Review Article

Risk or associated factors of wasting among under-five children in Bangladesh: A systematic review

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Background and Objectives: Wasting among under-five years old (U-5) children is a significant global public-health-nutrition burden. To effectively address this problem in Bangladesh, knowing its prevalence, causes and associated-factors are essential. This review aimed to identify evidences available in the existing-accessible literature/documents that describe the individual, socioeconomic, demographic, and contextual risk-factors associated with wasting among U-5 children in Bangladesh. **Methods and Study Design:** Electronic-databases included were MEDLINE, EMBASE, CINAHL, WoS, and Cochrane-Library written in English and published until 29 February 2024. **Results:** The search from the five databases yielded 167 publications. Of these, 50 papers/articles were duplicates and 108 were irrelevant, and nine have met the inclusion criteria. Additionally, 22 articles/documents were identified from other sources. Finally, a total of 31 articles/documents have been included in this review. The odds of childhood wasting observed were high for smaller birth-size, higher birth-order, male child, 12-24 months age-group, improper breastfeeding- and complementary-feeding practices, not-receiving DPT1 and/or measles vaccine, ≥1 sibling(s), maternal-undernutrition, less food-consumption during pregnancy, lack of maternal-education, lack of hand-washing practices by the mother/caregiver, paternal tobacco use, lower socioeconomic-status, food-insecurity, lack of access to hygienic-latrine and/or improved-water, Monsoon season (May-August), flood exposure, living especially in Barishal, Rajshahi Chittagong and Rangpur-division and/or Eastern part of Bangladesh, and urban-slum. **Conclusions:** The risk/associated factors of wasting among U-5 children in Bangladesh were found at various multilevel. Rarely caused by any one factor alone, wasting in U-5 children results from an interplay between pregnant-mother's health and nutrition, child-caring practices, diets, poverty, and disease, which vary by context.

Key Words: risk factors, associated factors, wasting, under-five children, Bangladesh

INTRODUCTION

Wasting defined by weight-for-length or height (WLZ/WHZ) <-2 z-score among children under five years (U-5 children) or mid-upper-arm-circumference (MUAC) <125 mm among 6-59 months age group is a significant global nutritional and public health burden in Bangladesh. Wasting makes children too thin and weak, and puts the children at higher risk of illnesses; wasting also leads to poor growth, development, and learning, and dying. In 2020, globally, 45.4 million U-5 children were wasted, 14.3 million were severely wasted (WLZ/WHZ <-3), and more than half of all children affected by wasting lived in Southern Asia.[1] Worldwide, 2.6 million children die each year due to malnutrition, and 45% of U-5 deaths were due to undernutrition.[2, 3] Around 13% of worldwide deaths were attributed to wasting in 2015, representing 875,000 preventable child deaths.[3] Childhood wasting rate has been reducing slowly at a global level including in Bangladesh over the past 40 years; but some countries such as India and Sri Lanka, recently noted rising prevalence rates.[4] An estimate highlighted that approximately 150,000 child deaths could be averted by reducing the increasing rate of wasting.[5] Over almost two decades, reduction of child wasting prevalence in Bangladesh has been very slow with national prevalence of 15% in 2004, 16% in 2011, and 17% in 2014.[6] Nevertheless, the prevalence rate is still not acceptable. Latest data from Bangladesh showed that, although child wasting prevalence is declining, it is still very high, ranging from

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8.4%[7] to 9.8%.[8] There is no nationwide estimation of wasting status in U-5 children in Bangladesh after 2019 nor after the Covid-19 pandemic. However, following the global estimates on the impact of Covid-19 on nutrition, the prevalence of wasting was expected to be increased from the recent report of UNICEF. Analysis, based on these estimates applied to 118 low- and middle income-countries, suggested that there could be a 14.3% increase in the prevalence of moderate or severe wasting among U-5 children due to COVID-19-related predicted country-specific losses in GNI per capita. We estimate this would translate to an additional of 6.7 million children with wasting in 2020; an estimated 57.6% of these children are in south Asia and an estimated 21.8% in sub-Saharan Africa.[9]

Many factors are yet to be known about the etiology or risk factors of malnutrition, including childhood wasting, which would help to target and formulate more cost-effectiveness interventions to reduce and prevent them. An array of risk or associated factors have been studied, lending support to nutrition-specific and nutrition-sensitive interventions in the context of health system strengthening; however, the importance of these risk or associated factors varies widely between studies and environments.[3] A detailed understanding of the main determinants of wasting particularly in the U-5 population of Bangladesh could help with national strategies against childhood wasting and will contribute to the scientific understanding of wasting in these populations in low-resource settings.

METHODS

This review identified evidence available in existing accessible literature and documents that describe the individual, socioeconomic, demographic, and contextual risk factors associated with wasting among U-5 children in Bangladesh. We conducted a systematic search of the electronic databases. Search included PubMed (MEDLINE), EMBASE (OVID platform), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science (WoS), and Cochrane Library. Only articles written in English and published before 29 February 2024 were reviewed.

Search string used: (acute undernutrition) OR (acute malnutrition) (Wasting*) OR (low weight-for-height) OR (low weight-for-length) OR (causes of wasting) OR (malnutrition) OR (malnourished) OR (child nutrition disorders) OR (MUAC less than 125 mm) AND (risk factor*) OR (associated factor*) AND (under-five children) OR (less than five years old children) AND Bangladesh.

We also used a snowball technique to identify additional relevant references from retrieved sources. Two investigators (MIH, and SH) reviewed each search result following the inclusion and exclusion criteria as follows: (1) the risk or associated factors of wasting in U-5 children were described in the articles and documents, and (2) information/data used were from Bangladesh. Exclusion criteria included studies that only described the risk or associated factors of underweight and or stunting but not of wasting, and do not contain data on Bangladeshi U-5 children. If an assessment of the suitability of the article was indeterminate based on the abstract and title, the full-text article was sought.

We reviewed the total number of papers, articles and documents retrieved and duplicates were excluded. Discrepancies between investigators' (MIH and SH) inclusion and exclusion determinations were uncommon (<5% of the total included articles) and lessened as the process progressed. When needed, these two investigators (MIH and SH) judged the differences in determinations during meetings with the other co-authors.

We conducted the review methods and reporting procedures following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[10] described in the PRISMA flowchart (Figure 1). The search from the five databases yielded 167 publications. Of these, 50 papers/articles were found to be duplicates and 108 were identified as irrelevant and the remaining 9 have met inclusion criteria. Additionally, 22 articles/documents were identified from other sources (e.g. searching the cross-references and from the Google search engine). Finally, a total of 31 papers/articles/documents were included in this review.

RESULTS

The list of total 31 papers/articles considered for this review were displayed in Table 1. The name of the lead author and year of publication, data sources, number of samples and age group of children studied, and the risk or associated factors of wasting (WLZ/WHZ <-2 and/or MUAC <125 mm) with the strength of association adjusting the covariates (other factors) were listed.

Table 2 to Table 5 depicted the various risk or associated factors that are significant after statistical calculation. Risk or associated factors found significant were as follow:

Children's own factors (Table 2)

Three of the 31 papers and articles reported a significant association of child wasting with birth size and birth order. Very small birth size (odds ratio (OR): 4.3) or smaller than average birth size (OR: 1.7 to 2.7), and (if birth weight was known then) low birth weight (baby's birth weight <2500 g) (OR:1.7), were found as risk factors of child's wasting. Similarly, higher birth order (3+) was found as another risk factor for childhood wasting (OR: 1.2 to 3.1). Only one study found a significant association between childhood stunting with wasting (OR: 1.2).

Eight studies revealed a significant association between the sex of the child with wasting. Among them, only one reported being female as a risk factor for wasting (OR: 1.4), the other six studies found male children as a risk factor for childhood wasting (OR: 1.2 to 1.5).

At least 10 of these 30 reviewed papers and articles reported a significant association of age of the child with wasting. Among the different age groups, the highest proportion of wasted children was found in <24 months old children, particularly in 12 to 23 months age group (OR: 8.8). Some other studies also reported higher odds (ranging from 1.1 to 4.0) of wasting in > 24 months age group.

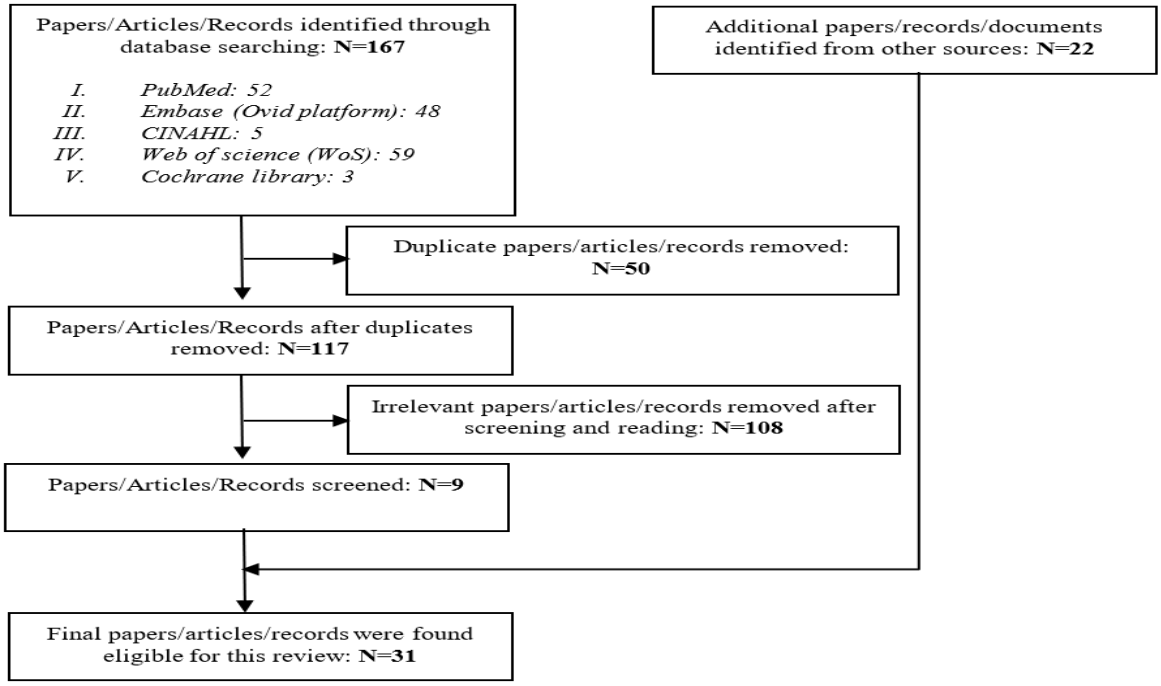

Figure 1. The PRISMA flowchart

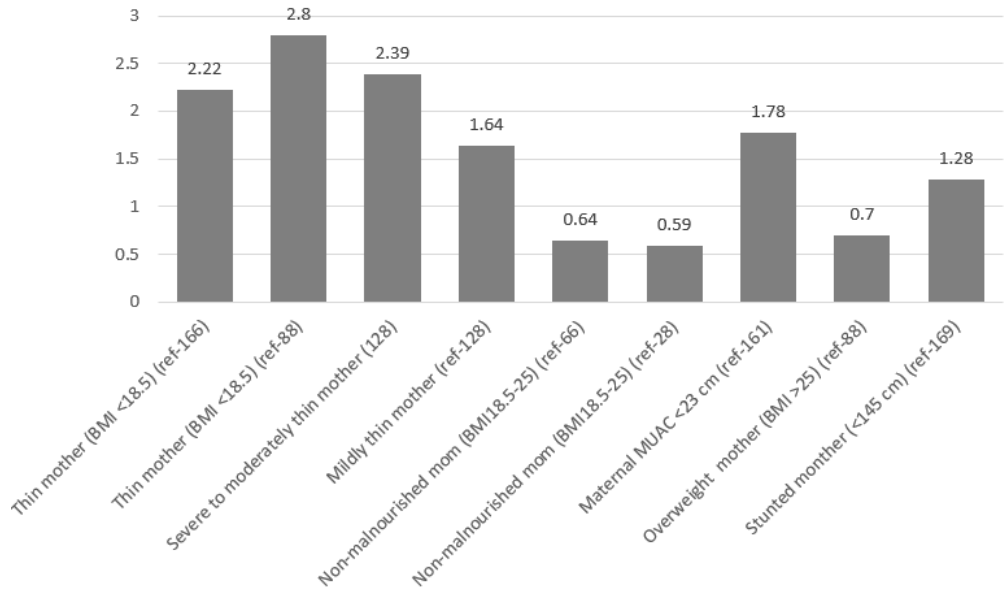

Figure 2. Wasting status of under-5 children by their mother's nutritional status

A total of 6 of the 31 reviewed papers and articles reported a significant association of breastfeeding practices or status of the child with her/his wasting. Five of these 6 studies reported that better breastfeeding practices were found as a protective factor of wasting. If predominant breastfeeding was stopped before 4 months of age, the risk of child's wasting also rapidly increased (OR: 2.7). For 6 to 59 months age group, fulfillment of minimum dietary diversity (MDD) (consuming 4 or more food groups in last 24 h) were found to be protective against childhood wasting (OR: for both 0.8). Similarly, not receiving more than 4 food groups was found as a significant risk factor for wasting (OR: 1.5).

Child vaccination was found to be significantly associated with wasting status of children in two studies. Not receiving DPT1 vaccine (OR: 1.8) and measles vaccine (OR: 1.6) was found as a risk factor for wasting in children. The odds of receiving any medicine/drop on the day preceding the survey were 67% higher (p<0.001) among wasted than non-wasted children. Illness during previous two weeks was found as a risk factor (OR: 3.1) for wasting. A negative association (Coefficient: -0.1, p=0.046) between WHZ and Shigella was reported in one study.

Table 1. The list of total 30 papers and articles that have been considered for this review

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Das et al (2021)[159]	Data were extracted from the Global Enteric Multicentre Study	< 5 years male and female children	2,788	WHZ <-2	- Shigella infection: -0.11 (-0.21 to - 0.001), *p*=0.046 - Campylobacter positive diarrhoea: 0.22: (0.08 - 0.37), 0.003
Ghosh et al. (2021)[160]	Cross-sectional study in rural Noakhali; December 2019 to February 2020	< 5 years Male and Female children	108	WHZ <-2	OR (95% CI), p-value No hand washing before feeding the baby OR: 1.51, *p* <0.006
Haque et al (2021)[161]	Cross-sectional	< 2 years Male and Female children	5,069 households	WHZ <-2	Maternal MUAC <23: 1.78 (1.50-2.12); *p* < 0.001.
Rahman et al (2021)[162]	This work utilized malnutrition data that was derived from Bangladesh Demographic and Health Survey which was conducted in 2014.	< 5 years Male and Female children	7,079	WHZ <-2	- Barisal: 1.56 (1.21–2.02), *p*<0.05 - Chittagong: 1.40 (1.11-1.77), *p*<0.05 - Rajshahi: 1.50 (1.16–1.93), *p*<0.05 - Rangpur: 1.31 (1.01–1.69), *p*<0.05 - Male child: 1.17 (1.03–1.33), *p*<0.05 - Age < 12 months: 1.38 (1.22-1.58), *p*<0.05 - Poor: 1.38 (1.14–1.68), *p*<0.05
Talukder et al (2021)[163]	This study extracted necessary information from Bangladesh Urban Health Survey (BUHS) 2013	< 5 years Male and Female children	10,511	WHZ <-2	- Age > 48 months: 1.14 (1.04-1.32), *p*<0.01 Mother's education up to: - Primary: 0.75 (0.63-0. 95), *p*<0.001 - Secondary or higher: 0.58 (0.48-0. 98), *p*<0.001 - Wealth index, middle (compared to poor): 0.82 (0.76-0.90), *p*<0.001 - Wealth index, rich (compared to poor): 0.58 (0.40-0.94), *p*<0.001 - ANC services: 0.83 (0.53-0.94), *p*<0.05 - Breast fed: 0.43 (0.42-0.95), *p*<0.01 - City-corporation slum (compared to other city areas): 1.35 (1.04-1.45), *p*<0.001

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Rahman et al (2020)[166]	Bangladesh Demographic Health and Survey conducted in 2014.	< 5 years Male and Female children	7,131	WHZ<-2 to -3 WHZ <-3	For moderate wasting - Barisal: 1.57 (1.16–2.11), *p*=0.003 - Rajshahi: 1.64 (1.22–2.19), *p*=0.001 - Rural: 1.23 (1.01–1.50), *p*=0.035 - Less than average birth size: 1.65 (1.32–2.05), *p*<0.001 - Thin mother (BMI 18.5): 2.22 (1.70–2.91), *p*<0.001 - Non-malnourished (BMI 18.5): 2.22 (1.70–2.91), *p*<0.001 For severe wasting - Barisal: 2.11 (1.37–3.24), *p*=0.001 - Rajshahi: 1.64 (1.22–2.19), *p*=0.001 - Rural: 1.23 (1.01–1.50), *p*=0.035 - Less than average birth size: 1.65 (1.32–2.05), *p*<0.001 - Thin mother (BMI 18.5): 2.22 (1.70–2.91), *p*<0.001 - Male child: 1.48 (1.18–1.86), *p*=0.001 - Less than average birth size: 1.74 (1.28–2.36), *p*<0.001 - No measles vaccine: 1.58 (1.14–2.17), *p*=0.005 - Thin mother (BMI 18.5): 1.45 (1.00–2.11), *p*=0.048 - Poor: 1.51 (1.06-2.14), *p*=0.019
Raihan et al (2020)[26]	Data used from Suchana program, a large-scale, 7-year nutrition program serving around 250,000 poor house-holds in north-east Bangladesh; the program began in 2015 and will reach around 1.7 mil-lion people in the Sylhet and Moulvibazar districts.	6-23 months old Male and Female children	4,400	WLZ <-2	- Asset index, 3rd quintile: 0.65 (0.47-0.93), *p*=0.018 - Maternal BMI: 0.91 (0.87-0.95), *p*<0.001 - More than usual maternal food consumption status during last pregnancy: 0.80 (0.64-0.98), *p*=0.031 - Usual maternal food consumption status during last pregnancy: 0.75 (0.59-0.95), *p*=0.020

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Raihan et al (2020)[26]	Data used from Suchana program, a large-scale, 7-year nutrition program serving around 250,000 poor households in north-east Bangladesh; the program began in 2015 and will reach around 1.7 million people in the Sylhet and Moulvibazar districts.	6-23 months old Male and Female children	4,400	WLZ <-2	- If mother knows diarrheal management: 0.51 (0.30-0.87), *p*=0.014 - Female child: 0.72 (0.58-0.89), *p*=0.003 - Child received any medicine or vitamin – drop on the day preceding the survey: 1.67 (1.30-2.13), *p*<0.001
Hoq et al (2019)[167]	Mixed Method matched case control in the Kurigram district of Bangladesh.	6-59 months old Male and Female children	Case-52 Control-95	WHZ <-2 and/or MUAC 125 mm	- Birth order (first child): 0.3 (0.09-0.96), *p*=0.042 - Number of family members: 1.30 (1.02-1.65), *p*=0.033 - Illness in the last 2 weeks: 3.08 (1.13-8.42), *p*=0.028 - Access to hygienic latrine: 0.25 (0.07-0.82), *p*=0.022
Sheikh et al (2019)[168]	Bangladesh Demographic and Health Survey (BDHS) 2014	< 2 years Male and Female children		WLZ <-2	- Received minimum dietary diversity: 0.78 0.59-1.04), *p*<0.01 - Received minimum meal frequency: 0.78 (0.61-0.99), *p*<0.01
Khatun et al (2019)[169]	Bangladesh Demographic and Health Survey (BDHS) 2004, 2007, 2011, & 2014	< 5 years Male and Female children	28,123	WLZ <-2	Every 1 cm increase in maternal height significantly reduced the risk of wasting (RR = 0.986 (0.980, 0.992) and severe wasting (RR = 0.984 (0.971, 0.997). The children of the short statured mothers (<145 cm) had 1.28 (1.14-143) times the risk of wasting, and 1.43 (1.11-1.83) times the risk of severe wasting than the tall mothers (≥155 cm).
Harding et al (2018)[88]	Bangladesh Demographic and Health Survey (DHS) 2014	< 5 years Male and Female children	6,965	WHZ <-2	- Rural: 1.24 - Lack of improved water: 1.78 - Thin mother (BMI <18.5): 1.56 - Overweight mother (BMI >25): 0.70 - Male child: 1.18 - Age > 12 months: 0.60 - Stunted child: 1.2 - Barisal: 1.36 (1.02, 1.81) - Rajshahi: 1.42 (1.07, 1.88)

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Hossain et al (2018)[170]	Using data of Bangladesh Demographic Health Survey (2014)	< 5 years Male and Female children	7,173	WHZ<-2	Percentage, *p*-value - Wasting rate was highest in Barisal division (17·74 %) and lowest in Dhaka division (12.01%), *p*=0.001 - Wasting rate gradually increased with decreasing of wealth quintile: higher in lowest quintile (17.1%) vs. lowest in highest quintile (11.78%), *p*=0.008 - Wasting rate was highest in younger age group and gradually decreased up to 48 months of age, *p*=0.004 - Wasting rate was highest if mother was undernourished (BMI <18.5), *p*<0.001
Islam et al (2018)[171]	Cohort study	< 6 months Male and Female children	154	WLZ <-2	- Age of the infant: 0.27 (0.16–0.44), *p*<0.001 - Exclusive breastfeeding during 4-8 weeks of age (compared to who stopped earlier): 0.04 (0.004–0.36), *p*=0.005 - Schooling years of mother: 0.83 (0.71-0.97), *p*=0.02 - access to household electricity: 0.27 (0.09-0.81), *p*=0.02
Mohsena et al (2018)[172]	Data were from a longitudinal data set comprising a nationally representative data sample collected in 2014 and the Food Security Nutrition Surveillance Project (FSNSP) conducted in 2011 and 2012.	< 5 years Male and Female children	Number of households in different years of sampling: 1988 (N = 1231), 2000 (N = 1872), 2014 (N = 2896)	WHZ<-2	- Post-Amon harvest season (January-April): 0.74 (0.66-0.83), *p*<0.001 - Post-Aus harvest season (September-December): 0.76 (0.68-0.85), *p*<0.001 - Eastern hills agro-ecological zone: 0.83 (0.70-0.99), *p* <0.05 - Birth season of the child was not associated with childhood wasting.

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Choudhury et al (2017)[128]	October 2011 to November 2013 through the Food Security Nutritional Surveillance Project in Bangladesh	< 24 months	10,291	WLZ < -2	<6 months age group - Child age: 0.86 (0.75–0.97), *p*=0.017 - Not exclusively breast fed: 1.79 (1.23–2.61), *p*=0.003 - Severe to moderately thin mother: 1.97 (1.12–3.47), *p*=0.019 - Mildly thin mother: 1.57 (1.03–2.38), *p*=0.034 - No dietary diversity (≤4 food groups): 1.49 (1.02–2.19), *p*=0.041 6-11months age group: - Child age: OR: 1.1 (1.02–1.19), *p*=0.014 - Severe to moderately thin mother: 2.39 (1.67–3.44), *p*<0.001 - Mildly thin mother: 1.64 (1.15–2.34), *p*=0.007 - Severe food insecurity: 1.41 (1.04–1.91), *p*=0.025 - For drinking use of surface water: 0.5 (0.26-0.95), *p*=0.035 12-23 months age group: - Monsoon season: 1.45 (1.15–1.84), *p*=0.002 - Illiterate mother: 1.53 (1.05–2.23), *p*=0.028 - Severe to moderately thin mother: 2.11 (1.68–2.65), *p*<0.001 - Mildly thin mother: 1.38 (1.11–1.72) , *p*=0.004 - Less food consumption during pregnancy: 1.25 (1.03–1.52), *p*=0.025 - Having non-hygienic latrine: 1.36 (1.04–1.78), *p*=0.025 - Moderate food insecurity: 1.66 (1.12–2.46), *p*=0.011 - Severe food insecurity: 1.34 (1.09–1.63), *p*=0.005

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Hasan et al (2016)[173]	Cross-sectional nationally representative BDHS surveys (1996-2011)	< 5 years Male and Female children	28,941	WHZ <-2	RR: ((95% CI), *p*-value Mothers with secondary or higher education: 0.82 (0.74, 0.91)
Chowdhury et al (2016)[66]	Using data of Bangladesh Demographic Health Survey (2011)	< 5 years Male and Female children	7,568	WLZ < -2	Non-malnourished mother (BMI18.5-25): 0.64 (0.55-0.76), *p*< 0.001 Overweight mother (BMI >25): 0.35 (0.26-0.48), *p*< 0.001 Living in eastern region of Bangladesh: 1.37 (1.02-1.84), *p*=0.037
Rahman et al (2016)[14]	Data on child nutrition has been extracted from a nationally representative sample survey i.e. the Bangladesh Demographic Health Survey (BDHS) 2011 conducted between November 2010 and April 2011.	< 5 years Male and Female children	7,530	WHZ <-2	RR (95 CI), p-value LBW: 1.71 (1.53-1.92), *p*=<0.05
Das et al, (2015)[174]	Chart analysis from Diarrhoeal Disease Surveillance of icddr,b	< 5 years Male and Female children	16,948	WHZ <-2	≥1 under-5 siblings: 1.12 (1.04, 1.21), *p* <0.001
Raj et al (2015)[175]	Nationally representative data of Demographic and Health Surveys of Bangladesh (2011), India (2005-6) and Nepal (2011).	< 5 years Male and Female children	Ban: 7,861 Ind: 46,655 Nep: 2,475	WHZ <-2	- Higher birth order (3+): 1.14 (1.04-1.25) - For girls but not boys, number of brothers increased risk for severe wasting: - 1 vs. 0 brothers: 1.31 (1.11-1.55); - 2 vs. 0 brothers: 1.36 (1.07, 1.73
Fuchs et al (2014)[64]	Case-control study	< 5 years Male and Female children	449	WHZ <-2	- Child's age >1 year: 3.14 (1.43-6.90), *p*=0.004 - Predominant breastfeeding stopped before 4 months: 2.67 (1.23-5.80), *p*=0.013 - Undernourished mother (BMI <18.5): 2.80 (1.20-6.53), *p*-0.017 - Father with low-paid job: 5.78 (2.54-13.16). *p*<0.001 - Monthly income < 10000 taka (1 US $=80 taka): 2.87 (1.31-6.29), *p*=0.008

Table 1. The list of total 30 papers and articles that have been considered for this review (cont.)

Trial name	Data taken from or type of study	Population	Sample size	Dependent variable: wasting (WHZ < -2 or MUAC <125 mm)	Findings on the associated/risk factors Odds Ratio (95% CI), *p*-value
Alom et al (2012)[176]	BDHS 2007	< 5 years Male and Female children	6,150	WHZ < -2	- Child age: 12-23 months compared to <6 months age group: 1.51 (1.16-1.97), *p*<0.01 - Mother's education, Secondary compared to illiterate mother: 0.68 (0.56-0.83), *p*<0.01 - Mother's education, higher compared to illiterate mother: 0.65 (0.45-0.98), *p*<0.05 - Father's occupation, labourer compared to agriculture: 0.78 (0.63-0.91), *p*<0.01 - Currently breast fed: 1.44 (1.17-1.77), *p*<0.01
Chowdhury et al (2011)[177]	Secondary Data analysis from hospital surveillance system of icddr,b	< 5 years Male and Female children	13,555	WHZ < -2	For moderate wasting - Child age <24 months: 0.73 (0.66-0.81) - Illiterate mother: 1.54 (1.41-1.68) - Lower SES: 2.64 (2.36-2.96) - Middle SES: 1.77 (1.59-1.97) For severe wasting - Child age < 24 months: 0.76 (0.65-0.88) - Illiterate mother: 1.63 (1.43-1.87) - Lower SES: 2.83 (2.35-3.40) - Middle SES: 1.83 (1.52-2.20)
Goudet et al (2011)[178]	This study comprises a secondary analysis of data collected by the International Food Policy Research Institute (IFPRI) (del Ninno, 2001)	< 5 years Male and Female children	757 households	WHZ <-2	Flood exposure: 25.06 (1.81–347.45)
Best et al (2007)[109]	households that participated in the Nutritional Surveillance Project stratified, multistage cluster sample	< 5 years Male and Female children	77,678	WHZ < -2	- For wasting, parental tobacco use: 1.10 (1.03-1.17), *p*=0.004 - For severe wasting, parental tobacco use: 1.14 (0.98 –1.32), *p*=0.09
Rayhan et al (2006)[28]	BDHS1999-2000 Data used: with case-control design	< 5 years Male and Female children	77,678	WHZ < -2	- Birth size of the baby compared to average size: - Very small: 1.885, *p*<0.001 - Smaller than average: 1.69, *p*<0.001 - Non-malnourished mother: 0.594, *p*<0.001
Henry et al (1993)[179]	Case-control study	< 5 years Male and Female children	151	MUAC < 110 mm (Marasmus)	- Children from families with other children under 5 years of age: 2.51 (1.33-4.74) - Consumptions off formulae food: 16.41 (3.39-79.36), *p*<0.05 - 5 years of schooling of mother: 0.34 (0.15-0.76), *p*=0.01 - Birth order ≥4: 3.14 (1.59-6.20), *p*=0.001
Jubayer et al (2022)[180]	Cross-sectional study at St. Martin's Island of Bangladesh	< 5 years male and female children	256	WHZ <-2	- Male child: 2.03 (1.33-3.11), p=0.001 - lowest wealth quintile: 2.88 (1.22-6.77), *p*=0.015

Table 2. Risk or associated factors of child wasting (those were children's own factors)

Risk or associated factors	Odds Ratio (95% CI), *p*-value	Reference (respectively)
Birth size		
Very small	4.31 (1.87-9.92), *p*=0.001	Hossain et al (2020)[165]
Smaller than average	2.67 (1.21-5.81), *p*=0.014	Hossain et al (2020)[165]
	1.65 (1.32-2.05), *p*<0.001	Rahman et al (2020)[162]
	1.69, *p*<0.001	Rayhan et al (2006)[28]
Low birth weight:	1.71 (1.53-1.92), *p*=<0.05	Rahman et al (2016)[14]
Birth order (first child)	0.3 (0.09-0.96), *p*=0.042	Hoq et al (2019)[167]
Higher birth order (3+)	1.14 (1.04-1.25), *p*<0.05	Raj et al (2015)[175]
	3.14 (1.59-6.20), *p*=0.001	Henry et al (1993)[179]
Stunted child	1.20, *p*<0.05	Harding et al (2018)[88]
Child's sex		
Female child	1.44 (1.17–1.77), *p*<0.001	Choudhury et al (2000)[37]
	0.68 (0.58-0.79), *p*<0.001	Chowdhury et al (2020)[164]
	0.75 (0.65-0.87), *p*<0.001	Hossain et al (2020)[165]
	0.72 (0.58-0.89), *p*=0.003	Raihan et al (2020)[26]
Male child	21.17 (1.03-1.33), *p*<0.05	Rahman et al (2021)[162]
	1.48 (1.18-1.86), *p*=0.001	Rahman et al (2020)[166]
	1.18, *p*<0.05	Harding et al (2018)[88]
Age of the child		
<12 months	1.38 (1.22-1.58), *p*<0.05	Rahman et al (2021)[162]
	13.34 (8.22-21.63), *p*<0.001	Choudhury et al (2000)[37]
12-23 months	8.77 (5.40-14.26), *p*<0.001	Choudhury et al (2000)[37]
	1.44 (1.18-1.76), *p*<0.001	Chowdhury et al (2020)[164]
12-23 months	1.51 (1.16-1.97), *p*<0.001	Alom et al (2012)[176]
<24 months	0.73 (0.66-0.81), *p*<0.05	Chowdhury et al (2011)[177]
24-35 months	3.95 (2.40-6.52), *p*<0.001	Choudhury et al (2000)[37]
36-48 months	1.87 (1.03-3.40), *p*<0.001	Choudhury et al (2000)[37]
>48 months	1.14 (1.04-1.32), *p*<0.01	Talukder et al (2021)[163]
>12 months	0.60, *p*<0.05	Harding et al (2018)[88]
	3.14 (1.43-6.90), *p*=0.004	Fuchs et al (2014)[64]
Child feeding		
Breast feeding	0.43 (0.42-0.95), *p*<0.01	Talukder et al (2021)[163]
Exclusive breastfeeding during 4-8 weeks of age	0.04 (0.004-0.36), *p*=0.0005	Islam et al (2018)[171]
Predominant breastfeeding stopped before 4 months	2.67 (1.23-5.80), *p*=0.013	Fuchs et al (2014)[64]
Not exclusively breast fed:	1.79 (1.23–2.61), *p*=0.003	Choudhury et al (2017)[128]
Consumptions of formulae food	16.41 (3.39-79.36), *p*<0.05	Henry et al (1993)[179]
Older child's food related variables		
Received minimum dietary diversity	0.78 (0.59-1.04), *p*<0.01	Sheikh et al (2019)[168]
No dietary diversity (≤4 food groups)	1.49 (1.02-2.19), *p*=0.041	Choudhury et al (2017)[128]
Received minimum meal frequency	0.78 (0.61-0.99), *p*<0.01	Sheikh et al (2019)[168]
Child's vaccination		
Non-receiving DPT1	1.82 (1.45-2.28), *p*<0.001	Choudhury et al (2000)[37]
No measles vaccine	1.58 (1.14-2.17), *p*=0.005	Rahman et al (2020)[166]
Child received any medicine/drop on the day preceding the survey	1.67 (1.30-2.13), *p*<0.001	Raihan et al (2020)[26]
Illness in the last 2 weeks	3.08 (1.13-8.42), *p*=0.028	Hoq et al (2019)[167]
Shigella infection:	Coefficient: 0.11 (-0.21- −0.001)	Das et al (2021)[159]

Siblings and parental factors (Table 3)

Having one or more siblings was found as an associated factor of wasting of the index child in 3 studies (OR: ranging from 1.1 to 2.5). For girls (but not boys), the number of male siblings increased the risk for severe wasting (OR: 1.3).

Ten of these 31 reviewed papers and articles reported a significant association between maternal nutritional status with child wasting (Figure 2). Thinner or undernourished mothers were found as risk factor for their children's wasting. An increase of one cm in maternal height significantly reduced the risk of wasting (RR = 0.986 (0.980, 0.992) and severe wasting (RR = 0.984; (0.971, 0.997). The children of short-statured mothers (<145 cm) had 1.3 times higher risk of wasting and 1.4 times higher risk of severe wasting than tall mothers (≥155 cm). Food consumption during pregnancy was also a significant risk factor for the wasting status of the index child. During pregnancy, food consumption more than usual was found as protective (OR: 0.8) and less food consumption was found as a risk factor (OR: 1.3) for child wasting.

Seven studies found that all levels (from primary to higher study) of maternal education were protective against childhood wasting (Figure 5). Moreover, illiteracy of the household head was also found as a significantly associated factor of a child's wasting status. The presence of mothers' knowledge of diarrheal management was found as a significant protective factor for childhood wasting. Lack of hand-washing practices by the mother/caregiver before feeding the baby was significantly

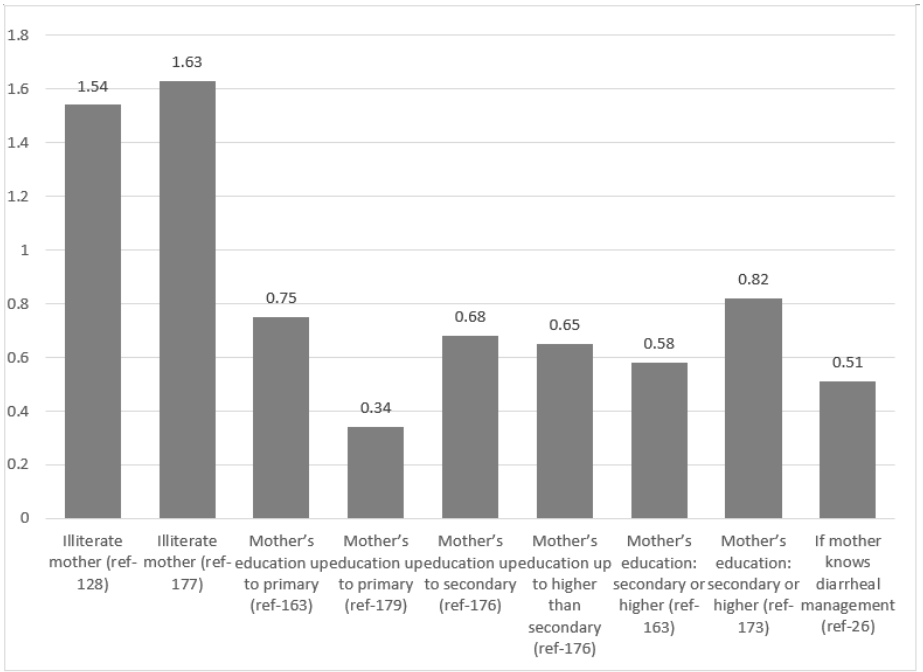

Figure 3. Wasting status of under-5 children by their mother's education status

Table 3. Siblings and parent-related risk or associated factors of child wasting

Risk or associated factors	Odds Ratio (95% CI), *p*-value	Reference (respectively)
Under-5 siblings: ≥ 1	1.09 (1.01-1.18), *p*=0.032	Hossain et al (2020)[165]
	1.12 (1.04-1.21), *p*<0.001	Das et al, (2015)[174]
	2.51 (1.33-4.74)	Henry et al (1993)[179]
For girls but not boys, the number of brothers increased the risk of severe wasting	1.31 (1.11-1.55), *p*<0.05	Raj et al (2015)[175]
Maternal nutrition status		
Maternal BMI	0.91 (0.87-0.95), *p*<0.001	Raihan et al (2020)[26]
Thin mother (BMI <18.5)	2.22 (1.70-2.91), *p*<0.001	Rahman et al (2020)[166]
	1.56, *p*<0.05	Harding et al (2018)[88]
	2.80 (1.20-6.53), *p*-0.017	Fuchs et al (2014)[64]
Severe to moderately thin mother	2.39 (1.67-3.44), *p*<0.001	Choudhury et al (2017)[128]
Mildly thin mother	1.64 (1.15-2.34), *p*=0.007	Choudhury et al (2017)[128]
Non-malnourished mother	0.64 (0.55-0.76), *p*< 0.001	Chowdhury et al (2016)[66]
(BMI18.5-25)	0.594, *p*<0.001	Rayhan et al (2006)[28]
Maternal MUAC <23 cm	1.78 (1.5-2.12), *p* <0.001	Haque et al (2021)[161]
Overweight mother (BMI >25)	0.70, *p*<0.05	Harding et al (2018)[88]
Maternal height	RR: Moderate wasting = 0.986 (0.980-0.992) Severe wasting = 0.984 (0.971-0.997)	Khatun et al., 2019[169]
Short-statured mothers (<145 cm) compared to tall mothers (≥155 cm)	RR: Moderate wasting = 1.28 (1.14-1.43) Severe wasting = 1.43 (1.11-1.83)	Khatun et al., 2019[169]
Maternal food consumption		
More than usual maternal food consumption status during the last pregnancy	0.80 (0.64-0.98), *p*=0.031	Raihan et al (2020)[26]
Less food consumption during pregnancy	1.25 (1.03-1.52), *p*=0.025	Choudhury et al (2017)[128]
Maternal education		
Schooling years of mother	0.83 (0.71-0.97), *p*=0.02	Islam et al (2018)[171]
Illiterate mother	1.54 (1.41-1.68), *p*<0.05	Choudhury et al (2017)[128]
	1.63 (1.43-1.87), *p*<0.05	Chowdhury et al (2011)[177]
Mother's education up to primary	0.75 (0.63-0.95), *p*<0.001	Talukder et al (2021)[163]
	0.34 (0.15-0.76), *p*=0.01	Henry et al (1993)[179]
Mother's education up to Secondary	0.68 (0.56-0.83), *p*<0.01	Alom et al (2012)[176]
Mother's education: higher	0.65 (0.45-0.98), *p*<0.05	Alom et al (2012)[176]
Mother's education: secondary or higher	0.58 (0.48-0.98), *p*<0.001	Talukder et al (2021)[163]
	0.82 (0.74, 0.91), *p*<0.05	Hasan et al (2016)[173]
No education of household head	1.59 (1.16-2.18), *p*<0.001	Choudhury et al (2000)[37]
If the mother knows diarrheal management:	0.51 (0.30-0.87), *p*=0.014	Raihan et al (2020)[26]
No hand washing by the mother/caregiver before feeding the baby	1.51, *p* <0.006	Ghosh et al. (2021)[160]
Parental tobacco use	1.10 (1.03-1.17), *p*=0.004	Best et al (2007)[109]

associated (OR: 1.5) to childhood wasting. Parental tobacco use was reported as a significant risk factor (OR: 1.1) that exacerbated the child's wasting status.

Socioeconomic factors (Table 4)

Seven studies reported that the wasting rate gradually increased with decreasing wealth quintile i.e. highest in the lowest quintile. Thus, middle-class, upper-middle-class and upper-class economic conditions were found as significant protective factors, and lower-middle-class and lower-class economic conditions were found as significant risk factors for child wasting as well as other forms of undernutrition. Fathers with a low-paid job were found as a significant risk factor (OR: 5.8) for child wasting. Similarly, a monthly family income of less than 10,000 taka (USD 1 = BDT 80 during the study period) was also a risk factor (OR: 2.9) for childhood wasting.

Food insecurity (either moderate or severe) was also found as s significant risk factor for child wasting (OR: 1.3 to 1.7) in one study. Access to a hygienic latrine was a protecting factor (OR: 0.3) and not having any hygienic latrine was found as a risk factor (OR: 1.4) for child wasting. Likewise, lack of access to improved water was also found as a risk factor (OR: 1.8). Access to household electricity was found as a very protective factor (OR: 0.3) for child wasting in one study.

Season, geographic location, and rural-urban residence factors (Table 5)

Seasonal variances were also observed in three studies, e.g. during post-Amon harvest season (January-April) (OR: 0.7) and post-Aus harvest season (September-December) child wasting rate was found to be reduced (OR: 0.7 and 0.8 respectively). However, during the Monsoon season (May-August) child wasting rate increased (OR: 1.5). In addition, flood exposure was found as a huge risk factor (OR: 25.1) for child wasting in one study. The risk of child being wasted was found to be higher if the residence was in Barisal, Rajshahi, Chittagong, and Rangpur divisions. Living in the eastern region of Bangladesh was associated with higher risk (OR: 1.4). The odds of childhood wasting were observed high in urban slums (1.4) in one study, and rural areas (1.2 to 1.2) than urban non-slum areas in two studies.

DISCUSSION

The findings of this review revealed that several factors affect or are associated with the wasting status of U-5 children in Bangladesh. These include (but not limited to) child's birth size, birth order, age, breastfeeding practices and status, diseases and immunization status; siblings and family size; mother's nutritional status; mother's or parent's education; parent's smoking habit; income and socioeconomic status; dietary diversity during pregnancy and availability of food or food insecurity at the household; hygiene and WASH practices; season and residence of children in different government administrative division and geographical location, slum or rural areas.

Our review suggested that children having low birth weight (LBW) or smaller than average size at birth had a higher risk of being wasted, which fits with the findings from Nigeria,[11] Ethiopia,[12] and Ghana[13] and other regions.[3, 14] LBW was found to be associated with a number of supplements involved in childhood development e.g. vitamin A, zinc, and iron.[15] The observed association between birth weight and malnutrition is consistent with the findings of other studies.[16-22] Since child malnutrition can be traced to the fetal period,[22] favorable socio-demographic conditions during the postnatal period usually cannot fully compensate for this initial setback. Since lower birth size is a salient predictor of wasting, reducing the factors influencing this such as adequate maternal nutritional status and prenatal care, might lead to a reduction in the prevalence of wasting.[3]

Table 4. Socioeconomic risk or associated factors of child wasting

	Odds Ratio (95% CI), *p*-value	Reference (respectively)
Wealth index		
Poor (compared to better wealth index)	2.88 (1.22-6.77), p=0.015	Jubayer et al (2020)[180]
	1.38 (1.14-1.68), p<0.05	Rahman et al (2021)[162]
	1.51 (1.06-2.14), p=0.019	Rahman et al (2020)[166]
Wealth index, middle (compared to poor)	0.82 (0.76-0.90), p<0.001	Talukder et al (2021)[163]
	0.73 (0.57-0.92), p=0.008	Hossain et al (2020)[165]
	0.65 (0.47-0.93), p=0.018	Raihan et al (2020)[26]
Wealth index, rich (compared to poor)	0.58 (0.40-0.94), p<0.001	Talukder et al (2021)[163]
	0.74 (0.57-0.96), p=0.025	Hossain et al (2020)[165]
Lower socioeconomic status	2.64 (2.36-2.96), p<0.05	Chowdhury et al (2011)[177]
Middle socioeconomic status	1.77 (1.59-1.97), p<0.05	Chowdhury et al (2011)[177]
Father with a low-paid job	5.78 (2.54-13.16), p<0.001	Fuchs et al (2014)[64]
Father's occupation labourer compared to agriculture	0.78 (0.63-0.91), p<0.01	Fuchs et al (2014)[64]
Monthly family income < 10000 taka (1 US $=80 taka)	2.87 (1.31-6.29), p=0.008	Fuchs et al (2014)[64]
Food insecurity		
Moderate food insecurity	1.66 (1.12-2.46), p=0.011	Choudhury et al (2017)[128]
Severe food insecurity	1.34 (1.09-1.63), p=0.005	Choudhury et al (2017)[128]
Latrine type		
Access to hygienic latrine	0.25 (0.07-0.82), p=0.022	Hoq et al (2019)[167]
Having non-hygienic latrine	1.36 (1.04-1.78), p=0.025	Choudhury et al (2017)[128]
Lack of improved water	1.78, p<0.05	Harding et al (2018)[88]
Access to household electricity	0.27 (0.09-0.81), p=0.02	Islam et al (2018)[88]

Table 5. Seasons, geographic location, and rural-urban residence-related risk or associated factors of child wasting

The risk or associated factors	Odds Ratio (95% CI), *p*-value	Reference (respectively)
Season		
Post-Amon harvest season (January-April)	0.74 (0.66-0.83), $p<0.001$	Mohsena et al (2018)[172]
Post-Aus harvest season (September-December)	0.76 (0.68-0.85), $p<0.001$	Mohsena et al (2018)[172]
Monsoon season	1.45 (1.15-1.84), $p=0.002$	Choudhury et al (2017)[128]
Flood exposure	25.06 (1.81-347.45), $p<0.05$	Goudet, et al (2011)[178]
Administrative division/area/region		
Barisal	1.56 (1.21-2.02), $p<0.05$	Rahman et al (2021) [162]
	1.57 (1.16-2.11), $p=0.003$	Rahman et al (2020) [166]
	1.36 (1.02-1.81), $p<0.05$	Harding et al (2018)[88]
Chittagong	1.40 (1.11-1.77), $p<0.05$	Rahman et al (2021)[162]
Rajshahi	1.50 (1.16-1.93), $p<0.05$	Rahman et al (2021)[162]
	0.68 (0.50-0.94), $p=0.019$	Chowdhury et al (2020)[164]
	1.64 (1.22-2.19), $p=0.001$	Rahman et al (2020)[166]
	1.42 (1.07-1.88), $p<0.05$	Harding et al (2018)[88]
Rangpur	1.31 (1.01-1.69), $p<0.05$	Rahman et al (2021)[162]
Mymensingh	0.59 (0.42-0.84), $p=0.004$	Hossain et al (2020)[165]
Living in the Eastern region of Bangladesh	1.37 (1.02-1.84), $p=0.037$	Choudhury et al (2016)[66]
Eastern Hills agro-ecological zone	0.83 (0.70-0.99), $p<0.05$	Mohsena et al (2018)[172]
City-corporation slum (compared to other city areas)	1.35 (1.04-1.45), $p<0.001$	Talukder et al (2021)[163]
Rural (compared to urban) residence	1.23 (1.01-1.50), $p=0.035$	Rahman et al (2020)[166]
	1.24, $p<0.05$	Harding et al (2018)[88]

Our review found that sex of the child was an important indicator of wasting, and this finding is coherent with the previous studies conducted in Ethiopia,[12] Nigeria,[11] and India.[23] Boys were found 16-36% more likely to be wasted than girls in Afghanistan, Bangladesh, India, and Pakistan. This is contradictory to some early literature on child undernutrition in South Asia, whereby girls were more likely to be stunted or wasted than boys.[24, 25] The higher prevalence of wasting among male children compared to female children as found in this study is consistent with previous study reports[11, 26-29] as well as studies from Pakistan, Ghana, and Sub-Saharan Africa.[30-33] Moreover, all Demographic and Health Surveys in Bangladesh, India, and Nepal since mid-1990s have documented that the prevalence of wasting is higher among boys than girls. The mechanisms that underlie this relationship are unclear and warrant further investigation. However, it is often argued that the vulnerability of male children reflects a natural process.[34] Epidemiological proof suggested that male children are biologically more vulnerable to morbidity as compared to girls.[35, 36] Other possible reasons behind the lower wasting rate among female children than male children can be explained by some factors: a) discrimination against female children in the allocation of food and healthcare within the household is now not as common as it was.[37, 38] b) with gender differences, female children cope better than male children with less sufficient amount of food.[38] Although traditionally male children receive more attention from parents in Bangladesh, this situation has been changing recently. The Government of Bangladesh has implemented policies and programs aimed at enhancing female education, with the provision of stipends and free education for female students, and has encouraged female participation in every job sector. This has resulted in an upgrade of the economic conditions of women in Bangladesh, which has helped them participate in decision-making in almost all sectors where they are involved, especially within their own families. Consequently, parents now value the intelligence of their female children. Therefore, female children now face less discrimination in attention, and have adequate food provision, care, and support.

As we found children aged 12–23 months were more likely to suffer from wasting than the younger age group, confirming similar findings that older age was significantly associated with moderate wasting in children.[2, 39] Older age (compared to less than 12 months) as a risk or associated factor for acute malnutrition (wasting) and other forms of undernutrition was also found in Tamil Nadu, India,[40] and Uganda.[41] Similar findings on wasting and undernutrition have been repeatedly documented by other studies.[23, 32, 42, 43] This can be explained by the fact that majority of children in Bangladesh are breastfed exclusively or at least predominantly for 5 to 6 months postnatally and a good proportion of children continues breast milk for up to 12 months,[44] hence the signs of malnutrition appear later when inadequate complementary feeding practices impede the child's nutritional status and growth. However, the increased wasting rate observed in children older than 24 months age group was not observed in our review.

Our review further revealed that breastfeeding status has a significant effect on the wasting status of children. Children had a lower risk of wasting when mothers had better breastfeeding practices. This is expected as breastmilk supplies all the necessary nutrients and also protects against infections. It should be noted that good nutritional status of the mother can lead to better breastfeeding and helps the mother to recover faster from both physical and mental stress after pregnancy. Other studies also reported the association between breastfeeding practices and nutritional status.[45-48] Early initiation of breastfeeding and continuation of breastfeeding confirmed the protective effect against childhood diarrheal morbidity, which emphasizes universal breastfeeding programs for reducing diarrhea-related morbidities in the first two years of life.[45, 49] The

hygienic and nutritional risks associated with bottle feeding and artificial milk are well known,[50-52] and previous studies also found that breastfeeding had a significant and substantial impact on overall survival of undernourished children.[53, 54]

Our findings on vaccination status and wasting concur with the findings from Papua New Guinea[55] where they also reported that children with compromised nutritional status were less likely to be fully vaccinated.

Acute morbid conditions are one of the immediate causes of acute malnutrition (wasting) in children.[2] Similar to our findings, studies in Ethiopia[56] and India[57] also found significant associations of wasting specially with diarrhea and respiratory illness. The relationship between wasting and diseases, explained by Ayana et al. (2015), as a decrease in appetite and in the absorption of nutrients from the intestine during illness, can lead to weight loss.[56] Wasting was more prevalent in the children who suffered from fever, which is also a result consistent with those of previous studies.[11, 39, 56, 58, 59] Ayana et al. further demonstrated that febrile illness was positively associated with reduced food intake and increased loss of fluids, which might lead to acute childhood undernutrition (wasting).

Our review observed an association between childhood malnutrition and the presence of under-5 siblings in a household. Although difficult to explain, this might be related to childcare and proper feeding practices. Studies reported that educated women prefer to have fewer children and adopt family planning measures, which help improve the overall nutritional status of children.[60] The presence of many young siblings i.e. the occurrence of close birth intervals may have adverse effects on nutritional status due to early weaning from breastmilk. Family size has been documented as a risk factor for malnutrition in several studies in Ethiopia, Pakistan, India, and Malaysia.[21, 56, 57, 61, 62] They explained that children receive less attention from their parents when there is more than one child in the family in the same age group. Studies conducted in Africa[41] and India[63] also reported an association between child wasting and inappropriate feeding practice and other care practices.

A mother of good nutritional status is likely to have healthier babies.[64, 65] Poor maternal nutritional status was found to be a significant predictor of childhood wasting. Therefore, ensuring a better maternal nutritional status is essential and should be included in the formulation of policies and in programs on prevention of child undernutrition. Several similar studies have illustrated that low maternal body mass index (BMI) is related to acute undernutrition in children.[11, 12, 28, 39, 59, 66, 67] Das and Gulshan (2017)[67] found that the children of mothers with a BMI of <18.5 had 2.1 times higher risk of being wasted than those of mothers with BMI >25.5. Rayhan and Khan (2006)[28] estimated that the children of mothers with a BMI >18.5 were 40% less likely to be wasted than those of mothers with BMI <18.5. Chowdhury et al. (2016)[66] found similar results. After controlling for many relevant covariates, maternal MUAC < 23 cm was significantly correlated with wasting, stunting, and underweight status among children. These findings are consistent with results from other settings,[68-71] suggesting that maternal MUAC is a significant predictor of childhood malnutrition. The relationship between low maternal BMI and child wasting may be mediated through poor birth outcomes.[72] Undernourished mothers often deliver low-birth-weight (LBW) infants,[73] which is an attributable risk factor for increased childhood malnutrition, morbidity, and mortality. Breastfeeding adequacy may also be compromised[74, 75] in maternal malnutrition and such mothers might have less energy to appropriately care for their children. Appropriate maternal BMI and weight gain during pregnancy are associated with positive fetal outcomes,[76] indicating optimal maternal nutrition status is associated with positive birth outcomes.[76, 77] Assuming that current maternal BMI reflects maternal BMI status during pre-pregnancy, our findings indicate that the protective effect of a higher BMI on wasting among children is sustained over a long period, hence higher maternal BMI could protect children from becoming malnourished. Furthermore, mothers with a low BMI or who are undernourished may not be able to produce and provide sufficient amounts of breastmilk for their infants, which may be a critical factor that leads to acute malnourishment among children.[28]

Our finding of an inverse association between maternal height and wasting among U-5 children echoes findings from others.[78, 79] Pooled data from 54 low-income countries showed that for every one-centimeter increase in maternal height significantly reduced the risk of wasting (relative risk = 0.994; 95% CI: 0.993, 0.995) among U-5 children.[78] Similarly, another large national survey (NFHS, 2005-2006) in India reported that every one-centimeter increase in maternal height was inversely associated with U-5 wasting (RR = 0.989; 95% CI: 0.984, 0.994).79 The findings from these studies also confirmed the intergenerational association between maternal stature and child undernutrition in Bangladesh.

Our review observed positive associations between increased maternal food consumption during pregnancy and adequate pregnancy weight gain with birth outcomes and subsequent growth and development; and an association between maternal nutrition during pregnancy and fetal growth. Similar findings were also documented in other literature.[3, 80] Fetal growth retardation due to sub-optimal nutrient intake during pregnancy may lead to a low birth weight, which is a critical risk factor for delayed growth during the first two years of life.[3, 81] Hence, increased maternal food consumption during pregnancy may protect younger children from moderate wasting. An analysis of the cost-effectiveness of interventions for maternal and child health outcomes in terms of cost per death averted showed that maintaining optimal nutrition during pregnancy was the most expensive intervention.[82]

Different studies determined the association between the education of parents and the nutritional status of U-5 children.[83, 84] Particularly, mother's education is an underlying factor for wasting among U-5 children as found in our review and also reported by other researchers.[12, 17, 23, 85-88] Children born to mothers with no education were more exposed to being wasted than children of mothers having primary, secondary, or higher education. This is because an educated mother has a better understanding of the basic needs of her newborn baby, and also has a greater scope of learning about the child's health. This finding calls for greater attention of the government to

form policies to facilitate educational environments at the institutional level, particularly for girls. Educated mothers are expected to be more aware of the health, hygiene, and sanitation of their children and consequently can take better care of the children healthwise.[89]

Multiple studies[90, 91] suggested that maternal knowledge of nutrition and health is significantly associated with children's nutrition status. Maternal knowledge of diarrheal management can be viewed as a proxy indicator for knowledge on managing common ailments. This knowledge can help prevent or reduce the duration of diarrheal and other common illnesses in children, thereby reducing the incidence of infections, an important risk factor for wasting. That indicated that raising awareness of mothers on the management of diarrhea and other minor ailments could be a potentially useful major intervention to prevent wasting. The result of our review is supported by other studies, showing an association between parental education with improved nutritional status of children in India, Thailand, Peru, Ghana, and Brazil.[23, 92-94] Studies have also indicated that high level of maternal education are associated with protective childcare behaviors such as vitamin A capsule supplementation, complete childhood immunizations, better sanitation, and use of iodized salt.[95] Higher education also provides women a higher level of autonomy, greater decision-making power in the family regarding health-related matters, and better use of modern health facilities which could lead to better health outcomes of children.[96, 97]. Besides, there is a consensus that higher education leads to higher income. Hence, increasing household earnings enables parents to invest more in health care services and proper food intake for their children.[98] A possible reason behind this might be that educated mothers are usually more empowered and thus they make substantial decisions on dietary diversity and child health.[99] To empower women to make decisions on their own and their children's health, it is mandatory to educate them.[100] Besides, keeping girls in schools longer can delay the age of marriage and age of first birth, which might be a suitable way to empower them.[101, 102] Previous research[28, 103] found that primary education of mothers reduced the risk of childhood stunting, underweight, and wasting in U-5 children in Bangladesh. This finding was consistent with that of,[104] which showed that higher level of maternal education significantly reduced the odds of malnutrition in U-5 children in Malawi, Tanzania, and Zimbabwe and that a lower level of education had no impact. This pattern of prevalence was also reported in previous research.[28, 105]

Similar to our findings, a study in Indonesia also detected an association between paternal smoking and an increased risk of child malnutrition.[106] Several studies in different parts of the world including Bangladesh revealed that money spent on smoking is potentially money not spent on food and deprives the family from their basic needs.[107-110] If the lower-income group could reallocate their smoking expenditure on food, there may be a considerable benefit on improved child nutrition, as well as child health.

Our review observed that children from families with lower income have a higher chance of acute undernutrition than children from middle-and-upper income families. Similar findings were reported in other studies.[2, 111, 112] Income insecurity leads to food insecurity, forcing family members to consume foods that are poor in both quality and quantity. Studies conducted in Bangladesh and India also observed that lower family income is a risk factor for childhood acute malnutrition.[40, 113] Children coming from families with higher income and capital tend to have better diets with higher nutritional conditions, leading to lower odds of having wasted children.[114] The wealth index was negatively associated with wasting. Women from wealthy families have a better/greater intake of nutrients and their children have better nutritional status, whereas poor families are unlikely to manage the cost and remain undernourished.[115] Previous research found that the odds of being wasted are higher among children of poor families than those of rich families.[17, 23, 27, 59, 72, 87] Lower economic status is related to some issues closely linked to the wealth index that would increase acute undernutrition among U-5 children as inadequacy of wealth means inadequacy of basic amenities, such as education, health services, food, and shelter.[87] Diseases such as fever and diarrhea frequently occur in poor families and lead to childhood undernutrition.[87, 116] Ortiz et al. (2013) and Musa et al. (2017) have mentioned that poor access to health services can be related to acute undernutrition.[116, 117] Household wealth has been widely referenced as a determinant of wasting.[114]

This review identified lack of dietary diversity as one of the key problems of childhood wasting. Previous surveys have reported that households consume low-quality diets with little diversity because they lack the resources to grow or purchase micronutrient-rich foods.[118] The findings of this review support existing literature on the association of child undernutrition with less maternal food consumption during pregnancy.[119] In the context of maternal characteristics causing wasting in children, the amount and diversity of food consumed during pregnancy has been found as a contributing factor to both maternal and child health and nutritional status.[120] In most of the reviewed articles, the data collection was based on cross-sectional design, we assumed that current maternal dietary diversity would reflect the dietary diversity during her last pregnancy. However, socioeconomic status also demonstrated significant role for ensuring dietary diversity and the wealthier quintiles had better access and afford the minimal acceptable diet (MAD) (who consumed ≥ 4 food groups in the 24 h) than those who are poorest.[121] It is evident that poor people also do not use the advantages of health-care services if their particular health problem is not severe as they do not have proper financial security.[122] The effect of food insecurity remained strong even after controlling for common and significant socioeconomic characteristics. Therefore, intervention should be taken to eradicate food insecurity. A comprehensive National Food Policy developed in Bangladesh in 2008 was followed in 2011 by the Country Investment Plan, which provided stakeholders with a clear roadmap for investment in agriculture, food security and nutrition.[123] Low dietary intake of micronutrients has negative consequences for children's growth. Nutritional practice of children is hampered by various causes, such as poverty, lack of parental education, especially maternal education, ine-

qualities in urban-rural place of residence, underutilization of health service, poor quality care, and environment.[103, 124-126] Severely food insecure children also led to the higher prevalence of stunting, wasting, and underweight.[127] The significant association between household food insecurity and malnutrition in children was also reported.[128, 129] Moreover, the proportion of children receiving MAD (consumed ≥ 4 food groups in the 24 h preceding the survey) and the proportion of food secure households were both lower than the national figures;[6] thus, there malnutrition could be alleviated by improving MAD and food security status. Previous literature found that children's nutrition status is associated with food availability in the household.[128] MDD is significantly associated with the child nutritional status which reduces the risk of stunting, wasting, and underweight,[130, 131] as the variety and quantity of food items reflects an increase of micronutrients intake.

Unhealthy household environment was found as an underlying cause of acute malnutrition (wasting).[2] The relationship with hygienic latrine and control of waterborne diseases, such as diarrhea, is well stablished. The authors also reported significant decrease in under 2 child malnutrition over time in the intervention area with better coverage of hygienic latrine compared with only health intervention area.[132] A study conducted in Ethiopia also found that malnutrition was associated to latrine access.[56] In general, several studies that were carried out in developing communities suggest an association between childhood diarrhea and poor hygiene and WASH conditions.[133-135] Diarrhea causes lower appetite and often affect the absorption of nutrients.[136] Likewise, undernutrition may prolong the duration and frequency of diarrhea as well as worsen the overall health condition of the child.[137] Diarrhea may also have an indirect contribution to undernutrition through the costs of medication that households spend in treatment, which may affect their food budget.[138] Overall, limited water access, and poor hygiene and sanitation can laed to diarrhea, which can lead to undernutrition. Similar to one of our findings, other studies also reported access for electricity connection and refrigeration for storing perishable food items may lead to an increase consumption of nutritious foods. The relationship between childhood undernutrition/wasting with refrigerator ownership and increased dietary diversity and reduced food insecurity has been established in the literature.[139, 140]

Seasonality is closely related to domestic crop production, which aligns with the significant association between the post-harvest and monsoon seasons and various categories of undernutrition, including wasting in children. Like us, other studies have found that children are more likely to have poorer nutritional status in the dry season compared to the wet season.[141] Also, due to the difference in harvesting period of staples, Bangladesh traditionally suffers a loss in rice production during monsoon, which translates to an increase in child wasting especially in the rural communities.[142]

Also, similar to our findings, other studies found a significant regional differences in terms of prevalence of malnutrition.[111, 143] Malnutrition may conceal important intraregional differences due to diverse cultural norms that might affect nutritional practice. Wide regional variations within countries have also been reported by other studies.[144, 145] An earlier study in India found an increasing prevalence of child malnourishment in certain spatial areas, described as 'pockets of concentration' of malnourishment.[146] Even in countries like the United States and Malaysia, malnutrition-prevalent regions still exist, most of which are populated by ethnic minorities and spatially distanced from the major urban centers.[147] Thus, it is not surprising that similar pockets exist in Bangladesh, where the Haor (a bowl- or saucer-shaped tectonic depression that is submerged with run-off rainwater from upstream) areas are geographically distinct from other areas. Findings of the present study suggest that policymakers need to turn their heads to the Haor Basin area to decrease inter-regional disparity.

The place of residence was also found to be a significant risk factor in U-5 children wasting in other studies.[148, 149] Our review also revealed that the prevalence of wasting in slum areas was higher than non-slum areas. The possible reason is that most people in slum areas are illiterate and poor. No or less education makes them less aware about the nutritional condition of their children, and lack of wealth leads to them not able to provide adequate nutritious food for their U-5 children. Living in poorer rural conditions with inadequate food intake, lack of fundamental health services and greater risk to infections can lead to rural children being more prone to wasting and stunting than those in urban areas and live in better-off households. This result supported the findings from earlier research in other developing countries[23, 31, 150, 151] and further confirmed that household economic condition is a key component of nutritional status of children under two years in developing countries. In developing countries, rural–urban inequality in child malnutrition remained unchanged over the last decades due to economic hardship, inadequate health facilities, and insufficient education.[67, 152, 153] Rural children had a higher risk of wasting than those from urban areas, probably due to lower access to adequate education, poorer household socioeconomic circumstances, poorer quality medical facilities, lack of transportation and individuals' poor knowledge about nutrition. This finding corroborates with those of previous studies,[11, 27] where the population most vulnerable were rural households severely affected by difficulties related to poverty and health. Therefore, income-generating activities and awareness building interventions in rural areas may improve the nutritional status of the children in these areas.[154]

Strengths and limitations

This review has several strengths and limitations. The main strength of this study is that the data of different studies were of national level in Bangladesh. Given this, the findings will help the policy makers within the country to formulate appropriate national-level policies and programs to reduce wasting among U-5 children. However, the review has its limitations. Most reviewed papers, articles and reports were from cross-sectional study. Causality cannot be inferred due to the cross-sectional nature of this study; hence, only association between variables were reported. Most of the reviewed papers, articles and

reports analyzed cases have acute malnutrition defined by the WLZ-score cut-off value. Inclusion of acutely malnourished cases defined by MUAC cut-off value was only in few studies. Inclusion of wasting status by MUAC in all studies gave us the opportunity to analyze the full spectrum of cases that can be considered as moderate or severe wasting. One of the possible limitations may be interviewer bias, whereby in most studies, the personnel who obtained the anthropometric measurements of the children and mothers also conducted the interviews. However, most of the variables identified as risk or associated factors for acute malnutrition in our study were objective. Finally, information (especially the morbidity data) collected through maternal responses may be prone to recall bias. Nonetheless, the systematic sampling and robust sample size ensured that potential recall bias is diluted. Despite all of these, the findings can be generalized at the country level because data were mostly from nationally representative household surveys.

Conclusion and recommendation

These review-findings shed light upon some possible policy responses in dealing with wasting among U-5 children in Bangladesh and similar countries. Many of the underlying determinants of wasting have become the primary focus of nutrition programing in recent years for prevention. As suggested by World Health Organization (WHO), targeted actions against wasting is not only vital but also cost effective.[155] Emphasis has appropriately come to be placed on the first 1,000 days, that is, the period from conception through two years of life, as the critical window of opportunity where substantial impacts can be achieved on child physical growth and brain development.[3, 156, 157]

The Government of Bangladesh has prioritized and implemented nutrition specific interventions including supporting infant and young child feeding (IYCF), micronutrient supplementation, food fortification and other health interventions e.g. antenatal care services which should be strengthened and continued ensuring quality and equity. In addition, community awareness activities should also be strengthened to improve awareness on appropriate IYCF practices, maternal and adolescent nutrition and health knowledge and attitudes towards health care, health and reproductive behaviors. Curative services, such as: early detection of wasted children (especially by MUAC screening) with special attention to hard-to-reach parts of the country, such as the Chittagong Hill Tracts, tea gardens, haor or flood plains, urban slums, and Forcibly Displaced Myanmar Nationals etc.; referral to stabilization centers for the children suffering from severe wasting or severe acute malnutrition; establishment of community based management of acute malnutrition (CMAM); inclusion of rotaviral vaccine in the National EPI program, etc. should be started or strengthened as early as possible. The World Bank recently estimated that every US$ 1 invested in the treatment of severe wasting brings US$ 4 in economic benefits.[158]

Nutrition-sensitive interventions which include access to safe water, sanitation, women's education, gender equality, female autonomy and empowerment, nutrition sensitive social safety net programs and the availability of diversified nutrient rich safe food– are key drivers of reductions in children's wasting and other forms of undernutrition. Interventions to improve education and household income-generating activities among poor households to reduce inequalities, in addition to targeted nutrition care of the mother and child, should be supported further as stated in the national policy agenda.

Interventions to increase coverage and access to hygienic latrines need to be intensified by the local government and the non-governmental organizations.

The causal framework of acute malnutrition is complex and needs multi-sectoral preventive interventions to improve nutrition status of children. The findings of this systematic review suggest that long-term above mentioned relevant, doable and sustainable strategies/programs with the combined efforts of government and non-governmental organizations for tackling malnutrition in U-5 children in Bangladesh must be considered and continued. Further reductions in child wasting and other forms of undernutrition require an increase of investment, improved coordination between relevant sectors and strengthened monitoring.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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REFERENCES

1. WHO. The UNICEF/WHO/WB Joint Child Malnutrition Estimates (JME) group released new data for 2021. 2021.
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J. Maternal and child undernutrition: global and regional exposures and health consequences. The Lancet. 2008;371:243-60.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet. 2013;382:427-51.
4. World Health Organization. Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division: executive summary. World Health Organization 2019. https://iris.who.int/handle/10665/327596.
5. Howlader SR, Sethuraman K, Begum F, Paul D, Sommerfelt A, Elisabeth, A, Kovach T. Investing in Nutrition Now: A Smart Start for Our Children, Our Future. Estimates of Benefits and Costs of a Comprehensive Program for Nutrition in Bangladesh, 2011–2021. Executive Summary of the PROFILES and Nutrition Costing Technical Report. Washington, DC:Food and Nutrition Technical Assistance III Project (FANTA), FHI 360 2012.
6. Research NIoP, Training - NIPORT/Bangladesh, Mitra, Associates, ICF International. Bangladesh Demographic and

Health Survey 2014. Dhaka, Bangladesh: NIPORT, Mitra and Associates, and ICF International; 2016.
7. Research NIoP, Training - NIPORT, Health Mo, Family Welfare, ICF. Bangladesh Demographic and Health Survey 2017-18. Dhaka, Bangladesh: NIPORT/ICF; 2020.
8. Bangladesh Bureau of Statistics (BBS) and UNICEF Bangladesh. Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report. Dhaka, 2019.
9. Bangladesh: Bangladesh Bureau of Statistics (BBS).Headey D, Heidkamp R, Osendarp S, Ruel M, Scott N, Black R, Shekar M, Bouis H, Flory A, Haddad L, Walker N, Standing Together for Nutrition c. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. Lancet. 2020;396:519-21.
10. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6:e1000097-e.
11. Akombi BJ, Agho KE, Merom D, Hall JJ, Renzaho AM. Multilevel Analysis of Factors Associated with Wasting and Underweight among Children Under-Five Years in Nigeria. Nutrients. 2017;9:44.
12. Demissie S. Magnitude and Factors Associated with Malnutrition in Children 6-59 Months of Age in Pastoral Community of Dollo Ado District, Somali Region, Ethiopia. Science Journal of Public Health. 2013;1:175. doi: 10.11648/j.sjph.20130104.12
13. Aheto JMK, Keegan TJ, Taylor BM, Diggle PJ. Childhood Malnutrition and Its Determinants among Under-Five Children in Ghana. Paediatr Perinat Epidemiol. 2015;29:552-61. doi: 10.1111/ppe.12222.
14. Rahman MS, Howlader T, Masud MS, Rahman ML. Association of Low-Birth Weight with Malnutrition in Children under Five Years in Bangladesh: Do Mother's Education, Socio-Economic Status, and Birth Interval Matter? PLoS One. 2016;11:e0157814-e.
15. Gluckman PD, Pinal CS. Regulation of Fetal Growth by the Somatotrophic Axis. J Nutr. 2003;133:S1741-S6. doi: 10.1093/jn/133.5.1741S.
16. Islam MM, Alam M, Tariquzaman M, Kabir MA, Pervin R, Begum M, Khan MMH. Predictors of the number of under-five malnourished children in Bangladesh: application of the generalized poisson regression model. BMC Public Health. 2013;13:11.
17. Mishra K, Kumar P, Basu S, Rai K, Aneja S. Risk Factors for Severe Acute Malnutrition in Children below 5 y of Age in India: A Case-Control Study. Indian J Pediatr. 2013;81:762-5. doi: 10.1007/s12098-013-1127-3.
18. Masiye F, Chama C, Chitah B, Jonsson D. Determinants of child nutritional status in Zambia: An analysis of a national survey. Zambia Soc Sci J. 2010;1:4. Available at: https://scholarship.law.cornell.edu/zssj/vol1/iss1/4
19. Jesmin A, Yamamoto SS, Malik AA, Haque MA. Prevalence and determinants of chronic malnutrition among preschool children: a cross-sectional study in Dhaka City, Bangladesh. J Health Popul Nutr. 2011;29:494-9.
20. Dhar B, Mowlah G, Nahar S, Islam N. Birth-weight status of newborns and its relationship with other anthropometric parameters in a public maternity hospital in Dhaka, Bangladesh. J Health Popul Nutr. 2002;20:36-41.
21. Wong HJ, Moy FM, Nair S. Risk factors of malnutrition among preschool children in Terengganu, Malaysia: a case control study. BMC Public Health. 2014;14:785.
22. Correia LL, Silva ACe, Campos JS, Andrade FMdO, Machado MMT, Lindsay AC, Leite AJM, Rocha HAL, Cunha AJLAd. Prevalence and determinants of child undernutrition and stunting in semiarid region of Brazil. Rev Saude Publica. 2014;48:19-28.
23. Meshram I, Balakrishna N, Arlappa N, Rao KM, Laxmaiah A, Brahmam GNV. Prevalence of Undernutrition, Its Determinants, and Seasonal Variation Among Tribal Preschool Children of Odisha State, India. Asia-Pac J Public Health. 2012;26:470-80. doi: 10.1177/1010539512441492.
24. Hill K, Upchurch DM. Gender Differences in Child Health: Evidence from the Demographic and Health Surveys. Popul. Dev. Rev. 1995;21:127-51. doi.org/10.2307/2137416.
25. Pillai VK, Ortiz-Rodriguez J. Child malnutrition and gender preference in India: The role of culture. Health Science Journal. 2015;6:8. Available at: file:///C:/Users/ihossain/Downloads/child-malnutrition-and-gender-preference-in-india-the-role-of-culture.pdf
26. Raihan MJ, Choudhury N, Haque MA, Farzana FD, Ali M, Ahmed SMT, Rahman SS, Faruque ASG, Ahmed T. Factors associated with moderate wasting among marginalized 6 to 23-month aged children in Bangladesh: Findings of the Suchana program baseline survey data. PLoS One. 2020;15:e0236786-e.
27. Rabbi AMF, Karmaker SC. Determinants of child malnutrition in Bangladesh-A multivariate approach. Asian J. Med. Sci.. 2015;6:85-90. doi:10.3126/ajms.v6i2.10404
28. Rayhan MI, Khan MSH. Factors causing malnutrition among under five children in Bangladesh. Pak J Nutr. 2006;5:558-62.
29. Islam MA, Rahman MM, Mahalanabis D. Maternal and socioeconomic factors and the risk of severe malnutrition in a child: a case-control study. Eur J Clin Nutr 1994;48:416-24.
30. Hazarika G. Gender Differences in Children's Nutrition and Access to Health Care in Pakistan. J Dev Stud. 2000;37:73-92. doi.org/10.1080/713600059
31. Hong R. Effect of economic inequality on chronic childhood undernutrition in Ghana. Public Health Nutr. 2007;10:371-8.
32. Wamani H, Astrøm AN, Peterson S, Tumwine JK, Tylleskär T. Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. BMC Pediatr. 2007;7:17.
33. Abera SF, Kantelhardt EJ, Bezabih AM, Gebru AA, Ejeta G, Lauvai J, Wienke A, Scherbaum V. Nutrition-specific and sensitive drivers of poor child nutrition in Kilte Awlaelo-Health and Demographic Surveillance Site, Tigray, Northern Ethiopia: implications for public health nutrition in resource-poor settings. Glob Health Action. 2019;12:1556572.
34. Wells JCK. Natural Selection and Sex Differences in Morbidity and Mortality in Early Life. J Theor Biol. 2000;202:65-76.
35. Elsmén E, Pupp IH, Hellström-Westas L. Preterm male infants need more initial respiratory and circulatory support than female infants. Acta Paediatr. 2004;93:529-33.
36. Kilbride HW, Daily DK. Survival and subsequent outcome to five years of age for infants with birth weights less than 801 grams born from 1983 to 1989. J Perinatol. 1998;18:102-6.
37. Choudhury KK, Hanifi MA, Rasheed S, Bhuiya A. Gender inequality and severe malnutrition among children in a remote rural area of Bangladesh. J Health Popul Nutr. 2000;18:123-30.
38. Marcoux A. Sex Differentials in Undernutrition: A Look at Survey Evidence. Population and Development Review, The Population Council, Inc. 2002;28:275-84.
39. Rahman A, Chowdhury S, Hossain D. Acute Malnutrition in Bangladeshi Children. Asia Pac J Public Health. 2009;21:294-302.

40. Jeyaseelan L, Lakshman M. Risk factors for malnutrition in South Infian children. J Biosoc Sci. 1997;29:93-100.
41. Kikafunda JK, Walker AF, Collett D, Tumwine JK. Risk Factors for Early Childhood Malnutrition in Uganda. Pediatrics. 1998;102:e45-e.
42. Ricci JA, Becker S. Risk factors for wasting and stunting among children in Metro Cebu, Philippines. Am J Clin Nutr. 1996;63:966-75.
43. Kavosi E, Hassanzadeh Rostami Z, Kavosi Z, Nasihatkon A, Moghadami M, Heidari M. Prevalence and determinants of under-nutrition among children under six: a cross-sectional survey in Fars province, Iran. Int J Health Policy Manag. 2014;3:71-6.
44. Haider R, Ashworth A, Kabir I, Huttly SRA. Effect of community-based peer counsellors on exclusive breastfeeding practices in Dhaka, Bangladesh: a randomised controlled trial. The Lancet. 2000;356:1643-7.
45. Arifeen S, Black RE, Antelman G, Baqui A, Caulfield L, Becker S. Exclusive Breastfeeding Reduces Acute Respiratory Infection and Diarrhea Deaths Among Infants in Dhaka Slums. Pediatrics. 2001;108:e67-e.
46. Demiss M. Child Undernutrition and Infant and Young Child Feeding Indicators: a Secondary Analysis of EDHS 2011-2016. Available at: thesisbank.jhia.ac.ke/cgi/ users/ login?target=http%3A%2F%2Fthesisbank.jhia.ac.ke%2F7027%2F1%2FMastewal%2520Demiss.pdf
47. Lubna M, Begum N, Khatoon S. Infant Feeding Practices and Nutritional Status of Children of Less Than 1 Year. Bangladesh J Obstet Gynaecol. 2016;30:74-9. doi: 10.3329/bjog.v30i2.30895
48. Zongrone A, Winskell K, Menon P. Infant and young child feeding practices and child undernutrition in Bangladesh: insights from nationally representative data. Public Health Nutr. 2012;15:1697-704. doi: 10.1017/S1368980012001073
49. Lamberti LM, Fischer Walker CL, Noiman A, Victora C, Black RE. Breastfeeding and the risk for diarrhea morbidity and mortality. BMC Public Health. 2011;11:1-12. doi: 10.1186/1471-2458-11-S3-S15
50. Jason JM, Nieburg P, Marks JS. Mortality and Infectious Disease Associated with Infant-Feeding Practices in Developing Countries. Pediatrics. 1984;74:702-27.
51. Brown KH, Black RE, de Romaña GL, de Kanashiro HC. Infant-Feeding Practices and Their Relationship With Diarrheal and Other Diseases in Huascar (Lima), Peru. Pediatrics. 1989;83:31-40.
52. Popkin BM, Adair L, Akin JS, Black R, Briscoe J, Flieger W. Breast-feeding and Diarrheal Morbidity. Pediatrics. 1990;86:874-82.
53. Briend A, Wojtyniak B, Rowland MG. Breast feeding, nutritional state, and child survival in rural Bangladesh. Br Med J (Clin Res Ed). 1988;296:879-82.
54. Briend A, Bari A. Breastfeeding improves survival, but not nutritional status, of 12-35 months old children in rural Bangladesh. Eur J Clin Nutr. 1989;43:603-8.
55. Samiak L, Emeto TI. Vaccination and nutritional status of children in Karawari, East Sepik Province, Papua New Guinea. PLoS One. 2017;12:e0187796-e.
56. Ayana AB, Hailemariam TW, Melke AS. Determinants of acute malnutrition among children aged 6–59 months in Public Hospitals, Oromia region, West Ethiopia: a case–control study. BMC Nutrition. 2015;1.
57. Goyal S, Agarwal N, editors. Risk factors for severe acute malnutrition in Central India. Medicine. 2015. Available at: https://www.semanticscholar.org/paper/Risk-factors-for-severe-acute-malnutrition-in-India-Goyal-Agarwal/6077b3c7c189608d2e4f890eac9bbef218ee38c5.
58. Dabale G, Sharma MK. Determinants of Wasting Among Under-Five Children in Ethiopia: A Multilevel Logistic Regression Model Approach. Int. J. Stats. 2014;3:368-77. doi: 10.6000/1929-6029.2014.03.04.5
59. Habyarimana F. Key determinants of malnutrition of children under five years of age in Rwanda: Simultaneous measurement of three anthropometric indices. African Population Studies. 2016:2. Available at: https://www.researchgate.net/publication/368183042_Key_determinants_of_malnutrition_of_children_under_five_years_of_age_in_Rwanda_Simultaneous_measurement_of_three_anthropometric_indices.
60. Biddulph J. Priorities and practice in tropical paediatrics. Journal of Paediatrics and Child Health. 1993;29:12-5. doi: 10.1111/j.1440-1754.1993.tb00429.x
61. Amsalu S, Tigabu Z. Risk factors for ever acute malnutrition inchildren under the age of five: a case-control study. Ethiop. J. Health Dev. 2008;22:1-96.
62. Rahim F, Afridi IG, Afridi JM. Association of risk factors with severe malnutrition in chilren under five years of age. J. Med. Sci. 2013;21:180-2.
63. Kumar D, Goel NK, Mittal PC, Misra P. Influence of infant-feeding practices on nutritional status of under-five children. Indian J Pediatr. 2006;73:417-21.
64. Fuchs C, Sultana T, Ahmed T, Iqbal Hossain M. Factors Associated with Acute Malnutrition among Children Admitted to a Diarrhoea Treatment Facility in Bangladesh. Int J Pediatr. 2014;2014:267806.
65. Torlesse H, Aguayo VM. Aiming higher for maternal and child nutrition in South Asia. Matern Child Nutr. 2018;14:e12739-e.
66. Chowdhury MRK, Rahman MS, Khan MMH, Mondal MNI, Rahman MM, Billah B. Risk Factors for Child Malnutrition in Bangladesh: A Multilevel Analysis of a Nationwide Population-Based Survey. J Pediatr. 2016;172:194-201.
67. Das S, Gulshan J. Different forms of malnutrition among under five children in Bangladesh: a cross sectional study on prevalence and determinants. BMC Nutrition. 2017;3.
68. Assefa N, Berhane Y, Worku A. Wealth status, mid upper arm circumference (MUAC) and antenatal care (ANC) are determinants for low birth weight in Kersa, Ethiopia. PLoS One. 2012;7:e39957-e.
69. Gewa CA, Oguttu M, Yandell NS. Maternal nutrition in rural Kenya: health and socio-demographic determinants and its association with child nutrition. Matern Child Nutr. 2012;8:275-86.
70. Kpewou DE, Poirot E, Berger J, Som SV, Laillou A, Belayneh SN, Wieringa FT. Maternal mid-upper arm circumference during pregnancy and linear growth among Cambodian infants during the first months of life. Matern Child Nutr. 2020;16:e12951-e.
71. Vasundhara D, Hemalatha R, Sharma S, Ramalaxmi BA, Bhaskar V, Babu J, Kankipati Vijaya RK, Mamidi R. Maternal MUAC and fetal outcome in an Indian tertiary care hospital: A prospective observational study. Matern Child Nutr. 2020;16:e12902-e.
72. Khan MN, Rahman MM, Shariff AA, Rahman MM, Rahman MS, Rahman MA. Maternal undernutrition and excessive body weight and risk of birth and health outcomes. Arch Public Health. 2017;75:12.
73. Kramer MS. The Epidemiology of Adverse Pregnancy Outcomes: An Overview. J Nutr. 2003;133:S1592-S6.
74. Osteria TS. Maternal nutrition, infant health, and subsequent fertility. Philipp J Nutr. 1982;35:106-11.
75. Brown KH, Akhtar NA, Robertson AD, Ahmed MG. Lactational Capacity of Marginally Nourished Mothers: Relationships Between Maternal Nutritional Status and

Quantity and Proximate Composition of Milk. Pediatrics. 1986;78:909-19.
76. Ludwig DS, Currie J. The association between pregnancy weight gain and birthweight: a within-family comparison. Lancet. 2010;376:984-90.
77. Crane JMG, White J, Murphy P, Burrage L, Hutchens D. The Effect of Gestational Weight Gain by Body Mass Index on Maternal and Neonatal Outcomes. J Obstet Gynaecol Can. 2009;31:28-35.
78. Ozaltin E, Hill K, Subramanian SV. Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. JAMA. 2010;303:1507-16.
79. Subramanian SV, Ackerson LK, Davey Smith G, John NA. Association of maternal height with child mortality, anthropometric failure, and anemia in India. JAMA. 2009;301:1691-701.
80. Jahan K, Roy SK, Mihrshahi S, Sultana N, Khatoon S, Roy H, et al. Short-Term Nutrition Education Reduces Low Birthweight and Improves Pregnancy Outcomes among Urban Poor Women in Bangladesh. Food Nutr Bull. 2014;35:414-21.
81. Hasan SMT, Rahman S, Locks LM, Rahman M, Hore SK, Saqeeb KN, Khan MA, Ahmed T. Magnitude and determinants of inadequate third-trimester weight gain in rural Bangladesh. PLoS One. 2018;13:e0196190-e.
82. Black R, Laxminarayan R, Temmerman M, Walker N. Disease Control Priorities, Third Edition (Volume 2): Reproductive, Maternal, Newborn, and Child Health. Washington, DC: World Bank; 2016.
83. Mshida HA, Kassim N, Mpolya E, Kimanya M. Water, Sanitation, and Hygiene Practices Associated with Nutritional Status of Under-Five Children in Semi-Pastoral Communities Tanzania. Am J Trop Med Hyg. 2018;98:1242-9.
84. van Cooten MH, Bilal SM, Gebremedhin S, Spigt M. The association between acute malnutrition and water, sanitation, and hygiene among children aged 6-59 months in rural Ethiopia. Matern Child Nutr. 2019;15:e12631-e.
85. Phengxay M, Ali M, Yagyu F, Soulivanh P, Kuroiwa C, Ushijima H. Risk factors for protein?energy malnutrition in children under 5 years: Study from Luangprabang province, Laos. Pediatr Int. 2007;49:260-5.
86. Urke HB, Bull T, Mittelmark MB. Socioeconomic status and chronic child malnutrition: wealth and maternal education matter more in the Peruvian Andes than nationally. Nutr Res. 2011;31:741-7.
87. Ambadekar NN, Zodpey SP. Risk factors for severe acute malnutrition in under-five children: a case-control study in a rural part of India. Public Health. 2017;142:136-43.
88. Harding KL, Aguayo VM, Webb P. Factors associated with wasting among children under five years old in South Asia: Implications for action. PLoS One. 2018;13:e0198749-e.
89. Abuya BA, Ciera J, Kimani-Murage E. Effect of mother's education on child's nutritional status in the slums of Nairobi. BMC Pediatr. 2012;12:80.
90. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HPS, Shekar M. What works? Interventions for maternal and child undernutrition and survival. The Lancet. 2008;371:417-40.
91. Saito K, Korzenik JR, Jekel JF, Bhattacharji S. A case-control study of maternal knowledge of malnutrition and health-care-seeking attitudes in rural South India. Yale J Biol Med. 1997;70:149.
92. Ruel MT, Menon P. Child Feeding Practices Are Associated with Child Nutritional Status in Latin America: Innovative Uses of the Demographic and Health Surveys. J Nutr. 2002;132:1180-7.
93. Armar-Klemesu M, Ruel MT, Maxwell DG, Levin CE, Morris SS. Poor Maternal Schooling Is the Main Constraint to Good Child Care Practices in Accra. J Nutr. 2000;130:1597-607.
94. Monteiro CA, Benicio MHDA, Conde WL, Konno S, Lovadino AL, Barros AJD, Victora CG. Narrowing socioeconomic inequality in child stunting: the Brazilian experience, 1974-2007. Bull World Health Organ. 2010;88:305-11.
95. Semba RD, de Pee S, Sun K, Sari M, Akhter N, Bloem MW. Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. The Lancet. 2008;371:322-8.
96. Cleland JG, van Ginneken JK. Maternal education and child survival in developing countries: The search for pathways of influence. Social Science & Medicine. 1988;27:1357-68.
97. Kishor S. Autonomy and Egyptian women: Findings from the 1988 Egypt Demographic and Health Survey. Calverton, Maryland, USA: Macro International; 1995.
98. Chowdhury TR, Chakrabarty S, Rakib M, Saltmarsh S, Davis KA. Socio-economic risk factors for early childhood underweight in Bangladesh. Global Health. 2018;14:54. doi: 10.1186/s12992-018-0372-7.
99. Vollmer S, Bommer C, Krishna A, Harttgen K, Subramanian SV. The association of parental education with childhood undernutrition in low- and middle-income countries: comparing the role of paternal and maternal education. Int J Epidemiol. 2017;46:312-23.
100. Samarakoon S, Parinduri RA. Does Education Empower Women? Evidence from Indonesia. World Dev. 2015;66:428-42. Available at: https://www.sciencedirect.com/science/article/pii/S0305750X14002678.
101. Alderman H, Headey DD. How Important is Parental Education for Child Nutrition? World Dev. 2017;94:448-64. doi: 10.1016/j.worlddev.2017.02.007.
102. Duflo E. Women Empowerment and Economic Development. J Econ. Lit. 2012;50:1051-79. doi:10.1257/jel.50.4.1051.
103. Das S, Hossain M, Islam MA. Predictors of child chronic malnutrition in Bangladesh. Proc Pakistan Acad Sci. 2008;45:137-155.
104. Makoka D. The impact of maternal education on child nutrition: Evidence from Malawi, Tanzania, and Zimbabwe. Calverton, Maryland, USA: ICF International; 2013.
105. Das S, Hossain Z, Nesa MK. Levels and trends in child malnutrition in Bangladesh. Asia-Pacific Population Journal. 2009;24:51-78. doi: 10.18356/6ef1e09a-en
106. Semba RD, Kalm LM, Pee Sd, Ricks MO, Sari M, Bloem MW. Paternal smoking is associated with increased risk of child malnutrition among poor urban families in Indonesia. Public Health Nutr. 2007;10:7-15.
107. Efroymson D, Ahmed S, Townsend J, Alam SM, Dey AR, Saha R, Dhar B, Sujon AI, Ahmed KU, Rahman O. Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. Tob Control. 2001;10:212-7.
108. Best CM, Sun K, de Pee S, Sari M, Bloem MW, Semba RD. Paternal smoking and increased risk of child malnutrition among families in rural Indonesia. Tob Control. 2008;17:38-45.
109. Best CM, Sun K, de Pee S, Bloem MW, Stallkamp G, Semba RD. Parental tobacco use is associated with increased risk of child malnutrition in Bangladesh. Nutrition. 2007;23:731-8.

110. Cohen N. Smoking, health, and survival: prospects in Bangladesh. The Lancet. 1981;317:1090-3.
111. Kandala N-B, Madungu TP, Emina JBO, Nzita KPD, Cappuccio FP. Malnutrition among children under the age of five in the Democratic Republic of Congo (DRC): does geographic location matter? BMC Public Health. 2011;11:261.
112. Medhin G, Hanlon C, Dewey M, Alem A, Tesfaye F, Worku B, Tomlinson M, Prince M. Prevalence and predictors of undernutrition among infants aged six and twelve months in Butajira, Ethiopia: the P-MaMiE Birth Cohort. BMC Public Health. 2010;10:27.
113. Ahmed AS, Ahmed T, Roy S, Alam N, Hossain MI. Determinants of undernutrition in children under 2 years of age from rural Bangladesh. Indian Pediatr. 2012;49:821-4.
114. Martorell R, Young MF. Patterns of stunting and wasting: potential explanatory factors. Adv Nutr. 2012;3:227-33.
115. Das S, Alam MA, Mahfuz M, El Arifeen S, Ahmed T. Relative contributions of the correlates of stunting in explaining the mean length-for-age z-score difference between 24-month-old stunted and non-stunted children living in a slum of Dhaka, Bangladesh: results from a decomposition analysis. BMJ open. 2019;9:e025439.
116. Ortiz J, Van Camp J, Wijaya S, Donoso S, Huybregts L. Determinants of child malnutrition in rural and urban Ecuadorian highlands. Public Health Nutr. 2013;17:2122-30.
117. Musa MK, Muhammad F, Lawal KM, Alauddin Chowdhury ABM, Hossain A. Risk Factors of Severe Acute Malnutrition among Under-five Children: A Hospital-based Study in Bangladesh. J Med Sci Health. 2017;03:13-21.
118. Torlesse H, Moestue H, Hall A, De Pee S, Kiess L, Bloem M. Dietary diversity in Bangladesh: evidence from the nutritional surveillance project. Alleviating malnutrition through agriculture in Bangladesh biofortification and diversification as sustainable solutions, Dhaka and Gazipur, Bangladesh. 2002:44-9.
119. Martorell R, Zongrone A. Intergenerational Influences on Child Growth and Undernutrition. Paediatr Perinat Epidemiol. 2012;26:302-14.
120. Virtanen SM, Uusitalo L, Kenward MG, Nevalainen J, Uusitalo U, Kronberg-Kippilä C, et al. Maternal food consumption during pregnancy and risk of advanced β-cell autoimmunity in the offspring. Pediatr Diabetes. 2010;12:95-9.
121. Nguyen PH, Avula R, Ruel MT, Saha KK, Ali D, Tran LM, Frongillo EA, Menon P, Rawat R. Maternal and Child Dietary Diversity Are Associated in Bangladesh, Vietnam, and Ethiopia. J Nutr. 2013;143:1176-83.
122. Rashidul Alam Mahumud MS, Abdur Razzaque Sarker. Trend of Healthcare Expenditures in Bangladesh over Last Decades. American Journal of Economics, Finance and Management. 2015;1:97-101. Available at: https://www.researchgate.net/publication/275014693_Trend_of_Healthcare_Expenditures_in_Bangladesh_over_Last_Decades/link/552e18320cf21acb09219ac2/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19.
123. Hasan MM, Ahmed S, Chowdhury MAH. Food Insecurity and Child Undernutrition: Evidence from BDHS 2011. J. Food Secur. 2013;1:52-7. Available at: http://pubs.sciepub.com/jfs/1/2/7.
124. Sah N. Determinants of child malnutrition in Nepal: a case analysis from Dhanusha, Central Terai of Nepal. J. Nepal Health Res. Counc. 2008;2:50-4. doi: 10.33314/ jnhrc.v0i0.89
125. Deolalikar AB. Poverty and Child Malnutrition in Bangladesh. J. Dev. Soc. 2005;21:55-90. doi:10.1177/0169796X05053067
126. Rusinga O, Moyo S. Determinants of child malnutrition in Changazi Ward in Chimanimani District, Zimbabwe. Journal of Emerging Trends in Educational Research and Policy Studies. 2012;3:187-92. Available at: https://www.semanticscholar.org/paper/Determinants-of-child-malnutrition-in-Changazi-Ward-Rusinga-Moyo/f41ce334b339c8ce2e286a0b83833189a705bdcb.
127. Ali D, Saha KK, Nguyen PH, Diressie MT, Ruel MT, Menon P, Rawat R. Household Food Insecurity Is Associated with Higher Child Undernutrition in Bangladesh, Ethiopia, and Vietnam, but the Effect Is Not Mediated by Child Dietary Diversity. J Nutr. 2013;143:2015-21.
128. Choudhury N, Raihan MJ, Sultana S, Mahmud Z, Farzana FD, Haque MA, Rahman AS, Waid JL, Chowdhury AMR, Black RE, Ahmed T. Determinants of age-specific undernutrition in children aged less than 2 years-the Bangladesh context. Matern Child Nutr. 2017;13:e12362.
129. Corsi DJ, Kyu HH, Subramanian SV. Socioeconomic and Geographic Patterning of Under- and Overnutrition among Women in Bangladesh. J Nutr. 2011;141:631-8.
130. Oduor FO. Malnutrition, dietary diversity, morbidity and associated factors among schoolchildren in Kibwezi district, Kenya. 2011. Available at: http://erepository.uonbi.ac.ke/bitstream/ handle/11295/56381/Oduor_Malnutrition%2C%20dietary%20diversity%2C%20morbidity.pdf?sequence=3].
131. Rah JH, Akhter N, Semba RD, Pee Sd, Bloem MW, Campbell AA, Moench-Pfanner R, Sun K, Badham J, Kraemer K. Low dietary diversity is a predictor of child stunting in rural Bangladesh. Eur J Clin Nutr. 2010;64:1393-8.
132. Hoq M, Brogan J. Evaluation of an integrated health-nutrition-WASH project to reduce malnutrition prevalence in children under two in Bangladesh. 2016. Available at: https://www.ennonline.net/fex/51/healthnutwashbangladesh].
133. Uwizeye D, Sokoni CH, Kabiru CW. Prevalence and correlates for diarrhoea in the mountainous informal settlements of Huye town, Rwanda. Springerplus. 2014;3:745.
134. Hongxing L, Wei Y, Guoqing D, Li W, Qing L, Shan W, Chuanlong X, Qi Z. Water and sanitation interventions to control diarrheal disease in rural China. J. Water Sanit. Hyg. Dev. 2016;6:640-9. doi: 10.2166/washdev.2016.131
135. Adane M, Mengistie B, Kloos H, Medhin G, Mulat W. Sanitation facilities, hygienic conditions, and prevalence of acute diarrhea among under-five children in slums of Addis Ababa, Ethiopia: Baseline survey of a longitudinal study. PLoS One. 2017;12:e0182783-e.
136. Martorell R, Yarbrough C, Yarbrough S, Klein RE. The impact of ordinary illnesses on the dietary intakes of malnourished children. Am J Clin Nutr. 1980;33:345-50.
137. Ngure FM, Reid BM, Humphrey JH, Mbuya MN, Pelto G, Stoltzfus RJ. Water, sanitation, and hygiene (WASH), environmental enteropathy, nutrition, and early child development: making the links. Annals of the New York Academy of Sciences. 2014;1308:118-28.
138. Chaese C, Ngure F. Multisectoral approaches to improving nutrition: Water, sanitation, and hygiene. Washington, DC: World Bank Group.2016.
139. Ballantine N, Rousseau GG, Venter DJL. Purchasing behaviour as a determinant of food insecurity in Klipplaat. J. Fam. Ecol. Consum. Sci.. 2009;36. doi:10.4314/jfecs. v36i1.47109
140. Faber M, Schwabe C, Drimie S. Dietary diversity in relation to other household food security indicators. International

Journal of Food Safety, Nutrition and Public Health. 2009;2:1-15. doi.org/10.1504/IJFSNPH.2009.026915
141. Chikhungu LC, Madise NJ. Seasonal variation of child under nutrition in Malawi: is seasonal food availability an important factor? Findings from a national level cross-sectional study. BMC Public Health. 2014;14:1146. doi: 10.1186/1471-2458-14-1146
142. Hossain M, Naher F, Shahabuddin Q. Food Security and Nutrition in Bangladesh: Progress and Determinants. Electronic Journal of Agricultural and Development Economics. 2005;2:103-32. Available at: https://www.researchgate.net/publication/5021675_Food_Security_and_Nutrition_in_Bangladesh_Progress_and_Determinants.
143. Zere E, McIntyre D. Inequities in under-five child malnutrition in South Africa. Int J Equity Health. 2003;2:7.
144. Spray AL, Eddy B, Hipp JA, Iannotti L. Spatial Analysis of Undernutrition of Children in Léogâne Commune. Haiti. Food Nutr Bull. 2013;34:444-61.
145. Mohsena M, Goto R, Nicholas Mascie-Taylor CG. Regional variation in maternal and childhood undernutrition in Bangladesh: evidence from demographic and health surveys. WHO South-East Asia J Public Health. 2015;4:139-49.
146. Nair KRG. Malnourishment among Children in India: A Regional Analysis. Economic and Political Weekly. 2007;42. Available at: https://www.epw.in/journal/2007/37/special-articles/malnourishment-among-children-india-regional-analysis.html].
147. Slifkin RT, Goldsmith LJ, Ricketts TC. Race and Place: Urban-Rural Differences in Health for Racial and Ethnic Minorities. NC: University of North Carolina at Chapel Hill; 2000. NC RHRP Working Paper Series, No. 66..
148. Wamani H, Tylleskär T, Astrøm AN, Tumwine JK, Peterson S. Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. Int J Equity Health. 2004;3:9.
149. Hien NN, Kam S. Nutritional Status and the Characteristics Related to Malnutrition in Children Under Five Years of Age in Nghean, Vietnam. J Prev Med Public Health. 2008;41:232.
150. Hong R, Mishra V. Effect of wealth inequality on chronic under-nutrition in Cambodian children. J Health Popul Nutr. 2016;24:89-99.
151. Kien VD, Lee H-Y, Nam Y-S, Oh J, Giang KB, Van Minh H. Trends in socioeconomic inequalities in child malnutrition in Vietnam: findings from the Multiple Indicator Cluster Surveys, 2000-2011. Glob Health Action. 2016;9:29263.
152. Fotso J-C. Urban–rural differentials in child malnutrition: Trends and socioeconomic correlates in sub-Saharan Africa. Health Place. 2007;13:205-23.
153. Srinivasan CS, Zanello G, Shankar B. Rural-urban disparities in child nutrition in Bangladesh and Nepal. BMC Public Health. 2013;13:581.
154. Kabir I, Khanam M, Agho KE, Mihrshahi S, Dibley MJ, Roy SK. Determinants of inappropriate complementary feeding practices in infant and young children in Bangladesh: secondary data analysis of Demographic Health Survey 2007. Matern Child Nutr. 2012;8:S11-S27.
155. WHO. Global nutrition targets 2025: breastfeeding policy brief (WHO/NMH/NHD14.7). Geneva: World Health Organization. 2014.
156. King JC. A Summary of Pathways or Mechanisms Linking Preconception Maternal Nutrition with Birth Outcomes. J Nutr. 2016;146:1437S-44S.
157. Wrottesley SV, Lamper C, Pisa PT. Review of the importance of nutrition during the first 1000 days: maternal nutritional status and its associations with fetal growth and birth, neonatal and infant outcomes among African women. J Dev Orig Health Dis. 2015;7:144-62.
158. Washington DCWBG. Investing in nutrition : the foundation for development – an investment framework to reach the global nutrition targets (English). 2016.
159. Das R, Haque MA, Chisti MJ, Faruque ASG, Ahmed T. Associated factors, post infection child growth, and household cost of invasive enteritis among under 5 children in Bangladesh. Sci Rep. 2021;11:12738.
160. Ghosh S, Kabir MR, Islam M, Bin Shadat Z, Ishat FS, Hasan R, Hossain I, Alam SS, Halima O. Association between water, sanitation, and hygiene practices (WASH) and anthropometric nutritional status among selected under-five children in rural Noakhali, Bangladesh: a cross-sectional analysis. Journal of Water, Sanitation and Hygiene for Development. 2020;11:141-51. doi: 10.2166/washdev.2020.133
161. Haque MA, Choudhury N, Farzana FD, Ali M, Raihan MJ, Ahmed SMT, Rahman SS, Siddiqua TJ, Faruque ASG, Ahmed T. Determinants of maternal low mid-upper arm circumference and its association with child nutritional status among poor and very poor households in rural Bangladesh. Matern Child Nutr. 2021;17:e13217-e.
162. Rahman SMJ, Ahmed NAMF, Abedin MM, Ahammed B, Ali M, Rahman MJ, Maniruzzaman M. Investigate the risk factors of stunting, wasting, and underweight among under-five Bangladeshi children and its prediction based on machine learning approach. PLoS One. 2021;16:e0253172-e.
163. Talukder A. Risk factors associated with wasting among under-5 children residing in urban areas of Bangladesh: a multilevel modelling approach. J of Public Health. 2019;29:525-31. doi:10.1007/s10389-019-01163-4
164. Chowdhury TR, Chakrabarty S, Rakib M, Afrin S, Saltmarsh S, Winn S. Factors associated with stunting and wasting in children under 2 years in Bangladesh. Heliyon. 2020;6:e04849.
165. 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. doi: 10.1016/j.childyouth.2020.105291
166. Rahman MS, Rahman MA, Maniruzzaman M, Howlader MH. Prevalence of undernutrition in Bangladeshi children. J Biosoc Sci. 2020;52:596-609. doi: 10.1017/S0021932019000683
167. Hoq M, Ali M, Islam A, Banerjee C. Risk factors of acute malnutrition among children aged 6-59 months enrolled in a community-based programme in Kurigram, Bangladesh: a mixed-method matched case-control study. J Health Popul Nutr. 2019;38:36.
168. Sheikh N, Akram R, Ali N, Haque SMR, Tisha S, Mahumud RA, Sarker AR, Sultana M. Infant and young child feeding practice, dietary diversity, associated predictors, and child health outcomes in Bangladesh. J Child Health Care. 2019;24:260-73.
169. Khatun W, Rasheed S, Alam A, Huda TM, Dibley MJ. Assessing the Intergenerational Linkage between Short Maternal Stature and Under-Five Stunting and Wasting in Bangladesh. Nutrients. 2019;11:1818.
170. Hossain MB, Khan MHR. Role of parental education in reduction of prevalence of childhood undernutrition in Bangladesh. Public Health Nutr. 2018;21:1845-54.
171. Islam MM, Arafat Y, Connell N, Mothabbir G, McGrath M, Berkley JA, Ahmed T, Kerac M. Severe malnutrition in infants aged <6 months-Outcomes and risk factors in Bangladesh: A prospective cohort study. Matern Child Nutr. 2019;15:e12642-e.

172. Mohsena M, Hossain M, Chakraborty B, Bayes A, Rahman ANM. Fragile environment, seasonality and maternal and childhood undernutrition in Bangladesh. J Biosoc Sci. 2017;50:579-603.
173. 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;12:929-39.
174. Das J, Das SK, Hasan T, Ahmed S, Ferdous F, Begum R, Chisti MJ, Malek MA, Mamun AA, Faruque ASG. Childhood malnutrition in households with contemporary siblings: a scenario from urban Bangladesh. Eur J Clin Nutr. 2015;69:1178-9.
175. Raj A, McDougal LP, Silverman JG. Gendered effects of siblings on child malnutrition in South Asia: cross-sectional analysis of demographic and health surveys from Bangladesh, India, and Nepal. Matern Child Health J. 2015;19:217-26.
176. Alom J, Quddus MA, Islam MA. Nutritional status of under-five children in Bangladesh: a multilevel analysis. J Biosoc Sci. 2012;44:525-35.
177. Chowdhury F, Chisti MJ, Hossain MI, Malek MA, Salam MA, Faruque ASG. Association between paternal smoking and nutritional status of under-five children attending Diarrhoeal Hospital, Dhaka, Bangladesh. Acta Paediatr. 2010;100:390-5. doi: 10.1111/j.1651-2227.2010.02067.x.
178. Goudet S, Griffths P, Bogin BA. Mother's body mass index as a predictor of infant's nutritional status in the post-emergency phase of a flood. Disasters. 2011;35:701-19.
179. Henry F, Briend A, Fauveau V, Huttly SR, Yunus M, Chakraborty J. Risk Factors for Clinical Marasmus: A Case-Control Study of Bangladeshi Children. Int J Epidemiol. 1993;22:278-83.
180. Jubayer A, Islam MH, Nayan MM. Malnutrition among under-five children in St. Martin's Island, Bangladesh: A cross-sectional study on prevalence and associated factors. SAGE Open Med. 2022;10:20503121221116246.