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Determinants of age-specific undernutrition in children aged less than 2 years—the Bangladesh context

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Abstract

Globally, undernutrition affects nearly half of all children aged less than 5 years. It is more prominent in low- and middle-income countries. This study aimed to identify the age-specific risk factors for different categories of undernutrition among Bangladeshi children aged less than 2 years. Data of 10,291 children aged less than 2 years were collected between October 2011 to November 2013 through the Food Security Nutritional Surveillance Project in Bangladesh. Simple logistic regression established bivariate relationships between the categories of undernutrition and the relevant risk factors. Multiple logistic regression constructed the age-specific regression models depicting the independent association and effect size of the risk factors contributing to the various categories of undernutrition among study population. Stunting was prevalent among 30.9% of the study children, whereas 9.7% were wasted and 24.9% were underweight. Being a male child, increase in age, maternal body mass index and education, and household food insecurity were the strongest predictors for all categories of undernutrition in terms of effect size. Our study shows that the different categories of childhood undernutrition have different age-specific risk factors. Maternal body mass index and household food insecurity were the common age-specific risk factors for all categories of undernutrition. We expect our findings to enhance the existing evidence base for the risk factors of undernutrition among children aged less than 2 years.

KEYWORDS

Bangladesh, food insecurity, stunting, underweight, undernutrition, wasting

1 | INTRODUCTION

The world has gained remarkable progress in achieving reduction in child mortality rate (Bryce, Black, & Victora, 2013; Wang et al., 2014; Black et al., 2013). Nevertheless, it was estimated that 6.3 million children aged less than 5 years died in 2013 (Wang et al., 2014). Undernutrition contributes to the death of nearly half of all children aged less than 5 years (Bryce et al., 2013; Black et al., 2013; Caulfield et al., 2004). Maternal undernutrition, strongly associated with fetal undernutrition (Bhutta et al., 2008; Ngure et al., 2014), alone is attributed to around 800,000 neonatal deaths per year globally (Bhutta et al., 2013). Convergence of many findings has shown that the highest concentration of child mortality exists in low- and middle-income countries especially in South Asian region (Liu et al.,

2012; Black et al., 2010; Hogan et al., 2010). Bangladesh, one of the most densely populated and poverty stricken countries in the world, is no exception to bearing a substantial malnourished child population (Chowdhury et al., 2013). Undernutrition in children is quantified using anthropometric status indicators, which incorporates height/length-for-age z-score (stunting), weight-for-height/length z-score (wasting), and weight-for-age z-score (underweight) for all children aged less than 5 years. The z-score value of less than -2 as per the World Health Organization growth standard defines the undernutrition condition (WHO, 2006). Latest data from Bangladesh show that, although on decline, the prevalence of stunting, wasting and underweight among children aged less than 5 years is still around 36%, 14% and 33% respectively (NIPORT, Mitra and Associates & ICF, 2016).

The Government of Bangladesh mainstreamed nutrition with existing health and family planning programs (Pelletier et al., 2012; DGHS, 2011) and emphasized on controlling undernutrition in its 5-year national health program, the national nutrition policy. The Food Security Nutritional Surveillance Project (FSNSP) contributes to the government of Bangladesh's initiatives in this regard. The FSNSP is currently the only food and nutrition security surveillance system in Bangladesh to collect data on food security and nutritional status from a nationally representative population. A prime domain of the FSNSP is child nutrition, focusing on factors that may contribute to undernutrition in children aged less than 2 years.

High impact nutritional interventions for the children aged less than 2 years can be designed with increased impact if age-specific risk factors are identified and appropriately addressed, as the common risk factors of undernutrition may not affect children of all age groups equally. It is also needed to be understood that the dietary requirements and consumption frequency for children aged less than 2 years are 'age group specific', with exclusive breastfeeding recommended for children aged 0 to 5 months along with continued breastfeeding and gradual introduction with increased frequency and variety of semi-solid and solid food consumption from 6 months onward.

This paper is based on the analysis of the FSNSP data to provide a unique opportunity to identify and explore the age-specific determinants of undernutrition, which includes child feeding practices, dietary diversity, child morbidity, socio-economic status, food insecurity, water, sanitation and hygiene status, and maternal pregnancy care. The age-specific groups of children aged less than 2 years that were considered in this paper were 0–5 months, 6–11 months, and 12–23 months. We expect that the paper would contribute to the existing body of knowledge and also inform program design for children aged less than 2 years.

2 | MATERIALS AND METHODS

The FSNSP, constituted of a nationally representative sample, follows a repeated cross-sectional survey design by collecting countrywide data from households over three seasons in Bangladesh: the post-*aman* crop harvest period (January–April), the height of the monsoon (May–August), and the post-*aus* crop harvest season (September–December). This paper used the FSNSP data available from seven rounds of data collection from October 2011 to November 2013. The details of FSNSP sample selection and data collection are

mentioned elsewhere (James P Grant School of Public Health (JPG-SPH)/Helen Keller International (HKI), 2012).

2.1 | Sample size

The single population proportion sample size calculation was based on the estimated prevalence of seven key indicators over the course of a year including child wasting, underweight, stunting, women's chronic energy deficiency, household food security, food deficit, and food consumption. For this paper, the available sample of 10,291 children aged less than 2 years who is the youngest child in the household, along with all their relevant information was used for analysis. The detail of sample size calculation has been mentioned elsewhere (James P Grant School of Public Health (JPG-SPH)/Helen Keller International (HKI), 2012). The study profile is illustrated in Figure 1. The data analysis exclusion criteria entails exclusion of data of children (youngest) with missing maternal data, children whose mother was pregnant at the time of data collection, and children whose height/length-for-age z-score was below -6 or weight-for-age z-score below -6 and weight-for-height/length z-score below -5 less than the World Health Organization standard cut-off (WHO, 2006).

2.2 | Variables of interest

Selection of the variables relevant for analysis was based on extensive literature review and our experience. Variables considered as relevant for child nutrition included age and gender, length and weight, vitamin A capsule intake within last 6 months, morbidity (history collected for 2 weeks preceding the survey), de-worming medication (applicable for 12- to 23-month children), dietary diversity (24-hr recall), initiation of breastfeeding, exclusive breastfeeding (considered for children below 6 months, 24-hr recall), breastfeeding status of the child (whether breastfed in last 24 hr), and age appropriate minimum acceptable diet (for children aged 6–23 months, continued breastfeeding and age appropriate dietary diversity and frequency).

Maternal characteristics evaluated were body mass index (BMI), education and occupation, post-partum vitamin A capsule intake (within 6 weeks of child birth), minimum acceptable maternal dietary diversity (consuming at least five of the nine food groups in last 24-hr, recall) (Arimond et al., 2009), quantity of food consumed, taking rest, and iron supplementation intake during last pregnancy, and antenatal care during last pregnancy and postnatal care (whether the mother had received care within 42 days of the last delivery).

Key messages

- There is diversity in risk factors for different categories of undernutrition in children aged less than 2 years.
- Child sex, age, maternal BMI, maternal education, and household food insecurity were found to be the strongest factors for determining age-specific undernutrition among children aged less than 2 years.
- Risk factors from the maternal characteristics domain, even in age stratified groups, appeared to be robust predictors for child undernutrition.

FIGURE 1 Study profile

The household demographic variables included asset index as a proxy indicator for household wealth. The asset index variable used in this paper was calculated following the Bangladesh Demographic and Health Survey methodology, which incorporates rural-urban difference (NIPORT, Mitra and Associates & ICF International, 2013). The data used to calculate asset index were ownership of homestead and agricultural land, furniture/household assets, material used for constructing floor, wall, and roof, number of rooms used for sleeping, and type of cooking fuel, livestock, and poultry. Other variables included income of the household (of last month), Household Food Insecurity Access Scale (Coates, Swindale, & Bilinsky, 2007), household toilet facility, use of a cleaning agent while washing hand, use of soap for hand washing after defecation, and source of drinking water.

2.3 | Data analysis

We used STATA (version 10) software for analyzing the data. The STATA `svyset` command for complex survey data analysis has been used. The detail function of the `svyset` command is explained in Stata manual (Stata Survey Data Reference Manual). The primary analysis involved descriptive statistics using appropriate cut-off values. Mean with 95% confidence interval for the continuous variables was obtained. Simple logistic regression was used to establish bivariate relationship between the age-specific response and outcome variables. Odds ratio was used as the measure of effect size of the assessed risk

factors. For multiple regression of the risk factors to explain the occurrence of age-specific child undernutrition, purposeful selection of variables was carried out. All variables with a *p*-value less than .15 were included in the regression models. It is highly unlikely that variables' *p*-value of .15 in bivariate analysis may contribute significantly to a regression model when other covariates are adjusted. This rationale has been described in other work as appropriate for this kind of analysis (Bursac et al., 2008). In the final age-specific multiple logistic regression models, variables were considered significant only if *p*-value was less than .05. Adjusted odds ratios with 95% confidence interval for all the age-specific models were recorded. Age and gender of the child were adjusted in all models as non-modifiable factors (Fenske et al., 2013). Additionally, seasonality encompassing the two post-harvest and the *monsoon* season was adjusted in each of the models constructed for regression analysis, with the intention to adjust the seasonal variation, if any, of the nutritional outcomes. Place of residence, that is, rural or urban, was not adjusted in the regression models as we wanted to portray a holistic picture, and the STATA `svyset` command already acknowledges the rural and urban stratification difference.

2.4 | Ethical consideration and consent procedure

The FSNP obtained ethical clearance from the European Union (Study number FOOD/2008/145-720) and this study was approved by the Research Review Committee and Ethical Review Committee,

TABLE 1 Descriptive statistics of the sample stratified by age-specific groups

	0–5 months <i>n</i> (%)	6–11 months <i>n</i> (%)	12–23 months <i>n</i> (%)	Overall <i>n</i> (%)
Household characteristics				
Household income (Tk)				
Below 3000	391 (20.39)	527 (22.37)	881 (19.8)	1799 (20.62)
3000 to <6000	504 (26.28)	631 (26.78)	1180 (26.52)	2315 (26.54)
6000 to <10000	427 (22.26)	461 (19.57)	1013 (22.77)	1901 (21.79)
10000 to <20000	359 (18.72)	456 (19.35)	827 (18.59)	1642 (18.82)
20000 and above	237 (12.36)	281 (11.93)	548 (12.32)	1066 (12.22)
Asset index				
Poorest	464 (20.19)	557 (20.28)	1039 (19.8)	2060 (20.02)
Poorer	461 (20.06)	575 (20.94)	1023 (19.49)	2059 (20.01)
Middle	457 (19.89)	548 (19.96)	1055 (20.1)	2060 (20.02)
Richer	451 (19.58)	554 (20.32)	1072 (20.39)	2077 (20.19)
Richest	466 (20.28)	508 (18.5)	1061 (20.22)	2035 (19.77)
Household food insecurity access				
Food secure	1086 (47.26)	1324 (48.22)	2542 (48.44)	4952 (48.12)
Mildly food insecure	108 (4.7)	141 (5.13)	264 (5.03)	513 (4.98)
Moderately food insecure	95 (4.13)	108 (3.93)	229 (4.36)	432 (4.2)
Severely food insecure	1009 (43.91)	1173 (42.72)	2213 (42.17)	4395 (42.7)
Toilet facility				
Non-hygienic	1729 (75.24)	2135 (77.75)	4013 (76.47)	7877 (76.54)
Hygienic	489 (21.28)	517 (18.83)	1050 (20.01)	2056 (19.98)
No facility	80 (3.48)	94 (3.42)	185 (3.53)	359 (3.49)
Hand wash (using an agent)	2215 (96.81)	2619 (96.18)	4964 (96.09)	9798 (96.28)
Source of drinking water				
Tube well	2015 (87.68)	2420 (88.13)	4683 (89.23)	9118 (88.59)
Piped water	108 (4.7)	121 (4.41)	244 (4.65)	473 (4.6)
Dug (protected)	9 (0.39)	7 (0.25)	10 (0.19)	26 (0.25)
Others (surface water)	166 (7.22)	198 (7.21)	311 (5.93)	675 (6.56)
Child characteristics				
Child nutritional status				
Stunted	472 (20.76)	611 (22.4)	2085 (39.85)	3168 (30.95)
Wasted	131 (5.7)	234 (8.52)	634 (12.04)	999 (9.71)
Underweight	378 (16.45)	581 (21.16)	1608 (30.64)	2567 (24.94)
Child health				
Had ailment(s) in the last 15 days	1422 (62.37)	1986 (73.36)	3490 (68.27)	6898 (68.32)
Sought treatment for ailment(s)	1085 (76.3)	1511 (76.12)	2575 (73.7)	5171 (74.94)
Received vitamin A capsule	—	1181 (43.97)	3595 (70.71)	4776 (61.48)
Received anthelmintic medicine	—	—	1503 (29.51)	1503 (29.53)
Child feeding practice				
Early initiation of breastfeeding (within 1 hr of birth)	1155 (50.66)	1354 (50.04)	2404 (47.03)	4913 (48.65)
Exclusive breast feeding (considering prelacteal feeding)	873 (39.32)	—	—	873 (39.32)
Exclusive breast feeding (consumption of breast milk only till 5 months of age)	1151 (51.85)	—	—	1151 (51.85)
Received colostrum	2048 (90.98)	2385 (89.73)	4452 (88.9)	8885 (89.59)
Dietary diversity (≥ 4 food groups)	8 (0.36)	423 (15.7)	1931 (37.85)	2362 (23.58)
Age appropriate minimum acceptable diet for children (age 6–23 months)				
Overall	—	439 (16.3)	1966 (38.54)	2405 (30.85)
6–8 months	—	153 (11.5)	—	153 (11.5)
9–23 months	—	272 (21.3)	1893 (39.46)	2165 (35.64)
6–23 months (non-breastfed)	—	14 (16.28)	73 (24.01)	87 (22.31)

(Continues)

TABLE 1 (Continued)

	0–5 months <i>n</i> (%)	6–11 months <i>n</i> (%)	12–23 months <i>n</i> (%)	Overall <i>n</i> (%)
Maternal characteristics				
Severely and moderately thin (<17)	152 (7.22)	313 (12.66)	638 (13.13)	1103 (11.69)
Mildly thin (17–18.49)	321 (15.24)	474 (19.17)	946 (19.53)	1741 (18.48)
Normal (18.5–24.49)	1401 (66.52)	1469 (59.43)	2834 (58.54)	5704 (60.56)
Overweight (25–30)	205 (9.73)	196 (7.93)	382 (7.91)	783 (8.32)
Obese (>30)	27 (1.28)	20 (0.81)	43 (0.89)	90 (0.96)
Minimum acceptable maternal dietary diversity (≥ 5 food groups)	1103 (52.37)	1351 (54.65)	2684 (55.46)	5138 (54.56)
Mother received vitamin A capsule	555 (30.65)	700 (26.07)	1087 (21.61)	2342 (24.58)
Maternal education				
No formal education	430 (18.72)	570 (20.77)	1129 (21.5)	2129 (20.69)
Primary incomplete	375 (16.33)	405 (14.76)	756 (14.39)	1536 (14.92)
Primary complete and secondary incomplete	1212 (52.76)	1448 (52.77)	2764 (52.69)	5424 (52.73)
Secondary complete or above	280 (12.19)	321 (11.7)	600 (11.42)	1201 (11.67)
Maternal occupation				
No income generating activity	2049 (89.2)	2368 (86.27)	4417 (84.2)	8834 (85.87)
Farmer	33 (1.44)	65 (2.37)	151 (2.88)	249 (2.42)
Labor	26 (1.13)	55 (2)	137 (2.61)	218 (2.12)
Business woman	30 (1.31)	51 (1.86)	117 (2.23)	198 (1.92)
Poultry/livestock rearing	121 (5.27)	151 (5.5)	332 (6.33)	604 (5.87)
Paid worker	34 (1.48)	49 (1.79)	77 (1.47)	160 (1.56)
Others	4 (0.17)	6 (0.22)	15 (0.29)	25 (0.24)
Antenatal care visit				
None	585 (25.69)	735 (27.27)	1456 (28.72)	2776 (27.64)
1–3 times	1025 (45.02)	1207 (44.79)	2225 (43.85)	4457 (44.37)
At least 4 times	667 (29.29)	753 (27.94)	1391 (27.43)	2811 (27.99)
Postnatal care visit				
	739 (32.45)	815 (30.22)	1490 (29.31)	3044 (30.27)
Food consumption during pregnancy				
Less	742 (32.59)	893 (33.11)	1678 (32.99)	3313 (32.93)
About the same	1039 (45.63)	1262 (46.79)	2347 (46.17)	4648 (46.22)
More	496 (21.78)	542 (20.1)	1060 (20.83)	2098 (20.85)
Resting during pregnancy				
Less	157 (6.9)	189 (7.01)	385 (7.53)	731 (7.25)
About the same	846 (37.15)	1078 (39.97)	2038 (40.09)	3962 (39.4)
More	1274 (55.95)	1430 (53.02)	2663 (52.37)	5367 (53.36)
Received iron tablet				
Not taken	959 (42.15)	1169 (43.47)	2245 (44.38)	4373 (43.63)
Rarely (1–2 times a month)	90 (3.96)	99 (3.68)	145 (2.86)	334 (3.33)
Sometimes (1–4 times a week)	211 (9.27)	301 (11.19)	585 (11.55)	1097 (10.94)
Mostly (at least 5 times a week)	1015 (44.62)	1120 (41.65)	2086 (41.2)	4221 (42.1)

the two obligatory components of the institutional review board of icddr,b (formerly known as International Centre for Diarrhoeal Disease Research, Bangladesh) (Grant number: O1116). Verbal informed consent was taken from study participants.

3 | RESULTS

All age stratified descriptive statistics derived by analyzing the data are presented in Table 1.

3.1 | Bivariate and multivariate statistics

The results of the bivariate and multivariate analyses showing the odds ratios and *p*-values for variables of interest related to the various forms of undernutrition are presented in Tables 2–4.

3.1.1 | Stunting

Being male, children of mothers who were mildly thin or mothers with no formal education or did not complete primary schooling were associated with stunting among children 0–5 months old.

TABLE 2 Predictors of stunting

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Predictors of stunting 0–5 months				
Child sex				
Female	Reference		Reference	
Male	1.32 (1.07–1.62)	0.011	1.31 (1.06–1.63)	0.014
Child age	1.05 (0.97–1.12)	0.215	1.05 (0.97–1.12)	0.218
Seasonality				
Post-aman	Reference		Reference	
Monsoon	0.98 (0.75–1.29)	0.882	1.0 (0.76–1.32)	0.999
Post-aus	1.04 (0.81–1.35)	0.750	1.08 (0.84–1.4)	0.544
Initiation of breastfeeding				
<1 hr of birth	Reference		Reference	
≥1 hr of birth	1.17 (0.97–1.41)	0.109	1.19 (0.98–1.45)	0.079
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	1.3 (0.9–1.89)	0.166	1.21 (0.83–1.77)	0.315
Mildly thin (17–18.49)	1.42 (1.09–1.84)	0.009	1.33 (1.03–1.72)	0.027
Overweight (25–30)	0.7 (0.47–1.03)	0.070	0.79 (0.53–1.18)	0.253
Obese (>30)	0.68 (0.24–1.95)	0.471	0.73 (0.25–2.12)	0.560
Maternal education				
Secondary complete or above	Reference		Reference	
No formal education	2.34 (1.58–3.45)	0.000	2.22 (1.48–3.33)	0.000
Primary incomplete	1.86 (1.22–2.84)	0.004	1.79 (1.16–2.76)	0.009
Primary complete and secondary incomplete	1.36 (0.94–1.96)	0.103	1.34 (0.91–1.98)	0.134
Predictors of stunting 6–11 months				
Child sex				
Female	Reference		Reference	
Male	1.41 (1.18–1.68)	0.000	1.51 (1.25–1.81)	0.000
Child age	1.08 (1.03–1.13)	0.003	1.08 (1.02–1.14)	0.006
Seasonality				
Post-aman	Reference		Reference	
Monsoon	0.99 (0.77–1.26)	0.910	0.98 (0.75–1.27)	0.871
Post-aus	1.28 (1.01–1.63)	0.039	1.14 (0.9–1.46)	0.279
Received colostrum				
Yes	Reference		Reference	
No	1.85 (1.38–2.46)	0.000	1.56 (1.15–2.12)	0.004
Child dietary diversity				
At least 4 food groups	Reference		Reference	
Less than 4 food groups	1.77 (1.34–2.34)	0.000	1.47 (1.09–1.97)	0.012
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	1.83 (1.41–2.38)	0.000	1.85 (1.42–2.4)	0.000
Mildly thin (17–18.49)	1.39 (1.06–1.82)	0.017	1.29 (0.99–1.68)	0.056
Overweight (25–30)	0.52 (0.31–0.85)	0.009	0.75 (0.47–1.19)	0.217
Obese (>30)	0.69 (0.2–2.39)	0.552	0.85 (0.24–3.04)	0.800
Maternal education				
Secondary complete or above	Reference		Reference	
No formal education	3.7 (2.45–5.57)	0.000	2.17 (1.38–3.41)	0.001
Primary incomplete	3.77 (2.54–5.6)	0.000	2.3 (1.51–3.51)	0.000
Primary complete and secondary incomplete	2.32 (1.58–3.42)	0.000	1.63 (1.09–2.43)	0.018
Received postnatal care				
Yes	Reference		Reference	
No	1.61 (1.33–1.96)	0.000	1.3 (1.06–1.59)	0.014
Household food insecurity access				

(Continues)

TABLE 2 (Continued)

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Food secure	Reference		Reference	
Mildly food insecure	1.48 (0.99–2.2)	0.054	1.23 (0.79–1.9)	0.363
Moderately food insecure	2.14 (1.38–3.31)	0.001	1.49 (0.93–2.4)	0.098
Severely food insecure	1.78 (1.48–2.15)	0.000	1.28 (1.04–1.57)	0.018
Predictors of stunting 12–23 months				
Child sex				
Female	Reference		Reference	
Male	1.23 (1.11–1.36)	0.000	1.21 (1.09–1.35)	0.001
Child age	1.05 (1.03–1.06)	0.000	1.05 (1.03–1.07)	0.000
Seasonality				
Post-aman	Reference		Reference	
Monsoon	1.05 (0.89–1.25)	0.537	1.08 (0.91–1.27)	0.388
Post-aus	1.23 (1.06–1.44)	0.007	1.2 (1.03–1.4)	0.018
Breastfeeding status				
Yes	Reference		Reference	
No	0.68 (0.52–0.89)	0.005	0.78 (0.6–1.02)	0.065
Child dietary diversity				
At least 4 food groups	Reference		Reference	
Less than 4 food groups	1.52 (1.33–1.72)	0.000	1.22 (1.06–1.39)	0.005
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	1.63 (1.35–1.96)	0.000	1.46 (1.22–1.75)	0.000
Mildly thin (17–18.49)	1.44 (1.22–1.7)	0.000	1.23 (1.04–1.46)	0.018
Overweight (25–30)	0.66 (0.52–0.83)	0.000	0.87 (0.69–1.1)	0.257
Obese (>30)	0.51 (0.24–1.05)	0.069	1.07 (0.54–2.13)	0.839
Maternal education				
Secondary complete or above	Reference		Reference	
No formal education	4.06 (3.18–5.19)	0.000	2.21 (1.67–2.92)	0.000
Primary incomplete	3.47 (2.7–4.47)	0.000	2.12 (1.62–2.79)	0.000
Primary complete and secondary incomplete	2.34 (1.88–2.91)	0.000	1.73 (1.36–2.2)	0.000
Antenatal care				
At least 4 times	Reference		Reference	
None	2.22 (1.89–2.6)	0.000	1.42 (1.19–1.69)	0.000
1–3 times	1.39 (1.21–1.61)	0.000	1.13 (0.97–1.31)	0.121
Received postnatal care				
Yes	Reference		Reference	
No	1.68 (1.48–1.91)	0.000	1.17 (1.02–1.36)	0.029
Type of latrine				
Hygienic	Reference		Reference	
Non-hygienic	1.81 (1.55–2.11)	0.000	1.18 (1–1.38)	0.049
No facility	3.82 (2.68–5.43)	0.000	1.87 (1.23–2.83)	0.004
Household food insecurity access				
Food secure	Reference		Reference	
Mildly food insecure	1.3 (1.02–1.65)	0.032	1.04 (0.8–1.36)	0.754
Moderately food insecure	1.78 (1.35–2.34)	0.000	1.29 (0.97–1.71)	0.078
Severely food insecure	1.75 (1.54–2)	0.000	1.17 (1.02–1.35)	0.028
Asset index				
Richest	Reference		Reference	
Poorest	1.76 (1.44–2.16)	0.000	1.17 (0.96–1.44)	0.119
Poorer	1.85 (1.55–2.22)	0.000	1.34 (1.1–1.64)	0.004
Middle	1.95 (1.62–2.35)	0.000	1.29 (1.05–1.58)	0.013
Richer	2.19 (1.82–2.64)	0.000	1.28 (1.05–1.56)	0.013

BMI, body mass index; CI, confidence interval; OR, odds ratio.

TABLE 3 Predictors of wasting

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Predictors of wasting 0–5 months				
Child sex				
Female	Reference		Reference	
Male	1.35 (0.93–1.94)	0.112	1.35 (0.91–2.02)	0.139
Child age	0.91 (0.81–1.04)	0.156	0.86 (0.75–0.97)	0.017
Seasonality				
Post- <i>aman</i>	Reference		Reference	
Monsoon	0.72 (0.43–1.19)	0.195	0.82 (0.49–1.36)	0.434
Post- <i>aus</i>	0.89 (0.6–1.34)	0.580	0.93 (0.62–1.4)	0.722
Exclusive breastfeeding				
Yes	Reference		Reference	
No	1.46 (1.04–2.04)	0.028	1.79 (1.23–2.61)	0.003
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	1.88 (1.09–3.25)	0.023	1.97 (1.12–3.47)	0.019
Mildly thin (17–18.49)	1.58 (1.05–2.38)	0.029	1.57 (1.03–2.38)	0.034
Overweight (25–30)	0.43 (0.17–1.07)	0.070	0.48 (0.19–1.2)	0.117
Minimum acceptable maternal dietary diversity				
At least 5 food groups	Reference		Reference	
Less than 5 food groups	1.56 (1.09–2.24)	0.015	1.49 (1.02–2.19)	0.041
Predictors of wasting 6–11 months				
Child sex				
Female	Reference		Reference	
Male	1.02 (0.78–1.34)	0.862	0.94 (0.71–1.26)	0.696
Child age	1.12 (1.04–1.2)	0.003	1.1 (1.02–1.19)	0.014
Seasonality				
Post- <i>aman</i>	Reference		Reference	
Monsoon	1.36 (0.93–1.99)	0.115	1.3 (0.87–1.94)	0.204
Post- <i>aus</i>	1.26 (0.87–1.83)	0.228	1.17 (0.8–1.72)	0.418
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	2.03 (1.41–2.94)	0.000	2.39 (1.67–3.44)	0.000
Mildly thin (17–18.49)	1.72 (1.21–2.44)	0.002	1.64 (1.15–2.34)	0.007
Overweight (25–30)	1.17 (0.71–1.91)	0.538	1.21 (0.72–2.04)	0.462
Obese (>30)	0.69 (0.09–5.38)	0.723	0.67 (0.08–5.36)	0.704
Household food insecurity access				
Food secure	Reference		Reference	
Mildly food insecure	0.95 (0.49–1.85)	0.891	0.92 (0.45–1.91)	0.831
Moderately food insecure	1.28 (0.67–2.44)	0.458	1.31 (0.67–2.59)	0.431
Severely food insecure	1.39 (1.05–1.84)	0.022	1.41 (1.04–1.91)	0.025
Source of drinking water				
Tube well	Reference		Reference	
Piped water	1.15 (0.65–2.03)	0.622	1.46 (0.82–2.58)	0.195
Dug protected	1.74 (0.2–15.07)	0.612	2.29 (0.25–20.83)	0.461
Others (surface water)	0.62 (0.37–1.02)	0.058	0.5 (0.26–0.95)	0.035
Predictors of wasting 12–23 months				
Child sex				
Female	Reference		Reference	
Male	1.1 (0.95–1.28)	0.213	1.14 (0.96–1.36)	0.142
Child age	0.99 (0.97–1.02)	0.623	1 (0.97–1.02)	0.732
Seasonality				

(Continues)

TABLE 3 (Continued)

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Post- <i>aman</i>	Reference		Reference	
Monsoon	1.54 (1.21–1.97)	0.001	1.45 (1.15–1.84)	0.002
Post- <i>aus</i>	1.22 (0.96–1.56)	0.102	1.18 (0.94–1.47)	0.160
Maternal education				
Secondary complete or above	Reference		Reference	
No formal education	2.29 (1.62–3.24)	0.000	1.53 (1.05–2.23)	0.028
Primary incomplete	1.87 (1.33–2.64)	0.000	1.34 (0.9–1.98)	0.151
Primary complete and secondary incomplete	1.29 (0.93–1.79)	0.124	1.02 (0.72–1.45)	0.898
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	2.23 (1.79–2.79)	0.000	2.11 (1.68–2.65)	0.000
Mildly thin (17–18.49)	1.44 (1.18–1.77)	0.000	1.38 (1.11–1.72)	0.004
Overweight (25–30)	0.64 (0.43–0.95)	0.026	0.75 (0.49–1.15)	0.187
Obese (>30)	0.2 (0.03–1.51)	0.119	0.3 (0.04–2.17)	0.231
Food consumption during pregnancy				
About the same	Reference		Reference	
Less	1.28 (1.05–1.55)	0.014	1.25 (1.03–1.52)	0.025
More	0.89 (0.7–1.15)	0.377	1.01 (0.8–1.29)	0.908
Type of latrine				
Hygienic	Reference		Reference	
Non-hygienic	1.78 (1.4–2.27)	0.000	1.36 (1.04–1.78)	0.025
No facility	1.84 (1.13–3.01)	0.014	1.01 (0.6–1.72)	0.957
Household food insecurity access				
Food secure	Reference		Reference	
Mildly food insecure	1.43 (0.99–2.08)	0.059	1.31 (0.88–1.95)	0.190
Moderately food insecure	1.93 (1.3–2.84)	0.001	1.66 (1.12–2.46)	0.011
Severely food insecure	1.65 (1.4–1.95)	0.000	1.34 (1.09–1.63)	0.005

BMI, body mass index; CI, confidence interval; OR, odds ratio.

Being male, increase in age, deprivation of colostrum, consumption of less than four food groups, and children of mothers who were severely or moderately thin, had education below secondary level schooling, or did not receive any postnatal care and households with severe food insecurity were significantly associated with stunting in the 6- to 11-month-old group.

Being male, increase in age, post-*aus* season, consumption of less than four food groups, children of mothers who were severely/moderately or mildly thin, had education below secondary level schooling, or did not receive any postnatal or antenatal care, households with no or non-hygienic latrine facility, severely food insecure households, and most categories of asset index quintile were found to be significantly associated with stunting in the 12- to 23-month age group. Significant predictors of stunting for all age groups are tabulated in Table 2.

3.1.2 | Wasting

Increase in age, not being exclusively breastfed, children of mothers who were severely/moderately or mildly thin, and children of mothers who consumed less than five food groups were significantly associated with the occurrence of wasting among children aged 0–5 months.

For age group 6–11 months, variables significantly associated with wasting were increase in age, children of mothers who were severely/moderately or mildly thin, severely food insecure households, and consumption of surface water as drinking water.

Occurrence of wasting in the 12- to 23-month age group was significantly associated with *monsoon* season, children of mothers who were severely/moderately or mildly thin or with no formal maternal education, children of mothers who consumed less food than usual during pregnancy, households with non-hygienic latrine facility, and severely or moderately food insecure households. All significant predictors of wasting for all age groups are tabulated in Table 3.

3.1.3 | Underweight

Our result indicates that not being exclusively breastfed, children of mothers who were severely/moderately or mildly thin, children of mothers who did not receive any antenatal care or consumed less food than usual amount during pregnancy, and being children from household not belonging to the richest asset index quintile were all significantly associated with children being underweight in the 0- to 5-month group.

Increase in age, consumption of less than four food groups, children of mothers who were severely/moderately or mildly thin, children

TABLE 4 Predictors of underweight

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Predictors of underweight 0–5 months				
Child sex				
Female	Reference		Reference	
Male	1.11 (0.91–1.37)	0.306	1.09 (0.87–1.37)	0.452
Child age	1.04 (0.97–1.12)	0.295	0.98 (0.9–1.06)	0.620
Seasonality				
Post- <i>aman</i>	Reference		Reference	
Monsoon	1.02 (0.77–1.34)	0.907	1.06 (0.8–1.4)	0.672
Post- <i>aus</i>	0.91 (0.68–1.23)	0.553	0.92 (0.68–1.25)	0.613
Exclusive breastfeeding				
Yes	Reference		Reference	
No	1.4 (1.1–1.76)	0.006	1.39 (1.06–1.82)	0.017
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	2.39 (1.64–3.46)	0.000	2.1 (1.46–3.04)	0.000
Mildly thin (17–18.49)	1.73 (1.28–2.34)	0.000	1.51 (1.11–2.05)	0.009
Overweight (25–30)	0.75 (0.47–1.19)	0.224	0.95 (0.6–1.51)	0.833
Obese (>30)	0.22 (0.03–1.64)	0.138	0.53 (0.12–2.4)	0.412
Antenatal care				
At least 4 times	Reference		Reference	
None	1.89 (1.38–2.58)	0.000	1.51 (1.08–2.13)	0.016
1–3 times	1.32 (1.01–1.74)	0.045	1.2 (0.9–1.59)	0.217
Food consumption during pregnancy				
About the same	Reference		Reference	
Less	1.31 (1.03–1.66)	0.029	1.34 (1.05–1.71)	0.020
More	0.81 (0.59–1.11)	0.192	0.94 (0.68–1.28)	0.678
Asset index				
Richest	Reference		Reference	
Poorest	2.04 (1.4–2.97)	0.000	1.46 (1.01–2.13)	0.049
Poorer	1.84 (1.26–2.68)	0.002	1.78 (1.18–2.69)	0.006
Middle	2.3 (1.58–3.34)	0.000	1.8 (1.18–2.74)	0.006
Richer	2.11 (1.42–3.12)	0.000	1.77 (1.22–2.57)	0.003
Predictors of underweight 6–11 months				
Child sex				
Female	Reference		Reference	
Male	1.09 (0.9–1.31)	0.385	1.13 (0.92–1.4)	0.233
Child age	1.07 (1.02–1.14)	0.010	1.08 (1.01–1.15)	0.023
Seasonality				
Post- <i>aman</i>	Reference		Reference	
Monsoon	1.29 (0.96–1.72)	0.086	1.27 (0.96–1.67)	0.093
Post- <i>aus</i>	1.27 (0.97–1.65)	0.080	1.11 (0.85–1.46)	0.442
Child dietary diversity				
At least 4 food groups	Reference		Reference	
Less than 4 food groups	1.62 (1.19–2.2)	0.002	1.45 (1.03–2.02)	0.031
Received colostrum				
Yes	Reference			
No	1.65 (1.22–2.23)	0.001	1.33 (0.95–1.86)	0.092
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	2.75 (2.16–3.52)	0.000	2.77 (2.17–3.54)	0.000
Mildly thin (17–18.49)	1.99 (1.57–2.53)	0.000	1.83 (1.43–2.33)	0.000

(Continues)

TABLE 4 (Continued)

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Overweight (25–30)	0.77 (0.5–1.18)	0.227	1.05 (0.67–1.62)	0.841
Obese (>30)	0.85 (0.24–3.04)	0.799	1.12 (0.32–3.97)	0.855
Antenatal care				
At least 4 times	Reference		Reference	
None	2.22 (1.7–2.91)	0.000	1.73 (1.27–2.34)	0.000
1–3 times	1.45 (1.14–1.85)	0.003	1.26 (0.97–1.65)	0.087
Type of latrine				
Hygienic	Reference		Reference	
Non-hygienic	1.79 (1.36–2.34)	0.000	1.3 (0.98–1.73)	0.070
No facility	3.9 (2.31–6.59)	0.000	2.15 (1.16–3.96)	0.015
Household food insecurity access				
Food secure	Reference		Reference	
Mildly food insecure	1.14 (0.77–1.71)	0.510	0.97 (0.63–1.5)	0.892
Moderately food insecure	1.69 (1.08–2.65)	0.022	1.12 (0.67–1.88)	0.656
Severely food insecure	1.65 (1.38–1.97)	0.000	1.24 (1.02–1.51)	0.032
Predictors of underweight 12–23 months				
Child sex				
Female	Reference		Reference	
Male	1.11 (0.99–1.25)	0.074	1.1 (0.97–1.25)	0.141
Child age	1.03 (1.01–1.05)	0.001	1.04 (1.02–1.06)	0.000
Seasonality				
Post-aman	Reference		Reference	
Monsoon	1.43 (1.2–1.7)	0.000	1.47 (1.24–1.75)	0.000
Post-aus	1.23 (1.04–1.47)	0.018	1.18 (0.99–1.42)	0.065
Had ailment(s) in the last 15 days				
No	Reference		Reference	
Yes	1.29 (1.12–1.48)	0.000	1.31 (1.14–1.52)	0.000
Child dietary diversity				
At least 4 food groups	Reference		Reference	
Less than 4 food groups	1.61 (1.4–1.85)	0.000	1.35 (1.18–1.56)	0.000
Received iron tablet				
Mostly (at least times 5 times a week)	Reference		Reference	
Not taken	1.4 (1.22–1.61)	0.000	1.03 (0.88–1.2)	0.718
Rarely (1–2 times a month)	1.7 (1.16–2.49)	0.007	1.48 (1.01–2.17)	0.044
Sometimes (1–4 times a week)	1.09 (0.9–1.32)	0.394	0.97 (0.79–1.19)	0.755
Antenatal care				
At least 4 times	Reference		Reference	
None	2.02 (1.69–2.42)	0.000	1.34 (1.09–1.65)	0.006
1–3 times	1.32 (1.12–1.57)	0.001	1.11 (0.93–1.32)	0.244
Maternal BMI				
Normal (18.5–24.49)	Reference		Reference	
Severely or moderately thin (<17)	2.36 (1.99–2.8)	0.000	2.19 (1.85–2.61)	0.000
Mildly thin (17–18.49)	1.71 (1.47–1.98)	0.000	1.52 (1.29–1.78)	0.000
Overweight (25–30)	0.68 (0.52–0.89)	0.005	0.83 (0.62–1.11)	0.205
Obese (>30)	0.13 (0.03–0.56)	0.006	0.2 (0.05–0.87)	0.032
Maternal education				
Secondary complete or above	Reference		Reference	
No formal education	3.52 (2.72–4.55)	0.000	2.05 (1.51–2.78)	0.000
Primary incomplete	3.06 (2.35–4)	0.000	1.91 (1.41–2.59)	0.000
Primary complete and secondary incomplete	1.92 (1.52–2.43)	0.000	1.43 (1.09–1.86)	0.010
Household food insecurity access				

(Continues)

TABLE 4 (Continued)

	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Food secure	Reference		Reference	
Mildly food insecure	1.51 (1.14–1.99)	0.004	1.26 (0.93–1.71)	0.129
Moderately food insecure	2.06 (1.53–2.78)	0.000	1.44 (1.05–1.97)	0.025
Severely food insecure	1.75 (1.55–1.98)	0.000	1.16 (1–1.34)	0.051
Asset index				
Richest	Reference		Reference	
Poorest	1.87 (1.5–2.32)	0.000	1.45 (1.17–1.78)	0.001
Poorer	1.9 (1.57–2.31)	0.000	1.53 (1.25–1.86)	0.000
Middle	2.01 (1.68–2.42)	0.000	1.4 (1.12–1.74)	0.003
Richer	2.17 (1.76–2.67)	0.000	1.62 (1.3–2.01)	0.000

BMI, body mass index; CI, confidence interval; OR, odds ratio.

of mothers who did not receive any antenatal care, households with no latrine facility, and severely food insecure households were significantly associated with the underweight condition among the 6- to 11-month-old group.

Being underweight in the 12- to 23-month-old group was significantly associated with increase in child's age, monsoon season, children to have at least an episode of sickness in last 15 days, children to consume less than four food groups in everyday diet, being children of mothers who received iron supplementation no more than once or twice every month during their pregnancy, mothers who had no antenatal care visits, or mothers who were severely/moderately or mildly thin or obese, children of mothers who had education level below secondary schooling, moderate food insecure households, or any household that was not in the richest asset index quintile. Table 4 shows all significant predictors of underweight children for the three age-specific groups.

4 | DISCUSSION

This paper examines national survey data collected by FSNP in Bangladesh in order to identify significant risk factors for undernutrition. Child's sex, increase in child's age, maternal BMI, maternal education, antenatal care, and household food insecurity status are the common risk factors for age-specific undernutrition among children aged less than 2 years.

4.1 | Stunting

Of the significant predictors for stunting, results of several studies indicate household food insecurity to be a significant risk factor (Psaki et al., 2012; Ali et al., 2013; Saha et al., 2009). The significant association of latrine facility to stunting has been cited in many literatures (Ahmed et al., 2012; Islam et al., 2013; Medhin et al., 2010). For explaining the association between types of toilet facility and stunting, the issue of environmental enteropathy is at the forefront. Research suggests that chronic exposure to pathogenic bacteria, such as the fecal coliforms, causes colonization of the small intestine of young children leading to environmental enteropathy—a condition characterized by gut inflammation, nutrient malabsorption, and

consequently undernutrition of chronic nature (Ngure et al., 2014; Lin et al., 2014).

Our finding of low maternal BMI and maternal illiteracy and their significant association with stunting are consistent with earlier reports (Fenske et al., 2013; Ahmed et al., 2012; Islam et al., 2013; Zongrone, Winskell, & Menon, 2012; Baig-Ansari et al., 2006; Meshram et al., 2012; Olusanya, Wirz, & Renner, 2010; Wamani et al., 2006). Maternal BMI, the most common risk factor for all categories of undernutrition as found in this study, is likely to reflect the gross socio-economic condition of the households (McDonald et al., 2009). Additionally, higher maternal education is indicative of maternal knowledge and awareness on child rearing and nutrition and also found to be highly associated with child feeding (Osei et al., 2010). Higher maternal education translates to increased utilization of modern health care, a protective factor against stunting (Anwar et al., 2013). On our findings of the higher odds of being stunted, if the mother received less than the recommended number of antenatal care visits is in line with results from Bhutan (Aguayo, Badgaiyan, & Paintal, 2015) and also from Colombia and Peru, where significant association was observed between receiving antenatal care and reduction in stunting (Ramirez et al., 2012).

In terms of child characteristics and stunting, being male was positively associated with stunting in all age groups. This refutes previous findings in national (Islam et al., 2013; Meshram et al., 2012; Olusanya et al., 2010; Wamani et al., 2006) and regional (Osei et al., 2010; Anwar et al., 2013) studies but is in agreement with the findings of a nationwide survey in Bangladesh (Medhin et al., 2010). Similar findings have also been described in other country contexts in sub-Saharan Africa (Lin et al., 2013). Similar to our findings of the significant association between increase in age and increase in the prevalence of stunting was also observed among Nigerian school children (Senbanjo et al., 2011). The phenomenon is likely due to repeated morbid episodes with increase in age. Moreover, significance of child dietary diversity in context of stunting may be illustrated through the United Nations Children's Fund framework (Ali et al., 2013), which suggests that household food insecurity is an underlying cause of undernutrition. Finally, colostrum, considered to be a significant contributor to optimal child health (Wheeler et al., 2007), was found to be associated with the occurrence of stunting in the 6- to 11-month-old group if not fed, depicting adverse effect of colostrum deprivation.

4.2 | Wasting

Our result suggests surface water to have a protective effect on wasting in comparison with tube well water although a huge proportion of rural communities use tube well as the primary source of drinking water (NIPOIT, Mitra and Associates & ICF International, 2013). Arsenic contamination of tube well/ground water is a genuine public health problem in Bangladesh. Arsenic exposure, even of low concentration, has multiple adverse effect on the fetus, which may lead to serious conditions such as low birth weight (Gardner et al., 2011) and even wasting in later life (Minamoto et al., 2004). Surface water from ponds and canals is also used in rural Bangladesh and is filtered using pond sand filter technology, which purifies the water and makes it safe and drinkable (Safiuddin & Karim, 2003), explaining its protective effect against wasting. Seasonality is invariably related to domestic crop production, which agrees with the significant association of the post-harvest and *monsoon* season to different categories of undernutrition including wasting in the oldest age-specific group. It could be argued that production of rice, the staple cereal grain of Bangladesh, which provides both job opportunity and food to most people in the agro-based economy, varies as per the seasons. Hence, shortage in production or access in some seasons may induce food insecurity, which in turn acts as a critical risk factor for the acute form of undernutrition—wasting. Also to be noted that our findings support existing literature (Hossain, Naher & Shahabuddin, 2005) that because of difference in harvesting period of the staple cereal grain rice, Bangladesh traditionally suffers a loss in rice production during monsoon, which translates to increase in wasting especially in the rural communities.

In context of maternal characteristics causing wasting in children, amount and diversity of food consumed during pregnancy has always been scrutinized as a contributing factor to both maternal and child health (Virtanen et al., 2011). As our data collection was based on cross-sectional design, we assumed that current maternal dietary diversity would reflect the dietary diversity during her last pregnancy. Our findings support existing literature on the association of categories of child undernutrition with less maternal food consumption during pregnancy (Martorell & Zongrone, 2012).

4.3 | Underweight

Finally, on the risk factors of being underweight, our findings are in line with results derived from similar cross-sectional data on children aged less than 6 months that have shown association of exclusive breastfeeding with underweight (Kuchenbecker et al., 2014; Patwari, Kumar, & Beard, 2013). The data collection method for establishing exclusive breastfeeding was different for each of these studies, with some studies reporting a higher probability of recall bias, such that the results of the studies are not directly comparable. Future studies on the topic should use similar methodologies in order to gain profound understanding of the role of exclusive breastfeeding as a determinant of undernutrition.

On the association of maternal iron supplementation during pregnancy and children being underweight in the oldest age group, it is worthwhile to mention that although evidence from robust interventions is yet to be assessed, the general understanding is that iron

supplementation may improve birth outcome by enhancing maternal nutrition status (Bhutta et al., 2008).

Overall, our study has revealed the diversity of risk factors for different categories of undernutrition with few common ones, which are to be considered as the strongest risk factors for the overall child population who are aged less than 2 years. Child sex, age, maternal BMI, maternal education, and household food insecurity were found to be the strongest factors for determining age-specific undernutrition among children aged less than 2 years. Risk factors from the maternal characteristics domain, even in age stratified groups, appeared to be robust predictors as expected.

5 | LIMITATIONS AND STRENGTHS

As for data collection, it should be acknowledged that the data collection team for surveillance could not visit very remote hard-to-reach areas and therefore data were not collected from some hard-to-reach areas. The data were derived through cross-sectional surveillance method, which is incapable of establishing causal relationship; however, the repeated nature of the data collection enabled us to look on different trends in undernutrition. A number of information was collected through maternal responses, which might have introduced recall bias.

A cohort is advisable to establish temporal relationship among variables of interest, as we expect our findings to enhance the existing evidence base for the risk factors of undernutrition among children aged less than 2 years and inform the policy makers and relevant stakeholders about the different risk factors that significantly affect the nutritional status of different age-specific groups. As the data are country specific, special consideration must be taken on extrapolating the findings to other contexts.

6 | CONCLUSION

Our study confirms that the sex of the child, maternal BMI, maternal education, and household food insecurity were the strongest predictors of undernutrition. Maternal characteristics were the most robust predictors of undernutrition across the specified age groups. Our study indicates that risk factors for stunting, wasting, and underweight are different for the 0-to 5-month, 6- to 11-month, and 12- to 23-month age groups.

However, it would be advisable to replicate the study in other low- and middle-income countries in order to validate the reliability of the current results and to have a better understanding of the profound role of the statistically significant risk factors associated with undernutrition in age-specific groups under 2 years of age. We would recommend relevant stakeholders in nutrition programming to consider these age-specific risk factors when designing food security and nutritional programs.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

TA, NC, ZM, AMRC, and SS conceptualized the manuscript. NC, MJR, FDF, ASR, JLW, and MAH have performed statistical analysis. NC, MJR, FDF, ASR, and MAH drafted the manuscript. RB helped in conceptualization of the manuscript and interpretation of the findings. TA, ZM, SS, JLW, and RB contributed to the revision of the final draft for submission. This manuscript is based on data collected and shared by the Food Security Nutritional Surveillance Project (FSNSP), implemented by James P. Grant School of Public Health, Helen Keller International, and Bangladesh Bureau of Statistics with support from the European Union. This manuscript has been reviewed by FSNSP technical reviewers for scientific content and consistency of data interpretation, and significant comments have been incorporated prior to submission for publication. All authors have read and approved the final manuscript.

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