during measurements.

Data management and processing

Following data collection, the raw data were reviewed and manually cleaned to verify completeness, internal consistency, and the presence of outliers. Anthropometric indices, including weight-for-age, height-for-age, and BMI, were calculated using WHO 2006 growth standards. Undernutrition was defined by using a z-score cutoff of less than -2 for relevant indices. Outliers, identified as extreme deviations unlikely to represent true measurements, were excluded to maintain data integrity.

Statistical analysis

All analyses were performed using Python 3, ensuring flexibility and transparency through the use of Jupyter Notebooks. The pandas library was used for data manipulation, while seaborn and

matplotlib were employed for generating publication-quality visualizations. Statistical tests were conducted using the scipy library.

Descriptive statistics, including means, standard deviations, and ranges, were calculated for continuous variables (e.g., age, height, weight, and BMI). Frequencies with percentages were used for categorical variables (e.g., parental education level, occupation categories, and income groups).

Histograms and kernel density plots illustrated distribution patterns of anthropometric indicators. Inferential statistics included independent samples t-tests to compare mean BMI and other anthropometric measures across sex and family structure categories, with statistical significance defined at $p < 0.05$. Pearson correlation coefficients were calculated to examine linear associations among continuous variables such as child age, height, weight, and BMI. A correlation matrix was visualized using heatmaps to aid interpretation.

Stratified analyses assessed BMI distributions by parental education and occupation groups using boxplots and regression plots. Household income was analyzed both as a categorical and continuous variable to explore its relationship with child BMI. Income trends were illustrated with grouped bar plots and regression lines, revealing systematic variations in nutritional outcomes. This integrative analytical approach enabled a nuanced understanding of how socioeconomic determinants interact to shape child health outcomes in tea garden communities. Ethical approval for the study was obtained from the Ethical Review Board of Dhaka Medical College at May 14, 2022. Written informed consent was secured from all participating parents or legal guardians prior to data collection. Confidentiality and anonymity were strictly maintained; personal identifiers were excluded from analysis and reporting. Participants were informed of their right to withdraw from the study at any point without repercussion. The study adhered to the Declaration of Helsinki guidelines and respected all ethical standards for research involving human subjects.

RESULTS

Descriptive characteristics

A total of 330 children aged 12-60 months were included in this study from three tea garden communities in Sylhet Sadar Upazila, Bangladesh. The mean age of the children was 3.81 years (SD 1.12), with a range of 1 to 5 years. The average family size was 4.14 members (SD 1.00), with households ranging from 3 to 6 members. Anthropometric measurements showed substantial variability. Mean height was 93.1 cm (SD 14.4; range 50–124 cm) and mean weight was 13.0 kg (SD 3.7; range 4-28 kg). The mean Body Mass Index (BMI) among the children was 15.16 kg/m² (SD 3.85), with values ranging from a minimum of 8.4 to a maximum of 32.1 kg/m². This wide range of BMI indicates the coexistence of severe undernutrition and a few instances of potential overweight even in this young population. The interquartile range for BMI (25th percentile: 13.10, 75th percentile: 16.45) suggests that most children were clustered at lower BMI values, reflective of undernutrition, while a handful of outliers had high BMIs, suggestive of emerging overnutrition.

Table 1 presents the descriptive characteristics of 330 children and their family-related variables included in the study. The mean age of the children was 3.81 years (SD = 1.12), with a range from 1 to 5 years, indicating that the sample predominantly consisted of preschool-aged children.

Table 1. Descriptive statistics of study participants and child anthropometric characteristics (N = 330).

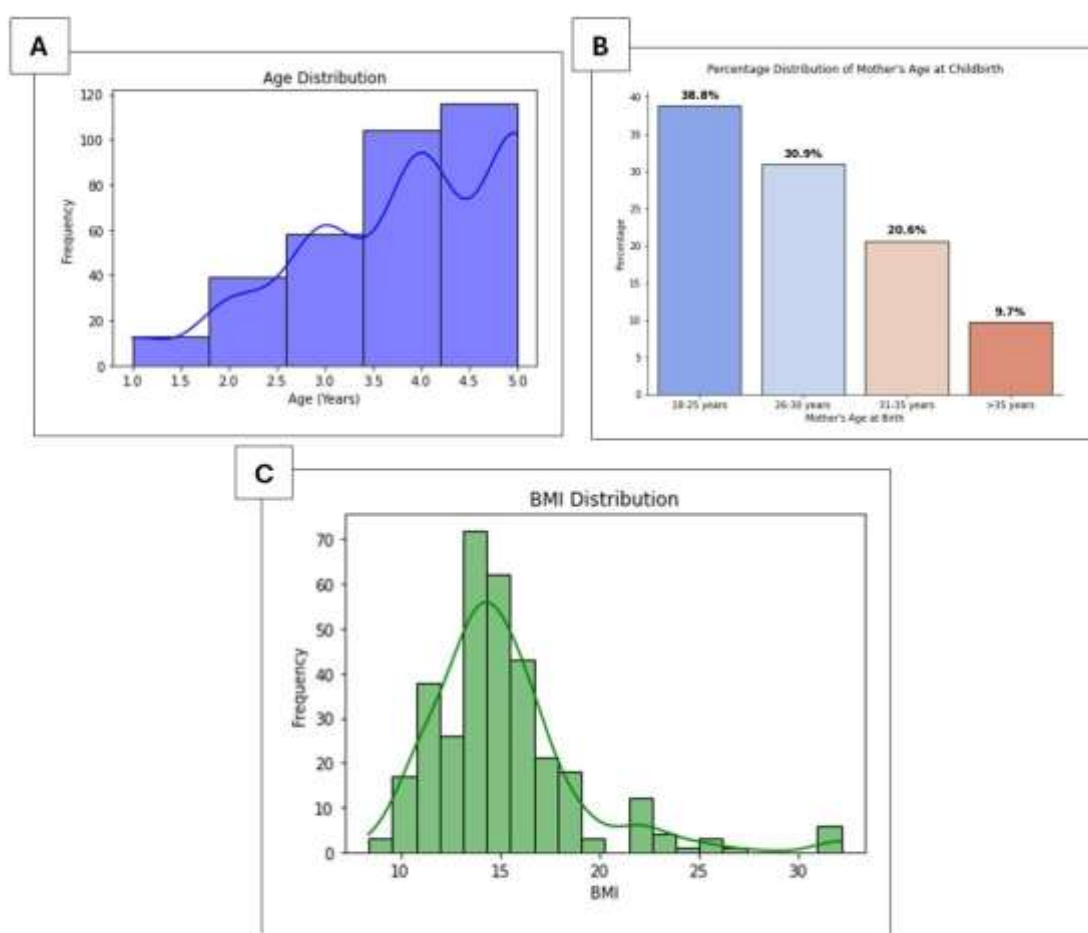
Variable	N	M	SD	Min	25%	Median	75%	Max
Age (years)	330	3.81	1.12	1.0	3.00	4.0	5.00	5.0
Family size	330	4.14	1.00	3.0	3.00	4.0	5.00	6.0
Child height (cm)	330	93.11	14.42	50.0	85.00	96.0	102.00	124.0
Child weight (kg)	330	13.03	3.70	4.0	10.00	13.0	15.00	28.0

Variable	N	M	SD	Min	25%	Median	75%	Max
Child BMI	330	15.16	3.85	8.4	13.10	14.52	16.45	32.14

* Note: M = mean; SD = standard deviation; Min = minimum; Max = maximum; BMI = body mass index

The average family size was 4.14 members (SD = 1.00), with family sizes ranging from three to six members, suggesting moderately sized households within the study population. Regarding anthropometric measurements, the mean child height was 93.11 cm (SD = 14.42), with a range of 50 to 124 cm, while the mean weight was 13.03 kg (SD = 3.70), with a range of 4 to 28 kg. These distributions reflect diverse growth patterns among children. The mean body mass index (BMI) was 15.16 (SD = 3.85), with a minimum BMI of 8.4 and a maximum of 32.14, indicating the presence of both undernutrition and potential overweight cases. The interquartile range (IQR), from the 25th percentile (13.10) to the 75th percentile (16.45), further shows variability in nutritional status. These descriptive statistics provide a comprehensive overview of the demographic and nutritional profiles of the children included in this study, serving as a basis for further inferential analyses.

Figure 1. Distribution of Children's age, mother's age at childbirth, and BMI of participant children **1A.** Age distribution of children aged 1–5 years living in urban slum areas of Dhaka, Bangladesh (N = 330). **1B.** Percentage distribution of mothers' age at childbirth, indicating that early maternal age is predominant in this slum population. Distribution of BMI values among under-five children in urban slum areas of Dhaka, showing a high prevalence of undernutrition.



Age distribution

Figure 1A illustrates the distribution of ages in the sample. The age histogram shows a roughly increasing frequency with age, with the highest concentration of children in the 4–5 year range. In other words, slightly older preschool-aged children were overrepresented in this urban slum cohort, whereas toddlers (particularly those around 1 year old) formed a smaller proportion of the sample. This may indicate that by the later preschool years, more children survive or are available for measurement, or that mothers of older children were more inclined to participate in the survey. The predominance of 4–5-year-olds might also reflect underlying demographic trends or survival biases in impoverished settings, where vulnerability is highest in infancy, and those who reach age 4–5 may represent survivors of early childhood risks.

Maternal age at childbirth

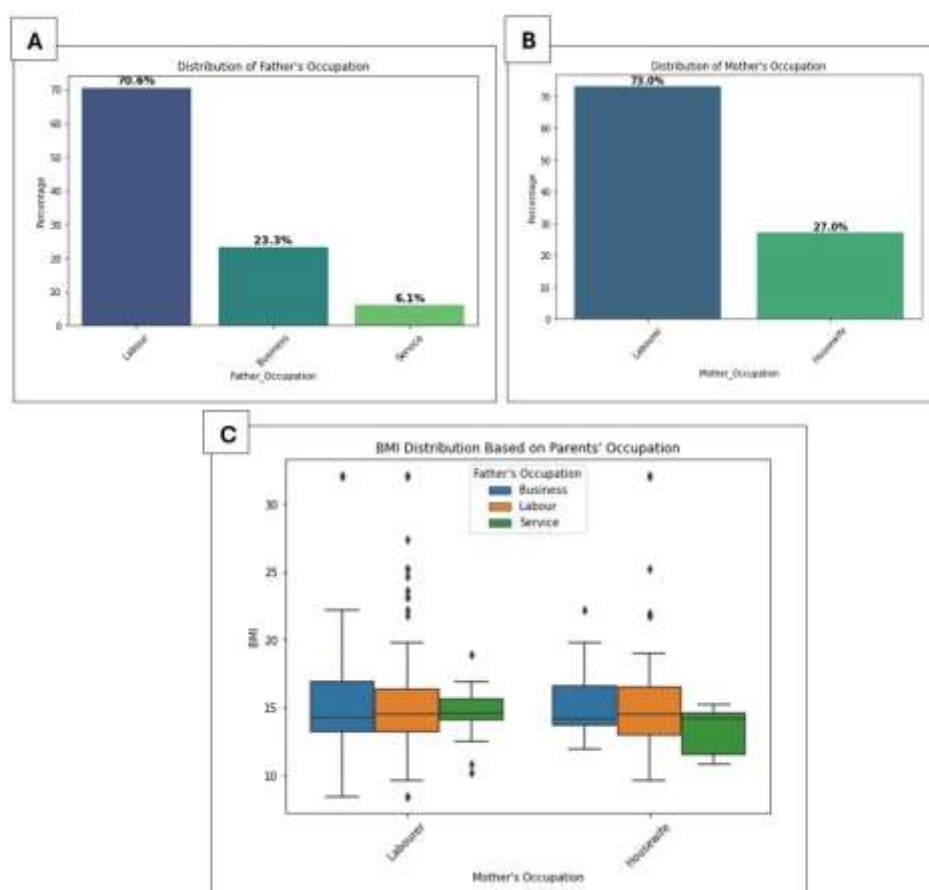
Figure 1B displays the percentage distribution of the mothers' ages at the time of giving birth. Notably, early motherhood was very common in this community. The largest segment of mothers (38.8%) was aged 18–25 years when they gave birth, and an additional 30.9% were aged 26–30 years. About 20.6% were in the 31–35-year range at childbirth, while only 9.7% of mothers were above 35 years old when the child was born. This indicates that a substantial proportion of children were born to young mothers in their late teens or early twenties. Such early maternal age is consistent with prevalent early marriage and childbearing practices in disadvantaged communities. The low proportion of mothers over 35 at childbirth suggests that most women complete childbearing at younger ages, possibly due to socio-cultural norms or health factors. Early maternal age has important implications for child health, as adolescent or very young mothers often face higher risks of adverse birth outcomes and may have less parenting experience, potentially contributing to suboptimal child nutrition and care.

Child BMI distribution

Figure 1C shows the distribution of BMI (kg/m^2) among the children. The histogram, overlaid with a smoothed density curve, reveals a left-skewed pattern. Most children had relatively low BMI values, clustering around a range of roughly 13–15 kg/m^2 . This indicates that underweight and low BMI status were widespread in this sample, aligning with a high burden of undernutrition. The peak of the distribution was below the expected healthy BMI range for well-nourished children of these ages, underscoring chronic nutritional deficits. A smaller tail of the distribution extended to higher BMI values above 20 kg/m^2 ; only a few children had BMIs exceeding 25 or even 30, which are suggestive of overweight or obesity for this age (these could be rare cases or possibly measurement anomalies).

The overwhelming preponderance of low BMI values confirms that undernutrition was the predominant concern in this urban slum population. Nevertheless, the presence of a few high-BMI outliers hints at the dual burden of malnutrition: even within a poor community, alongside many undernourished children, there can exist a minority of overweight children. Such a dual burden is increasingly recognized in transitioning populations. A child can be overweight yet still be malnourished in terms of micronutrient deficiencies or prior stunting. Overall, the BMI distribution observed here is consistent with findings from national surveys and studies in similar settings, which show slum-dwelling children are extremely vulnerable to undernutrition, with underweight and stunting rates often far higher than in non-slum populations.

Figure 2. Child BMI distribution across parents' occupation. **2A.** Distribution of fathers' occupation among study participants. Most fathers were engaged in labor work (70.6%), followed by business activities (23.3%) and service jobs (6.1%). **2B.** Distribution of mothers' occupation among study participants. The majority of mothers worked as laborers (73.0%), while 27.0% reported being housewives. **2C.** Child BMI distribution stratified by parents' occupation. Children's BMI varied across different parental occupation groups, with generally higher median BMI observed in children of parents engaged in business or service occupations compared to laborers.



Parental occupations

Figure 2A and 2B summarize the occupational status of the children's fathers and mothers, respectively. The data demonstrates that most parents worked in informal, labor-intensive jobs. About 70.6% of fathers were engaged in unskilled or semi-skilled labor (such as tea garden laborers, day laborers, rickshaw pullers, etc.), which typically involve low wages and high physical strain. Another 23.3% of fathers were involved in small business or petty trading activities, which represent slightly more stable income sources (for example, small shop owners or vendors). Only a very small fraction (6.1%) of fathers held formal service-sector or skilled jobs. This distribution highlights that most families relied on precarious livelihoods, with limited income security. Low and irregular earnings from daily labor can severely constrain household spending on food, healthcare, and sanitation, thereby impacting child nutrition.

Mothers' employment showed a somewhat similar pattern. As shown in Figure 2B, most mothers (73.0%) also participated in labor or informal work. Many of these women likely worked as tea garden pickers, domestic helpers, or engaged in other informal, small-scale income-generating activities. The remaining 27.0% of mothers identified as housewives who did not report formal employment outside the home. Notably, even those mothers who worked were generally in low-paid informal jobs, often juggling income generation with domestic duties. The dual burden on working mothers who earn an income while also serving as primary caregivers can be immense in such settings. Time and resource constraints on mothers may negatively affect child feeding and care practices, especially if alternative childcare support is lacking.

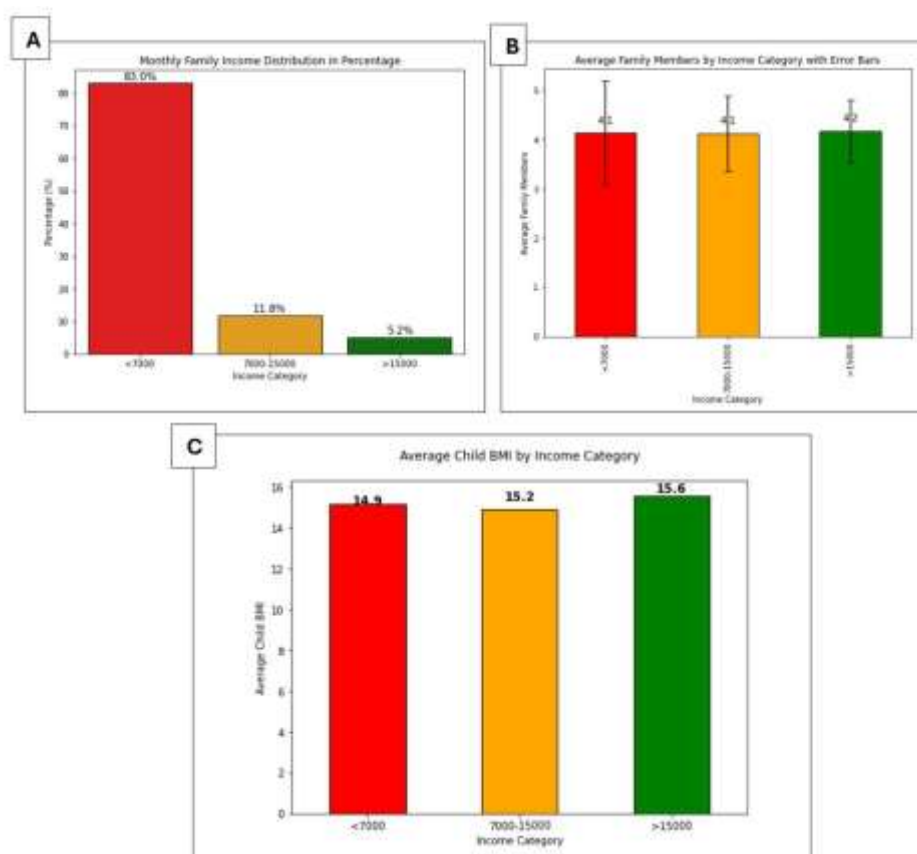
Child BMI by parental occupation

Figure 2C presents boxplots of the children's BMI stratified by fathers' occupation category and mothers' occupation category. These boxplots allow a comparison of the median and variability of child BMI across different occupational backgrounds of parents. Children with fathers in the "business" or "service" category (the relatively better-off jobs) tended to have a slightly higher

median BMI than children whose fathers were laborers. Similarly, children of mothers who were housewives (and thus possibly able to devote more time to childcare) showed marginally higher median BMI compared to children of working mothers in labor-intensive roles. For example, the median BMI of children whose fathers had business/service jobs was slightly higher than that of children of laborer fathers, and the spread (interquartile range) was somewhat narrower, indicating more consistently adequate nutrition in the former group.

However, it is essential to note the considerable overlap in BMI distributions across groups and the presence of outliers. In all occupational categories, some children had very low BMIs, reflecting that many factors beyond occupation influence nutritional status. The subtle upward shift in BMI for children of non-laborer fathers and non-working mothers (housewives) suggests that household socioeconomic stability is associated with better child nutrition. Parents in stable or higher-income occupations are more likely to provide a diverse diet and a healthier environment for their children. Conversely, when both parents are engaged in strenuous, low-paid labor, children may be at a higher risk of undernutrition due to resource constraints and reduced parental time for childcare. Nonetheless, the overlap of the boxplots indicates that occupation alone is not deterministic; it interacts with other factors, such as total income, education, and support systems within the household.

Figure 3. Impact of household income on child BMI. **3A.** Distribution of monthly household income among study participants. A vast majority of households earned less than 7,000 BDT per month, indicating widespread poverty. **3B.** Average family size by household income category. Family sizes were relatively consistent across income groups, though lower-income households faced higher per capita resource constraints. **3C.** Average child BMI by household income category. Children from higher-income households had higher average BMI, reflecting improved nutritional status with increasing economic resources.



Household income levels

Figure 3A shows the distribution of monthly household income among the participating families. The economic profile was heavily skewed toward the lowest income bracket, underscoring widespread poverty in this community. A striking 83.0% of households reported a monthly income of less than 7,000 BDT (Bangladeshi Taka), which is equivalent to roughly USD \$70-80 per month, an extremely low income by any standard, indicating these families lived well below the poverty line. About 11.8% of families fell into a middle-income range of 7,000-15,000 BDT per month, while only 5.2% of households earned above 15,000 BDT monthly. These figures illustrate the severe economic vulnerability faced by slum-dwelling families; the vast majority have very limited financial resources to meet basic needs.

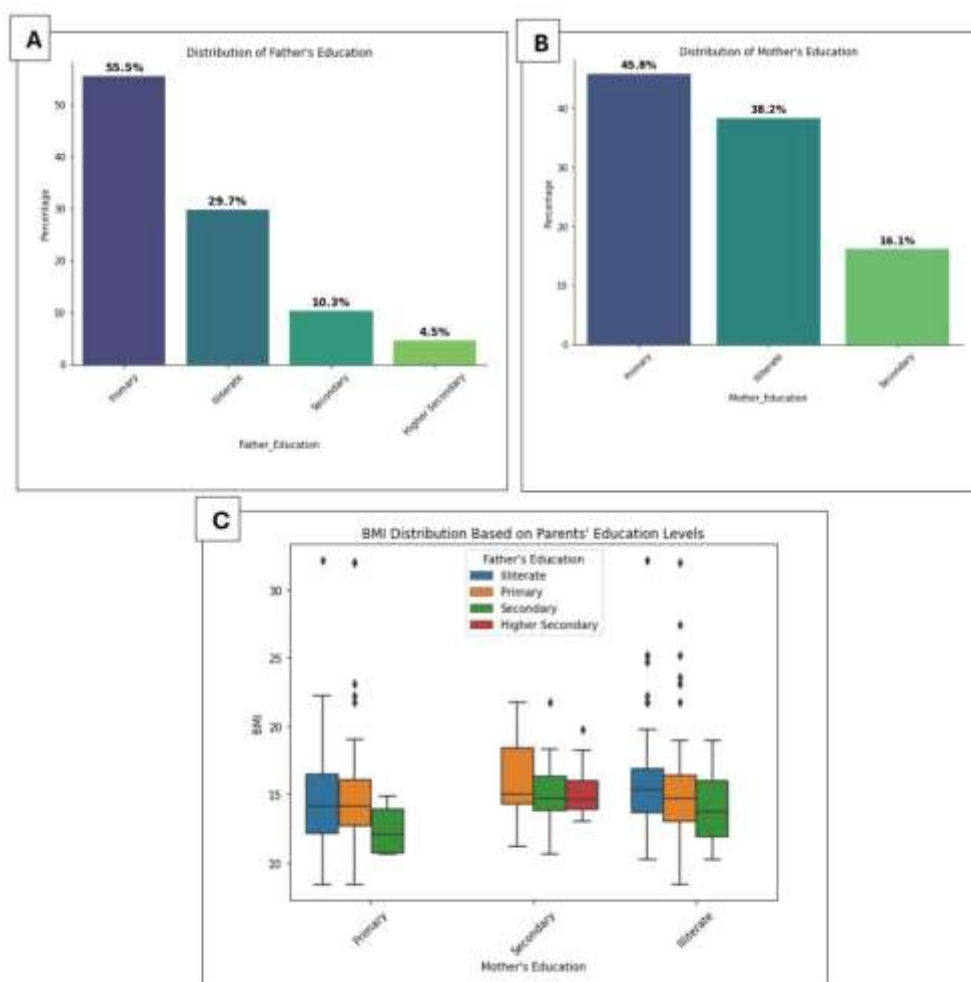
Figure 3B further examines whether household size varied by income level, as larger families might dilute per-capita resources. Interestingly, the average number of family members was relatively consistent across the income groups. Families earning <7,000 BDT had on average ~4.3 members, those in the 7,000-15,000 BDT group averaged ~4.1 members, and the >15,000 BDT group averaged ~4.2 members. The error bars (standard deviations) overlapped substantially, indicating no statistically significant difference in family size by income category. This suggests that family size was not a major differentiator of income in this sample; poorer and slightly better-off households had similar numbers of mouths to feed. The implication is that the per capita resources in low-income families were much lower, since income differed greatly while family size remained comparable. In practical terms, even if a poorer family has only one more child than a richer family, their far lower income means substantially less food and health expenditure available per child.

Child BMI by household income

Figure 3C highlights the relationship between household economic status and child nutritional outcomes by plotting the average child BMI within each income bracket. A transparent positive gradient is observed: children from the poorest households (<7,000 BDT/month) had the lowest mean BMI (approximately 14.9 kg/m²), whereas those from middle-income households (7,000–15,000 BDT) had a slightly higher average BMI (~15.2), and children from the relatively highest-income group (>15,000 BDT) showed the highest average BMI (~15.6). Although the differences in absolute BMI values appear modest, the trend is consistent with expectations that higher household income enables better nutrition. Even a small increase in BMI at the population level can reflect meaningful improvements in weight-for-height or weight-for-age status. In this community, children in the highest income category were, on average, about 0.7 BMI units heavier than those in the lowest category.

This pattern reinforces the critical role of poverty in child malnutrition: inadequate income constrains families' ability to provide sufficient and nutritious food, healthcare, and sanitation, thereby impairing child growth and development. The fact that family size did not differ significantly across income groups (as noted above) means that this BMI improvement is likely attributable to greater resources per child in higher-income families rather than to smaller families. Overall, the income-BMI relationship observed here aligns with broader evidence that economic poverty is associated with poorer child nutritional status, and even slight alleviation of poverty is linked to better child growth outcomes.

Figure 4. Child BMI distribution across parents' education. **4A.** Distribution of fathers' education levels among study participants. A majority of fathers had only a primary education (55.5%), with a substantial portion being illiterate. **4B.** Distribution of mothers' education levels among study participants. Most mothers had a primary education (45.8%), while 38.2% were illiterate, and only 16.1% had a secondary education. **4C.** Child BMI distribution based on parents' education levels. Children of more educated parents generally exhibited higher median BMI values, indicating the influence of parental education on their children's nutritional status.



Parental education levels

Figures 4A and 4B reveal strikingly low schooling among parents in these slum communities. Nearly 30 % of fathers are illiterate, and 55.5 % completed only primary school, leaving just 10.3 % with secondary and 4.5 % with higher-secondary or college education. Approximately 85% never progressed beyond grade 5. Mothers fare even worse: 38.2 % have no schooling, 45.8 % stopped at primary, and only 16.1 % reached secondary, with none attaining higher-secondary or tertiary training. This pervasive parental illiteracy, especially among mothers, limits health knowledge, household decision-making power, and earning potential, underscoring that child-nutrition interventions must confront profound educational deficits alongside poverty.

Child BMI by parental education

Figure 4C reveals a transparent education gradient in child BMI. Children whose parents have attained at least secondary schooling cluster around a higher, tighter median BMI in the mid-15 kg/m² range, while those of illiterate or primary-educated parents center on a lower, more variable band in the low-14 kg/m² range. The lower-education groups also show both very low BMI outliers signaling

severe undernutrition and occasional high BMI outliers, underscoring a double burden of malnutrition across all strata. These patterns underscore that parental education, especially maternal, remains a powerful social determinant of child nutrition, likely through improved health knowledge, feeding practices, and economic opportunities. Even so, education alone cannot fully shield children from undernutrition when poverty, precarious livelihoods, and poor living conditions persist, highlighting the need for integrated interventions that couple schooling gains with broader socioeconomic support.

DISCUSSION

This cross-sectional analysis conducted in Sylhet's tea garden communities reveals a strikingly high prevalence of child undernutrition, strongly shaped by adverse socioeconomic conditions. The study found a mean BMI of approximately 15 kg/m² among children aged 1-5 years, with a large proportion falling below established growth standards. This finding is consistent with prior research indicating that children in urban slums and peri-urban settlements in Bangladesh frequently experience higher rates of stunting and underweight than those in rural or affluent urban areas [6, 13, 14]. National surveys have reported stunting and underweight rates exceeding 40% in slum areas, reflecting profound nutritional inequities [1,5].

Our observation of a few cases of overweight and obesity among children, despite widespread undernutrition, underscores the emerging phenomenon of a double burden of malnutrition. Even within severely deprived settings, shifts in diet quality characterized by increased consumption of low-nutrient, calorie-dense foods can result in concurrent undernutrition and overnutrition [11,15], [16]. This paradox has been documented in other rapidly urbanizing low- and middle-income countries [17], highlighting the need for interventions that address not only caloric sufficiency but also diet diversity and quality.

An additional demographic pattern in our sample was the predominance of older preschool children (aged 4-5 years), with fewer younger children represented. This may reflect a combination of survival bias and caregivers' willingness to present older children for measurement. Undernutrition frequently begins within the first 1,000 days of life, often leading to early mortality or long-term developmental deficits [18]. The higher representation of older survivors could suggest that the most vulnerable infants and toddlers had already been lost to illness or migration, emphasizing the urgent need for early-life nutrition interventions in these communities [15].

Socioeconomic determinants

Among the most prominent determinants, parental education, particularly maternal education, emerged as a key factor associated with child nutritional status. In our study, nearly half of the mothers had no formal schooling, and none reported having received education beyond the secondary level. Evidence from Bangladesh and globally has consistently demonstrated that maternal education is a decisive protective factor against child undernutrition, operating through improved health literacy, better feeding and hygiene practices, and more proactive healthcare-seeking behavior [7,19,20]. Empirical analyses suggest that increases in female educational attainment have been responsible for nearly half of the reductions in child malnutrition rates in LMICs over recent decades [21,22].

Our findings show that children of mothers with at least primary or secondary education exhibited higher mean BMIs and fewer severe undernutrition cases, reinforcing these established relationships. The observed patterns further highlight that maternal education influences not only knowledge but also decision-making power and resource allocation within households. Paternal education, although generally less influential on direct caregiving practices, was also limited in our sample and likely contributed to constrained household socioeconomic mobility [23]. These results highlight the importance of educational investments for women and girls as a key intergenerational strategy to break the cycle of malnutrition [10].

Household economic status was another critical factor. Over 80% of families in this study reported monthly incomes below 7,000 BDT, placing them well below the poverty line. We found a transparent gradient: children from the poorest households had the lowest BMIs, while modestly

higher incomes correlated with better nutritional outcomes [24,25]. This finding aligns with extensive literature indicating that poverty is a fundamental determinant of child undernutrition through pathways of food insecurity, inadequate access to healthcare, and substandard living conditions [3].

Parental occupation was similarly impactful. Most parents were engaged in low-paid, informal labor characterized by instability and long working hours. Children of fathers in more stable or higher-paying jobs showed slightly improved nutritional outcomes [9]. Interestingly, children of non-working mothers (housewives) tended to have higher BMIs than those of working mothers, despite potential additional income from maternal employment. This supports findings from other slum studies suggesting that, in the absence of reliable caregiving support, maternal employment may negatively impact child nutrition due to reduced time for feeding, hygiene, and illness monitoring [26,27].

Maternal age at childbirth also emerged as a significant factor. A substantial proportion of mothers gave birth during adolescence or early adulthood. Early childbearing is closely linked to higher risks of low birth weight and subsequent undernutrition, driven by biological immaturity and limited maternal knowledge [1]. National surveys estimate that nearly two-thirds of Bangladeshi women are married before age 18, with adolescent mothers facing compounded vulnerabilities [10]. Our findings echo recent evidence that children born to adolescent mothers have significantly higher odds of stunting and underweight [10]. Interventions to delay age at first birth, such as strengthening education and enforcing child marriage laws, are therefore essential for improving child nutritional outcomes in slum settings.

Structural and environmental considerations

Beyond individual and household-level determinants, broader environmental factors inherent to slum life have a significant impact on child health [7]. The lack of safe water, inadequate sanitation, overcrowding, and poor housing conditions create a hazardous environment that facilitates the spread of infectious diseases and perpetuates the malnutrition-infection cycle [7,13]. Chronic infections such as diarrhea and respiratory illnesses not only exacerbate undernutrition but also impede recovery even when food is available. Our study context aligns with evidence from other urban slums in Bangladesh showing strong associations between poor hygiene, recurrent illness, and stunting [5,6].

These structural factors underscore the inadequacy of isolated medical or nutritional interventions. Instead, a comprehensive, multisectoral approach is needed, targeting both immediate and underlying determinants [2,15]. According to the UNICEF conceptual framework, interventions should address food security, caregiving practices, environmental health, and access to services simultaneously [16]. Nutrition-specific strategies, including growth monitoring, micronutrient supplementation, and treatment of acute malnutrition, must be integrated with nutrition-sensitive interventions, such as poverty alleviation programs, female education initiatives, water and sanitation improvements, and accessible primary healthcare.

Comparison with other studies

Our results mirror earlier work in Bangladesh's slums: Khan (2022) documented stunting and underweight rates of 44 % and 34 % in Dhaka, attributing them to poor environmental hygiene and maternal mental health, themes echoed in our analysis [19]; Fakir and Khan (2015) likewise found that income and maternal health knowledge predicted child nutrition better than asset-based wealth, supporting our emphasis on education and livelihoods [20]. The heightened malnutrition risk for children of adolescent mothers in our cohort is consistent with evidence from Mim et al. (2024) and Islam et al [26,27]. Our observation that maternal employment can undermine caregiving without adequate support aligns with Win et al. (2022), while national reports of rising female education and declining child marriage [1,3] and slum outreach programs such as BRAC's Manoshi [9] suggest that targeted social and health interventions can gradually improve these outcomes.

Public health implications

Effective control of child malnutrition in Bangladesh's slums demands an integrated public-health agenda that tackles poverty, education, health services, and basic infrastructure

together. Governments should expand social-safety-net programs, cash transfers, and livelihood support to raise household income [3], while parallel investments in girls' schooling and women's economic empowerment yield long-term gains in child growth [19,20]. Community-based nutrition and primary-care services must be linked with improved water, sanitation, and hygiene to break the cycle of infection and malnutrition [7,13]. Finally, enforcing legal age-of-marriage laws and promoting adolescent education to delay first birth can produce significant intergenerational benefits for child health [1, 26].

Study limitations

This cross-sectional design reveals associations but cannot establish causality or temporal order, and our focus on three Sylhet tea-garden estates with a modest sample (n = 330) limits generalizability to other Bangladeshi slum settings. Reliance on BMI rather than separate height-for-age and weight-for-height indices obscures distinctions between chronic and acute malnutrition and, together with the absence of direct dietary or morbidity data, limits insight into underlying pathways. Future work should employ longitudinal designs, diverse urban samples, and more comprehensive nutrition-and-health measures to clarify causation and tailor interventions.

CONCLUSIONS

Child undernutrition in Bangladesh's urban slums stems from intersecting socioeconomic forces: persistent poverty, low parental education, insecure informal work, and early maternal age that jointly depress BMI and drive widespread stunting and underweight. Tackling this burden therefore demands more than food aid or clinic outreach: policies must raise household incomes, expand parental (especially maternal) schooling, empower young women to delay marriage and childbirth, and improve the physical living environment. Prioritizing such comprehensive, slum-focused interventions is both a humanitarian duty and a prerequisite for Bangladesh's development, because no nation can reach its goals, including the Sustainable Development Goals and middle-income status, while a large share of its next generation remains physically and cognitively stunted.

Author Contributions: The authors confirm contribution to the paper as follows: study conception and design: AB, SR, & MS; data collection: AB, SR, PR, & JP; analysis and interpretation of results: AB, & SR; draft manuscript preparation: AB, SR, PR, NR & MS. All authors reviewed the results and approved the final version of the manuscript.

Funding: The project was partially funded by an internal grant from the School of Public Health at UNLV to Dr. Manoj Sharma under PG03008 to cover the expenses of the article processing fee.

Acknowledgments: We are thankful to our Department, School, and University.

Conflicts of Interest: The authors declare no conflict of interest.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Dhaka Medical College, Bangladesh.

References

1. UNICEF. Child Nutrition Report: Bangladesh 2023. Published 2023 [Accessed October 14, 2025]. Available from: <https://www.unicef.org/bangladesh/en/topics/malnutrition#:~:text=UNICEF%20launches%20first%20large%2Dscale,more%20able%20to%20d>
2. World Health Organization. Global Nutrition Report 2024: Action on Equity to End Malnutrition. Published 2024 [Accessed October 14, 2025]. Available from: <https://globalnutritionreport.org/>.
3. World Bank. Bangladesh Urban Poverty Assessment 2023. Published 2023 [Accessed October 14, 2025]. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/<https://documents1.worldbank.org/curated/en/793121572582830383/pdf/-Poverty-Assessment-Facing-Old-and-New-Frontiers-in-Poverty-Reduction.pdf>
4. UNICEF. Child Nutrition Report: Bangladesh 2022. Published 2022 [Accessed October 14, 2025]. Available from: <https://www.unicef.org/bangladesh/en/nutrition>
5. National Institute of Population Research and Training; ICF. Bangladesh Demographic and Health Survey 2022: Key Indicators. Published 2022 [Accessed October 14, 2025]. Available from: chrome-

- extension://efaidnbmnnnibpcajpcglclefindmkaj/<https://dhsprogram.com/pubs/pdf/PR148/PR148.pdf>
6. Rahman M, Ahmed S, Haque M. Nutritional Status of Children in Urban Slums of Dhaka. *BMC Nutr.* 2022;8(1):43. doi:10.1186/s40795-022-00521-3.
7. Chowdhury F, Rahman M, Akter T. Maternal Education and Child Nutrition: Evidence from Bangladesh. *Int J Public Health.* 2022;67:160. doi:10.3389/ijph.2022.00160.
8. Bangladesh Bureau of Statistics. Report on Bangladesh Sample Vital Statistics 2022. Published 2022 [Accessed October 14, 2025]. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/<https://file-dhaka.portal.gov.bd/uploads/b9cd8ba6-d513-4bdc-87ed-4a109beab642/656/94f/4e4/65694f4e4e750801571809.pdf>
9. Win H, Shafique S, Mizan S, Wallenborn J, Probst-Hensch N, Fink G. Association between mother's work status and child stunting in urban slums: a cross-sectional assessment of 346 child-mother dyads in Dhaka, Bangladesh (2020). *Arch Public Health.* 2022;80(1):192. doi: 10.1186/s13690-022-00948-6.
10. Sayeed A, Akter E, Chowdhury PB, Islam MS, Sultana MS, Nusrat N, et al. Contribution of socio-economic and demographic factors to maternal and child malnutrition in Bangladesh: Insights from a nationwide survey. *Nutr Health.* 2023; Advance online publication:02601060231200521. doi: 10.1177/02601060231200521.
11. De Onis M, Borghi E, Arimond M, Webb P, Croft T, Saha K, et al. Prevalence thresholds for wasting, overweight and stunting in children under 5 years. *Public Health Nutr.* 2019;22(1):175-179. doi: 10.1017/S1368980018002434.
12. World Health Organization. WHO Child Growth Standards. Published 2006 [Accessed October 14, 2025]. Available from: <https://www.who.int/tools/child-growth-standards/standards>
13. Choudhury N, Ahmed T, Hossain MI, Mandal BN, Mothabbir G, Rahman M, et al. Community-based management of acute malnutrition in Bangladesh: feasibility and constraints. *Food Nutr Bull.* 2014;35(2):277-285. doi: 10.1177/15648265140350021.
14. Hossain S, Chowdhury PB, Biswas RK, Hossain MA. Malnutrition Status of Children Under 5 Years in Bangladesh: A Sociodemographic Assessment. *Child Youth Serv Rev.* 2020;117:105291. doi.org/10.1016/j.childyouth.2020.105291
15. UNICEF; World Health Organization. Levels and Trends in Child Malnutrition: Key Findings of the 2019 Edition of the Joint Child Malnutrition Estimates. Published 2020 [Accessed October 14, 2025]. Available from: <https://www.unicef.org/reports/joint-child-malnutrition-estimates-levels-and-trends-child-malnutrition-2019>
16. UNICEF; World Health Organization; World Bank. Levels and Trends in Child Malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates 2023 Edition. Published 2023 [Accessed October 14, 2025]. Available from: <https://www.who.int/publications/i/item/9789240073791>
17. Ahmed T, Hossain M, Mahfuz M. Urban Malnutrition in Bangladesh: The Hidden Crisis. *Bangladesh J Public Health.* 2023;4(1):12–20. doi:10.3329/bjph.v4i1.62345.
18. Pelletier DL, Frongillo EA. Changes in Child Survival Are Strongly Associated with Changes in Malnutrition in Developing Countries. *J Nutr.* 2003;133(1):107–119. doi.org/10.1093/jn/133.1.107
19. Hasan MT, Soares Magalhaes RJ, Williams GM, Mamun AA. The role of maternal education in the 15-year trajectory of malnutrition in children under 5 years of age in Bangladesh. *Matern Child Nutr.* 2016;12(4):929-939. doi: 10.1111/mcn.12178.
20. Nahar MZ, Zahangir MS. The Role of Parental Education and Occupation on Undernutrition Among Children Under Five in Bangladesh: A Rural–Urban Comparison. *PLoS One.* 2024;19(8):e0307257. doi:10.1371/journal.pone.0307257.
21. Feng Y, Ding L, Tang X, Wang Y, Zhou C. Association Between Maternal Education and School-Age Children Weight Status: A Study from the China Health Nutrition Survey, 2011. *Int J Environ Res Public Health.* 2019;16(14):2543. doi:10.3390/ijerph16142543.
22. Amouzou A, Kozuki N, Gwatkin D. Where Is the Gap? The Contribution of Disparities Within Developing Countries to Global Inequalities in Under-Five Mortality. *BMC Public Health.* 2014;14:216. doi:10.1186/1471-2458-14-216.
23. Larson K, Halfon N. Family Income Gradients in the Health and Health Care Access of US Children. *Matern Child Health J.* 2009;14(3):332–342. doi:10.1007/s10995-009-0477-y.
24. Fakir AMS, Khan MWR. Determinants of Malnutrition Among Urban Slum Children in Bangladesh. *Health Econ Rev.* 2015;5:22. doi:10.1186/s13561-015-0059-5.
25. Rahman M. Nutritional Status of Children in Slums of Dhaka, Bangladesh. *Integr Food Nutr Metab.* 2016;2(4):1–5. doi:10.15761/ifnm.1000133.

26. Mim SA, Al Mamun ASM, Sayem MA, Wadood MA, Hossain MG, et al. Association of child marriage and nutritional status of mothers and their under-five children in Bangladesh: a cross-sectional study with a nationally representative sample. *BMC Nutr.* 2024;10(1):67. doi: 10.1186/s40795-024-00874-6.
27. Islam MZ, Chowdhury MRK, Kader M, Billah B, Islam MS, Rashid M. Determinants of low birth weight and its effect on childhood health and nutritional outcomes in Bangladesh. *J Health Popul Nutr.* 2024;43(1):64. doi: 10.1186/s41043-024-00565-9.



© 2025 by the authors. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).