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Original article

Minimum acceptable diet and undernutrition in Bangladesh: evidence from Multiple Indicator Cluster Survey 2019

Md Fuad Al Fidah [a], Md Ridwan Islam [a,*], Tahmeed Ahmed [a,b,c], Sharika Nuzhat [b]

[a] Nutrition Research Division, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Mohakhali, Dhaka, Bangladesh
[b] Clinical and Diagnostic Services, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Mohakhali, Dhaka, Bangladesh
[c] Office of the Executive Director, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Mohakhali, Dhaka, Bangladesh

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ABSTRACT

Background: Minimum acceptable diet (MAD) remains unattainable to many children residing in low- and middle-income countries. We aimed to identify the factors influencing MAD and its association with undernutrition among Bangladeshi children aged 6–23 months.

Methods: This cross-sectional study used nationally representative data from Multiple Indicator Cluster Survey, Bangladesh 2019. Total 5747 children (6–23 months) were included. Binary logistic regression models were developed to examine the association between outcome and independent variables. MAD was measured using proxy indicators, following updated WHO definitions. No causal conclusions can be drawn. Adjusted odds ratios (AOR) and their corresponding 95 % confidence intervals (CI) were reported. A p-value <0.05 was considered statistically significant.

Results: The prevalence of MAD was 30.0 %. The median age (in months) of participants with adequate MAD (12.0, IQR: 16.0–20.0) was significantly (p-value<0.001) higher than their counterparts (10.0, IQR :14.0–18.0). Higher odds of attaining adequate MAD were associated with urban residents (AOR:1.45; 95 %CI:1.26–1.67), children whose mothers received secondary (AOR:1.97, 95 %CI:1.57–2.47) and post-secondary (AOR:3.80, 95 % CI:2.97–4.86) education, were exposed to media (AOR:1.64; 95 % CI:1.45–1.86) and belonged to wealthier families. However, the lower odds of achieving adequate MAD was associated significantly with mothers being primary caregivers of another child (AOR:0.72, 95 %CI:0.63–0.83). Adequate MAD was associated with lower odds of being underweight among children (AOR:0.79, 95 % CI:0.66–0.94).

Conclusion: Less than one-third of Bangladeshi children aged 6–23 months achieved adequate MAD. These findings suggest the need for targeted interventions to improve complementary feeding practices, particularly in poorer and rural households, and to incorporate media in the interventions.

1. Introduction

Malnutrition, especially childhood malnutrition, remains a major global public health concern , particularly in low- and middle-income countries (LMICs). The Global Burden of Disease (GBD) report identifies malnutrition as a major contributor to disease burden among children.[1] This issue remains especially widespread in Asia and Africa, where approximately 85 % of all stunted children live. In many LMICs, the prevalence of wasting has reached or exceeded the critical threshold of 15 %.[1] However, point prevalence underestimates the cumulative burden of wasting in early childhood. A separate analysis showed that while 5.6 % of children were wasted at 24 months, 29.2 % had experienced at least one episode of wasting by that age, and 10.0 % had experienced two or more episodes.[2]

Malnutrition, especially among children under 5 years of age, remains a major global public health concern, particularly in low- and middle-income countries (LMICs). Within this group, children aged 6–23 months are especially vulnerable, as this period marks the transition from exclusive breastfeeding to complementary feeding.[3] Dietary diversity exhibits a crucial impact on their nutritional status by ensuring a proper diet. It has been reported that proper complementary feeding can prevent 6 % of malnutrition among children aged 6–23 months.[4]

* Corresponding author. Nutrition Research Division, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), 68, Shaheed Tajuddin Ahmed Sarani, Mohakhali, Dhaka, 1212, Bangladesh.
E-mail address: ridwan.islam@icddrb.org (M.R. Islam).

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Ensuring proper nutrition is the most crucial preventive measure to combat malnutrition and child mortality. This aligns with the second goal of the Sustainable Development Goals (SDG), which aims to achieve zero hunger and improve food security globally by 2030. Proper nutrition is essential to preventing both malnutrition and child mortality.[5]

Many children in low- and middle-income countries (LMICs) lack access to appropriate complementary foods, limiting their ability to meet nutritional requirements.[6] Based on an analysis of Demographic and Health Survey (DHS) data from 42 countries, Choudhury et al. reported that children aged 6–23 months consumed an average of only 2.81 out of 7 food groups, with the lowest dietary diversity found in Sub-Saharan Africa, followed by South and Southeast Asia.[7] Due to widespread poverty, parents in these regions often face challenges in providing adequate nutrition, leading to difficulties in ensuring dietary diversity for their children.[3] When a child's age reaches 6 months, he or she cannot get proper nutrition simply from breast milk due to an increased nutritional demand. Complementary feeding is essential to transition the child from breastfeeding to solid food.

The Minimum Acceptable Diet (MAD) is an Infant and Young Child Feeding (IYCF) indicator designed to assess appropriate complementary feeding patterns in children aged 6–23 months.[6] The MAD is also recognised as a core IYCF indicator for monitoring dietary adequacy among children.[8] It combines two measures—the minimum meal frequency (MMF) and the minimum dietary diversity (MDD). According to the World Health Organization (WHO), MAD refers to the proportion of children in this age group who achieved both MMF and MDD in the past 24 h. MAD evaluates both the quality (through MDD) and quantity (through MMF) of the consumed food, offering a more comprehensive view of a child's diet compared to MDD or MMF alone. As such, MAD is regarded as one of the key indicators of monitoring and guiding child feeding practices by the WHO.

A 2021 study involving 80 LMICs reported that only 10.1 % of these countries had prevalence levels above 50 % for MAD.[9] Among the Asian countries, low prevalence is reported in the Philippines (6.7 %).[10] However, countries like China (39.9 %) and Indonesia (41.6 %) show a much higher proportion.[11] In Bangladesh, according to the Bangladesh Demographic and Health Survey (BDHS) 2022, the proportion of MDD and MMF was found to be 39 % and 61 %, respectively.[12] For MAD, this proportion was reported as 34.07 % in 2018.[13]

Adequate MAD can prevent undernutrition-related issues such as stunting and wasting, which are key contributors to child mortality. Inadequate dietary intake can impair immune function and increase vulnerability to infectious diseases.[14] In contrast, proper dietary practices support healthy growth, improve immune response, enhance cognitive development, and reduce the risk of non-communicable diseases (NCDs).[13] Hence, it is crucial to promote the MAD to ensure a better future for the children of this age group.

There have been several studies that aimed to identify factors associated with MAD practice in Bangladesh.[13,15] While previous studies have explored MAD practices in Bangladesh, few have used nationally representative data aligned with the revised 2021 WHO definition, which includes eight food groups instead of seven. Our study addresses this gap by applying the updated definition to Multiple Indicator Cluster Survey (MICS) 2019 data.[6] This provides one of the first assessments of MAD prevalence and its nutritional associations under the new global standard. The aim of our study was to identify the factors associated with MAD practice and examine the association between MAD and nutritional status among children aged 6–23 months.

2. Methods

2.1. Data overview

For this study, we used nationally representative data from the Bangladesh Multiple Indicator Cluster Survey (MICS) 2019, conducted by the Bangladesh Bureau of Statistics (BBS) in collaboration with UNICEF. The dataset is publicly available and can be accessed through the UNICEF MICS website (https://mics.unicef.org/surveys). Details of the survey can be found in a different publication.[16] In short, the survey was conducted using a two-stage sampling strategy, with 64,400 households being selected. From the selected households, mothers or caregivers of children aged under 5 years were interviewed. All variables in this study were measured and recorded based on the responses of mothers or caregivers during interviews.

We included children aged 6–23 months (n = 5747) from the survey's publicly accessible "children dataset", which contained information on under 5 children. However, children from ineligible age categories, whose caregivers did not provide explicit consent, and with missing values on nutritional status and food consumption were excluded (Supplementary Fig. 01).

2.2. Outcome variables

The outcome variables of the study were minimum acceptable diet (MAD) and nutritional status of the participants.

2.3. Minimum acceptable diet (MAD)

The MAD was constructed using minimum dietary diversity (MDD) and minimum meal frequency (MMF), following the updated WHO Infant and Young Child Feeding (IYCF) guidelines.[6] MICS 2019 included data on all eight food groups required to assess MDD: breast milk; grains, roots, and tubers; legumes, nuts, and seeds; dairy products; flesh foods; eggs; vitamin-A rich fruits and vegetables; and other fruits and vegetables. Although MICS 2019 was conducted before the revised definition was released, all necessary variables were available. Specifically, we used the child's current breastfeeding status as a proxy for consumption of breast milk the previous day. If the respondent reported that the child was still being breastfed, we considered that the child consumed breast milk in the last 24 h, fulfilling the requirement for food group 1.[6] MAD was considered adequate when a child met both the MDD (consumption of $\geq$5 out of 8 food groups in the last 24 h) and the age-specific MMF criteria, as defined by WHO. The names of these food groups and the definition of MAD, MDD and MMF are presented in Table 01. MAD had two categories: "adequate" and "inadequate." Children who had both adequate MDD (consuming $\geq$5 food groups out of 8 in the last 24 h) and proper MMF (based on age and breastfeeding status) belonged to the adequate MAD group and vice versa.

2.4. Nutritional status

The child's nutritional status was considered based on undernutrition indicators (stunting, underweight, wasting, and overweight). The current study used the WHO recommendations to define these indicators (Table 01).

2.5. Independent variables

We conducted an *a priori* literature review to identify and define independent variables for analysis.[13,17–21] These variables include age, sex (male/female), residence (urban/rural), currently breastfeeding (yes/no), maternal education (up to primary/primary/secondary/post-secondary), paternal education (up to primary/primary/secondary/post-secondary), primary caregiver of another child (yes/no), media exposure (not exposed/exposed), and wealth index quintile (poorest/poor/middle/rich/richest). A dummy variable 'child's age' was created and categorized as '6–11 months', '12–23 months' to examine the association between the age group of the participants and the MAD.

Table 01
Operational definition of variables.

		Definition
Eight food groups	**Food group 01**	Breast milk (Calculated using the answer to the survey item: *Is (name of the child) still being breastfed?* If 'yes,' then the child is considered to have consumed food group 1)
	Food group 02	Grains, roots, and tubers
	Food group 03	Legumes, nuts, and seeds
	Food group 04	Dairy products (e.g., milk, yoghurt, and cheese)
	Food group 05	Flesh foods (e.g., meat, fish, poultry, and liver/organ meats)
	Food group 06	Eggs
	Food group 07	Vitamin-a rich fruits and vegetables
	Food group 08	Other fruits and vegetables
Minimum Dietary Diversity (MDD)	Consuming ≥5 out of 8 food groups in the past 24 h.	
Minimum Meal Frequency (MMF)	The minimum number of feedings is calculated as: i) Two feedings of solid, semi-solid, or soft foods (breastfed children aged 6–8 months) ii) Three feedings of solid, semi-solid, or soft foods (breastfed children aged 9–23 months) iii) Four feedings of solid, semi-solid, or soft foods or milk feeds (non-breastfed children aged 6–23 months).	
Minimum Acceptable Diet (MAD)	For breastfed children	Receiving at least MDD and MMF for their age during the previous day.
	For non-breastfed child	Receiving at least the MDD and MMF for their age the day before, in addition to having at least two milk feeds.
Stunting	Height/Length-for-Age Z-score (HAZ/LAZ) < −2 SDs	
Underweight	Weight-for-Age Z-score (WAZ) < −2 SDs	
Wasting	Weight-for-Height/Length Z-score (WHZ/WLZ) < −2 SDs	
Overweight	Weight-for-Height/Length Z-score (WHZ/WLZ) > 2 SDs	
Media exposure	Media exposure was considered using three variables frequency of reading newspapers or magazines, frequency of listening to the radio, and frequency of watching TV. After summation of these variables, two categories were considered: 'not exposed' (=0) and 'exposed' (>0).	
Wealth index	The wealth index is an opportunistic method based on the premise that the possession of observable or readily requested assets, services, and amenities correlates with the relative economic position of the household in the nation. Using the wealth index, households are categorized as: poorest, poor, middle, rich and richest.	
Primary caregiver of another child	The variable was derived from caregiver responses and reflects whether the mother was identified as the main caregiver of at least one additional child aged less than five years in the household.	

2.6. Statistical analysis

The study used STATA (version 17) for data analysis. The Shapiro–Francia test was used to check the normality of continuous variables. We estimated the frequency distribution and percentage for categorical variables, and the median (IQR) for continuous variables. The Chi-square test and the Mann-Whitney *U* test were used to examine the association between independent and dependent variables. Binomial logistic regression models were developed to assess associations between MAD and independent variables. Variable selection was based on existing literature and theoretical relevance to infant feeding and undernutrition. We included variables such as age, sex, residence, breastfeeding status, parental education, caregiver role, media exposure, and household wealth. All multivariable models were adjusted for key demographic factors (child's age and sex) and included all covariates to control for potential confounding. As the study aimed to investigate the individual association between MAD and the children's nutritional status, both unadjusted and adjusted binomial bivariate logistic regression models were also developed after adjusting for all other independent variables. Prior to modelling, multicollinearity among independent variables was assessed using variance inflation factors (VIFs), and no significant multicollinearity was detected. Model fitness was assessed using the likelihood ratio chi-square statistic. A p-value<0.05 was considered statistically significant. All statistical tests were two-sided and performed at a significance level of $\alpha = 0.05$.

Ethical statement

The study analysed data from a pre-existing survey conducted by UNICEF. Since the data set used in the analysis was de-identified and permission was taken from UNICEF to use it, no ethical approval was needed. Prior to conducting the survey, the protocol was approved by the technical committee of the Government of Bangladesh, led by the Bangladesh Bureau of Statistics (BBS).

3. Results

For the final analysis, we considered 5747 children. The proportion of adequate MAD, MDD, and MMF among children aged 6–11 months and 12–23 months is shown in Fig. 01, which was 30.0 %, 37.7 %, and 69.0 %, respectively. Overall, children in the older age group (12–23 months) demonstrated a higher prevalence of dietary adequacy across all three indicators.

The median (IQR) age was 15.0 (11.0–19.0) months, and most of the participants (51.2 %) were male, living in the rural areas (81.5 %). More than ninety per cent (94.3 %) of mothers were breastfeeding their children at the time of the survey. Media exposure was found among 63.1 % of mothers. The participants were mostly (23.4 %) from the poorest families. The prevalence of stunting, underweight, wasting and overweight was 25.8 %, 19.7 %, 10.5 % and 2.1 %, respectively. A higher proportion of stunted, underweight, and wasted children were found among children without adequate MAD than their counterparts (27.0 % vs 23.1 %; 21.1 % vs 16.6 % and 10.9 % vs 9.4 % respectively). However, the proportion of overweight children was higher among the children with adequate MAD (2.6 % vs 1.9 % in the inadequate MAD group). We found a significant association between MAD and age (p-value <0.001), sex (p-value = 0.030), residence (p-value <0.001), parental education (p-value <0.001), maternal media exposure (p-value <0.001), stunting (p-value = 0.002), and underweight (p-value <0.001) (Table 02).

After adjusting for age and sex, significant associations were found between adequate MAD and participants' characteristics. Children who live in urban areas were linked to 1.45 times higher odds of achieving adequate MAD (95 % CI: 1.26–1.67, p-value<0.001) compared to their counterparts. Similarly, significantly higher odds of adequate MAD were found among currently breastfeeding children (AOR: 5.05; 95 % CI: 3.48–7.34), mothers having secondary (AOR: 1.97; 95 % CI: 1.57–2.47) and post-secondary education (AOR: 3.80; 95 % CI: 2.97–4.86, p-value), fathers having primary (AOR: 1.65; 95 % CI: 1.35–2.03), secondary (AOR: 2.42; 95 % CI: 1.98–2.95) and post-secondary education (AOR: 4.68; 95 % CI: 3.76–5.83), mothers with media exposure (AOR: 1.64; 95 % CI: 1.45–1.86) and belonging to higher quintile families. However, lower odds (AOR: 0.72; 95 % CI: 0.63–0.83) of achieving adequate MAD were found among participants with mothers who are the primary caregivers of another child (Table 03).

After adjusting for confounders (age, sex, residence, currently breastfeeding, maternal education, paternal education, primary caregiver of another child, maternal media exposure, wealth index quintile), we found that children with adequate MAD were associated with lower odds of developing underweight (AOR: 0.79; 95 % CI: 0.66 = 0.94) (Fig. 02).

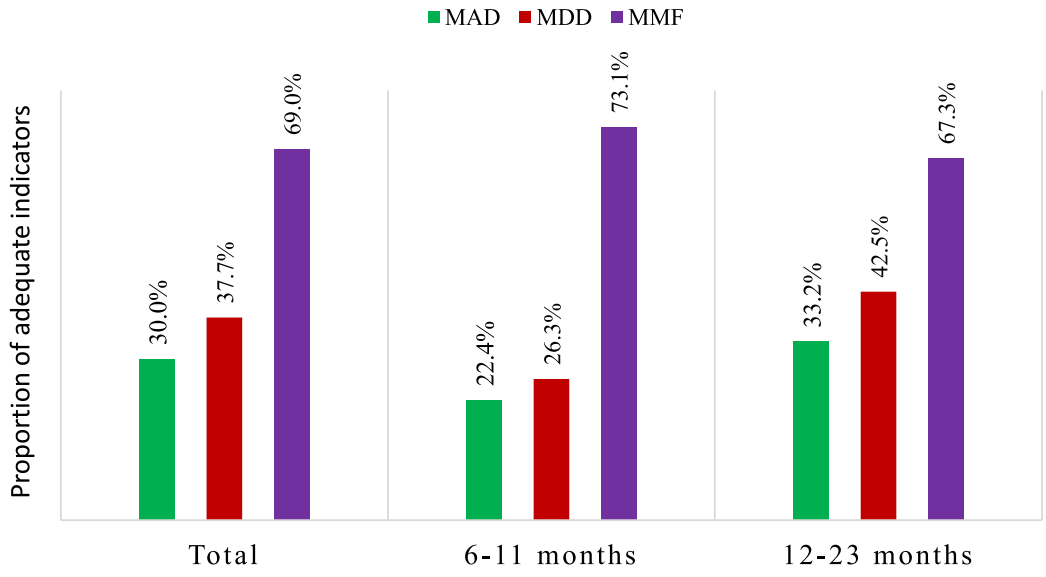


Fig. 1. Proportion of children achieving Minimum Acceptable Diet (MAD), Minimum Dietary Diversity (MDD), and Minimum Meal Frequency (MMF), by age group. A) Total, B) 6–11 months, C) 12–23 months.

Table 02
Distribution of socio-demographic characteristics of participants.

Variable	Category	Total n (%) (N = 5747)	MAD		p-value
			Inadequate n (=4023) (% = 70.0 %)	Adequate n (=1724) (% = 30.0 %)	
Age (median, IQR)		15.0 (11.0–19.0)	10.0 (14.0–18.0)	12.0 (16.0–20.0)	<0.001[a]
Sex	Male	2941 (51.2)	2021 (50.2)	920 (53.4)	0.030
Residence	Urban	1066 (18.5)	675 (16.8)	391 (22.7)	<0.001
Currently breastfeeding	Yes	5422 (94.3)	3730 (92.7)	1692 (98.1)	<0.001
Maternal education	Up to primary	564 (9.8)	457 (11.4)	107 (6.2)	<0.001
	Primary	1288 (22.4)	1005 (25.0)	283 (16.4)	
	Secondary	2879 (50.1)	2004 (49.8)	875 (50.8)	
	Post-secondary	1016 (17.7)	557 (13.8)	459 (26.6)	
Paternal education (n=5124)	Up to primary	949 (18.5)	785 (21.8)	164 (10.8)	<0.001
	Primary	1677 (32.7)	1257 (34.9)	420 (27.6)	
	Secondary	1663 (32.5)	1123 (31.2)	540 (35.5)	
	Post-secondary	835 (16.3)	436 (12.1)	399 (26.2)	
Primary caregiver of another child (n=4062)	Yes	2573 (63.3)	1789 (65.8)	784 (58.4)	<0.001
Maternal media exposure (n=5714)	Exposed	3608 (63.1)	2391 (59.8)	1217 (70.9)	<0.001
Wealth index	Poorest	1346 (23.4)	1067 (26.5)	279 (16.2)	<0.001
	Poor	1210 (21.1)	905 (22.5)	305 (17.7)	
	Middle	1131 (19.7)	823 (20.5)	308 (17.9)	
	Rich	1092 (19.0)	686 (17.1)	406 (23.5)	
	Richest	968 (16.8)	542 (13.5)	426 (24.7)	
Stunting	Present	1484 (25.8)	1086 (27.0)	398 (23.1)	0.002
Underweight	Present	1134 (19.7)	847 (21.1)	287 (16.6)	<0.001
Wasting	Present	602 (10.5)	440 (10.9)	162 (9.4)	0.081
Overweight	Present	123 (2.1)	78 (1.9)	45 (2.6)	0.108

[a] p-value from Mann-Whitney *U* test; MAD: Minimum acceptable diet.

4. Discussion

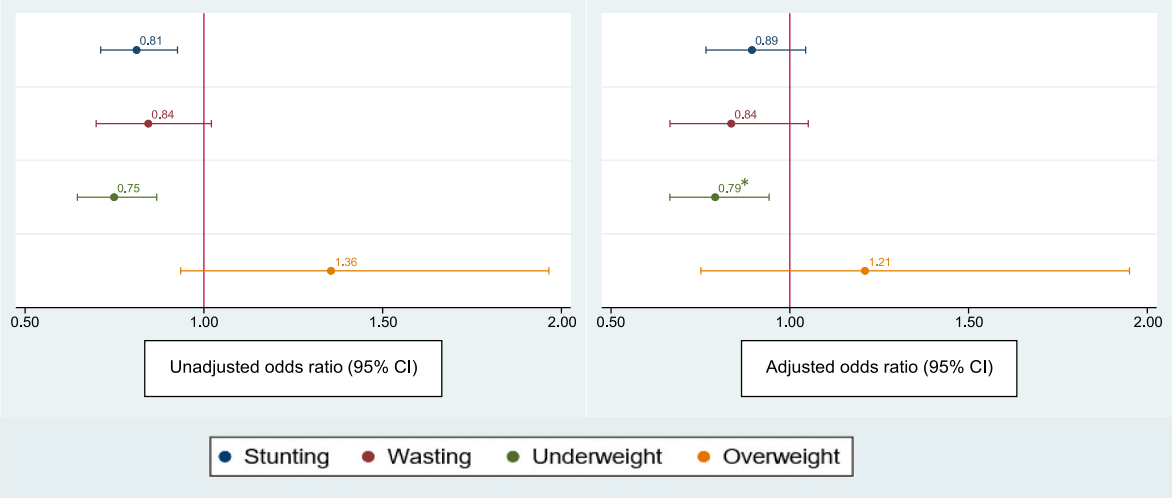
This study aimed to identify the factors associated with adequate MAD and examine its association with the nutritional status of Bangladeshi children aged 6–23 months. Proper nutrition and dietary diversity are crucial for children during this phase of life, as they determine their well-being, even extending to adult life.[4] MAD comprises Minimum Dietary Diversity (MDD), which reflects dietary quality, and Minimum Meal Frequency (MMF), an indicator of meal quantity or energy intake. It has been reported that proper complementary feeding can prevent undernutrition in under-5 children by 6 %.[4]

In our study, we found that 30.0 % of Bangladeshi children aged 6–23 months received adequate MAD, which is lower (38 %) compared to the report by Rahman et al.[22] The shift in WHO guidelines from seven to eight food groups for defining MDD in 2021 likely contributed to the discrepancy. A comparative study by *Roy* et al. demonstrated that applying the revised criteria produces consistently lower prevalence estimates of adequate MAD.[23]

Table 03
Association of adequate MAD with characteristics of participants.

Variables	Categories	Unadjusted OR		Adjusted OR[a]	
		UOR (95 % CI)	p-value	AOR (95 % CI)	p-value
Residence	Rural	Ref			
	Urban	1.45 (1.27–1.67)	<0.001	1.45 (1.26–1.67)	<0.001
Currently breastfeeding	No	Ref			
	Yes	4.15 (2.87–6.01)	<0.001	5.05 (3.48–7.34)	<0.001
Maternal education	Up to primary	Ref			
	Primary	1.20 (0.94–1.54)	0.145	1.27 (0.99–1.63)	0.062
	Secondary	1.87 (1.49–2.34)	<0.001	1.97 (1.57–2.47)	<0.001
	Post-secondary	3.52 (2.76–4.49)	<0.001	3.80 (2.97–4.86)	<0.001
Paternal education (n=5124)	Up to primary	Ref			
	Primary	1.60 (1.31–1.96)	<0.001	1.65 (1.35–2.03)	<0.001
	Secondary	2.30 (1.89–2.80)	<0.001	2.42 (1.98–2.95)	<0.001
	Post-secondary	4.38 (3.53–5.44)	<0.001	4.68 (3.76–5.83)	<0.001
Primary caregiver of another child (n=4062)	No	Ref			
	Yes	0.73 (0.64–0.83)	<0.001	0.72 (0.63–0.83)	<0.001
Maternal media exposure (n=5714)	Non-exposed	Ref			
	Exposed	1.64 (1.45–1.85)	<0.001	1.64 (1.45–1.86)	<0.001
Wealth index quintile	Poorest	Ref			
	Poor	1.29 (1.07–1.55)	0.007	1.78 (1.06–1.54)	0.010
	Middle	1.43 (1.19–1.72)	<0.001	1.45 (1.20–1.75)	<0.001
	Rich	2.26 (1.89–2.71)	<0.001	2.30 (1.91–2.75)	<0.001
	Richest	3.01 (2.50–3.61)	<0.001	3.05 (2.54–3.67)	<0.001

[a] Adjusted for age and sex; MAD: Minimum Acceptable Diet; CI: Confidence interval; Reference level for MAD: Inadequate. UOR: Unadjusted odds ratio; AOR: Adjusted odds ratio.



**: p-value=0.009 after adjusting for confounders (age, sex, residence, currently breastfeeding, maternal education, paternal education, primary caregiver of another child, maternal media exposure, wealth index quintile); CI: Confidence interval; Reference categories: Stunting=absent; Underweight=absent, Wasting=absent, Overweight=absent, MAD=not adequate.*

Fig. 2. Association between adequate MAD and child's nutritional status.

The prevalence of adequate MAD has risen from 9 % in 2011 to 20 % in 2014, and to 30 % in the present study,[24] reflecting gradual improvements. This progress may be attributed to national initiatives such as the National Nutrition Services (NNS),[25] alongside collaborations between NGOs and academic institutions to combat malnutrition.

We found that age was significantly linked to adequate MAD, with the median age of such children being higher than their counterparts. Similar reports *were* found in other studies,[4] potentially due to the practice of delayed introduction of complementary feeding[26] and the gradual introduction of solid food in different stages. Among the adequate MAD group, a significantly higher proportion were males (53.4 %) compared to females (46.6 %). In South Asia, male children are

often given preferential treatment in household food allocation due to perceived higher value. Historical data from the 1980s also documented this gender bias, showing that boys were consistently provided more calories and proteins than girls during early childhood.[27] While not directly comparable, this illustrates that gender-based nutritional disparities have long been a concern in the region.

Belonging to higher wealth quintile families was significantly associated with increased odds of receiving adequate MAD, with adjusted odds ratios of 1.43, 2.26, and 3.01 for children from middle, rich, and richest households, respectively. Household wealth likely enhances the ability to purchase a more diverse and sufficient quantity of food,[28] and has been identified as one of the most consistent determinants of infant and young child feeding (IYCF) practices in South Asian countries.[29] Urban residence was also positively associated with adequate MAD, consistent with earlier findings.[30] This may reflect broader access to food markets and higher household income, though these mechanisms remain speculative due to the absence of direct income and food security indicators in our dataset. Further research is warranted to clarify these pathways.

Breastfed children and those with educated parents were more likely to achieve adequate MAD. This is expected, as breastfeeding contributes to both MDD and MMF. Maternal education is a well-established determinant of appropriate feeding practices,[29] and in contexts of limited literacy, nutrition counselling has been shown to enhance child dietary diversity.[26,29] Conversely, children whose mothers cared for multiple young children had lower odds of receiving adequate MAD, likely due to time and resource constraints that limit the preparation of diverse meals.[28]

Media exposure among mothers was significantly associated with adequate MAD (AOR = 1.64), consistent with studies from Asia and Africa.[4,31,32] As a key method for disseminating information, media likely enhances maternal awareness of appropriate infant and young child feeding (IYCF) practices.[4]

Despite a marked reduction in child undernutrition recently, undernutrition remains a burning problem for Bangladesh. The prevalence of stunting, wasting, underweight and overweight among under-5 children is still alarming (22.6 %, 28.0 %, 9.8 % and 2.4 % respectively) in 2019.[16] The current study found that 25.8 % of the participants were stunted, 19.7 % underweight, 10.5 % were wasted, and 2.1 % were overweight. Adequate MAD was inversely associated with underweight status, aligning with evidence that dietary diversity reflects both nutritional quality and quantity, thereby lowering the risk of underweight.[33,34] These findings support our result and provide a plausible explanation for the observed association. However, while the evidence suggests a potential link between dietary adequacy and nutritional status, the cross-sectional nature of our study limits the ability to draw causal conclusions.

We found no significant association between MAD and stunting or wasting. Addae et al. also reported this finding in Ghana.[14] Stunting is regarded as an indicator for chronic malnutrition and wasting as malnutrition of recent onset.[14] Both of these indicators require some time to manifest, as the Bangladeshi culture of providing breastmilk to the child for up to 2 years (85 % in 2018)[35] provides protection against stunting. It has also been suggested that, since MAD is based on food consumption in the 24 h preceding the survey, it may not adequately capture long-term dietary patterns and thus may lack sensitivity in detecting chronic conditions like stunting,[14] and by extension, wasting. In contrast, underweight reflects both acute and chronic forms of malnutrition, making it more responsive to recent dietary intake and therefore more likely to show an association with MAD.

The study has several strengths, including a large, nationally representative dataset collected by BBS and UNICEF in 2019, ensuring generalizability and relevance. However, it also has limitations. Important factors like birth order, parental demographics, agricultural diversity, seasonality, maternal BMI, food security and recent morbidity data were not accounted for in our analysis. Recall bias may be present in caregiver responses about children's dietary habits, which may have led to misclassification error. The study used a proxy variable to account for the redefinition of MAD in 2021, which can be considered an indirect measure. Moreover, a notable limitation of the MAD indicator is that it does not capture the actual quantity of food consumed. While it accounts for dietary diversity and frequency, it does not reflect caloric adequacy or portion sizes, which are critical for assessing true nutritional sufficiency.[36] The MAD indicator is based on a 24-h dietary recall, it may not capture long-term feeding practices. In contrast, outcomes such as stunting or wasting develop over longer periods and may be influenced by cumulative exposures. As this study is based on cross-sectional data, all associations should be interpreted cautiously. The findings reflect correlations rather than causal effects.

5. Conclusion

This study provides insights into the proportion and predictors of Minimum Acceptable Diet (MAD) in Bangladeshi children. Fewer than one-third of children aged 6–23 months were found to receive adequate MAD. Several sociodemographic and parental factors were associated with MAD practice. Moreover, children with adequate MAD had significantly lower odds of being underweight. These findings suggest the need for targeted interventions focused on poorer households and rural areas. Media exposure and parental education may play an important role in promoting appropriate feeding practices. However, given the cross-sectional design, causality cannot be established. The use of a 24-h dietary recall and the absence of key variables limit the generalizability of our findings. Future longitudinal studies are recommended to better understand causal relationships and broader determinants of child nutrition in Bangladesh.

Author contributions

Conceptualization: MFAF, TA, SN; Data curation: MFAF, MRI; Formal analysis: MFAF, MRI; Methodology: MFAF, SN; Supervision: SN; Writing—original draft: MFAF, MRI; Writing—review and editing: TA, SN; Guarantor: MFAF.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cegh.2025.102140.

Data availability

Data is available in a public, open access repository. The study used data from MICS6 Survey, Bangladesh (2019) which is publicly available at https://mics.unicef.org/surveys.

References

1. Jeyakumar A, Babar P, Menon P, et al. Is infant and young Child-feeding (IYCF) a potential double-duty strategy to prevent the double burden of malnutrition among children at the critical age? Evidence of association from urban slums in pune, Maharashtra, India. In: Kumar M, ed. *PLOS ONE*. vol. 17. 2022 Dec 1, e0278152, 12.
2. Mertens A, Benjamin-Chung J, Colford JM, et al. Child wasting and concurrent stunting in low- and middle-income countries. *Nature*. 2023 Sep;621(7979): 558–567.
3. Guirindola MO, Maniego MLV, Silvestre CJ, Acuin CCS. Determinants of meeting the minimum acceptable diet among Filipino children aged 6-23 months. *Philipp J Sci*. 2018;147(1):75–89.
4. Farah S, Derese T, Abera L. Minimum acceptable diet and associated factors among children aged 6–23 months in jig-jiga, Somali region, eastern Ethiopia, 2022. *BMC Nutr*. 2024 Jan 11;10:11.
5. Atukunda P, Eide WB, Kardel KR, Iversen PO, Westerberg AC. Unlocking the potential for achievement of the UN sustainable development goal 2 - "zero Hunger" - in Africa: targets, strategies, synergies and challenges. *Food Nutr Res*. 2021;65.
6. WHO, UNICEF. *Indicators for Assessing Infant and Young Child Feeding Practices: Definitions and Measurement Methods [Internet]*. UNICEF: WHO; 2021 [cited 2023 Jan 1]. Available from: https://iris.who.int/bitstream/handle/10665/340706/9789240018389-eng.pdf?sequence=1.
7. Choudhury S, Headey DD, Masters WA. First foods: diet quality among infants aged 6–23 months in 42 countries. *Food Policy*. 2019 Oct;88, 101762.
8. Tufts University [Internet]. *Data4Diets: Building Blocks for diet-related Food Security Analysis*. Boston, MA; 2024 [cited 2025 Jul 4] Version 2.0. https://inddex.nutrition.tufts.edu/data4diets.
9. Gatica-Domínguez G, Neves PAR, Barros AJD, Victora CG. Complementary feeding practices in 80 Low- and middle-income countries: prevalence of and socioeconomic inequalities in dietary diversity, meal frequency, and dietary adequacy. *J Nutr*. 2021 Jul 1;151(7):1956–1964.
10. Guirindola MO, Maniego ML, Silvestre CJ, Acuin CC. Determinants of meeting the minimum acceptable diet among Filipino children aged 6-23 months. *Philipp J Sci*. 2018 Mar;147(1):75–89.
11. Molla A, Egata G, Getacher L, et al. Minimum acceptable diet and associated factors among infants and young children aged 6–23 months in amhara region, central Ethiopia: community-based cross-sectional study. *BMJ Open*. 2021 May 10;11(5), e044284.
12. Niport ICF. *Bangladesh Demographic and Health Survey 2022: Key Indicators Report*. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF; 2023.
13. Rahman MdS, Chowdhury MdRK, Islam MdR, et al. Determinants and projections of minimum acceptable diet among children aged 6–23 months: a national and subnational inequality assessment in Bangladesh. *Int J Environ Res Publ Health*. 2023 Jan 21;20(3):2010.
14. Addae HY, Sulemana M, Yakubu T, Atosona A, Tahiru R, Azupogo F. Low birth weight, household socio-economic status, water and sanitation are associated with stunting and wasting among children aged 6–23 months: results from a national survey in Ghana. *PLoS One*. 2024 Mar 28;19(3), e0297698.
15. 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 Jan;8(s1):11–27.
16. BBS, UNICEF Bangladesh. *Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report*. Dhaka, Bangladesh: BBS; 2019.
17. Al Fidah MF, Efa SS. Skin-to-skin contact and early initiation of breast feeding in Bangladesh: a cross-sectional study using MICS6, Bangladesh (2019) data. *BMJ Paediatr Open*. 2023 Nov;7(1), e002163.
18. Al Fidah MF, Islam MR, Rahman MM, et al. Community-level expenses for under-5 diarrheal cases prior to reporting at Dhaka hospital: a cross-sectional analysis in Bangladesh. *Clin Epidemiol Glob Health*. 2024 Nov, 101846.
19. Khanam M, Sarker AR. Dietary diversity among children aged 6-23 months in Bangladesh: determinants and inequalities. *Bangladesh Dev Stud*. 2023 May 2;XLIV(3 & 4):81–102.
20. Fidah MFA, Nabin AA, Efa SS. Factors associated with acute respiratory infection and healthcare-seeking behaviour among primary caregivers in Bangladesh: a study based on MICS 2019. *BMJ Public Health [Internet]*. 2024 Mar 13;2(1) [cited 2024 Apr 27] https://bmjpublichealth.bmj.com/content/2/1/e000576.
21. Al Fidah MF, Haider T, Roy D, Hossain ME, Efa SS. Temporal trends in diarrheal diseases and treatment responses among children under 5 in Bangladesh: insights from the multiple indicator cluster servers (2006-1019). Pediatr Neonatol. forthcoming;.
22. Rahman MS, Chowdhury MRK, Islam MR, et al. Determinants and projections of minimum acceptable diet among children aged 6–23 months: a national and subnational inequality assessment in Bangladesh. *Int J Environ Res Publ Health*. 2023; 20(3):2010.
23. Roy A, Hossain MM, Hanif AAM, et al. Prevalence of infant and young child feeding practices and differences in estimates of minimum dietary diversity using 2008 and 2021 definitions: evidence from Bangladesh. *Curr Dev Nutr*. 2022 Mar 3;6(4), nzac026.
24. Na M, Aguayo VM, Arimond M, Narayan A, Stewart CP. Stagnating trends in complementary feeding practices in Bangladesh: an analysis of national surveys from 2004-2014. *Matern Child Nutr*. 2018;14(S4), e12624.
25. Saha KK, Billah M, Menon P, El Arifeen S, Mbuya NVN. *Bangladesh National Nutrition Services: Assessment of Implementation Status [Internet]*. The World Bank; 2015 [cited 2025 Jul 5]. Available from: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/304161467993190270.
26. Owais A, Suchdev PS, Schwartz B, et al. Maternal knowledge and attitudes towards complementary feeding in relation to timing of its initiation in rural Bangladesh. *BMC Nutr*. 2019 Jan 30;5:7.
27. Chen LC, Huq E, D'Souza S. Sex bias in the family allocation of food and health care in rural Bangladesh. *Popul Dev Rev*. 1981;7(1):55–70.
28. Mistry SK, Hossain MB, Irfan NM, et al. Trends in complementary feeding indicators and intake from specific food groups among children aged 6–23 months in Bangladesh. *Int J Environ Res Publ Health*. 2022 Jan;19(1):550.
29. Senarath U, Agho KE, Akram D, et al. Comparisons of complementary feeding indicators and associated factors in children aged 6–23 months across five South Asian countries. *Matern Child Nutr*. 2012;8:89–106.
30. Raru TB, Merga BT, Mulatu G, et al. Minimum dietary diversity among children aged 6–59 months in East Africa countries: a multilevel analysis. *Int J Publ Health*. 2023 Jun 1;68, 1605807.
31. Dhawan D, Pinnamaneni R, Viswanath K. Association between mass media exposure and infant and young child feeding practices in India: a cross-sectional study. *Sci Rep*. 2023 Nov 7;13, 19353.
32. Dhami BK, Nath D, Lamichhane R. Factors influencing minimum acceptable diet (MAD) intake among children aged 6–23 months in remote Mid-Himalayan region of sudurpaschim, Nepal. *BMC Public Health*. 2025 Jan 20;25(1):237.
33. Walingo MK, Ekesa BN. Nutrient intake, morbidity and nutritional status of preschool children are influenced by agricultural and dietary diversity in Western Kenya. *Pakistan J Nutr*. 2013 Aug 15;12(9):854–859.
34. Hooshmand S. Dietary diversity and nutritional status of urban primary school children from Iran and India. *J Nutr Disord Ther [Internet]*; 2013 [cited 2025 Jul 5]; 03(02). Available from: https://www.omicsonline.org/dietary-diversity-and-nutritional-status-of-urban-primary-school-children-from-iran-and-india-2161-0509.S12-001.php?aid=12841.
35. Ahmed MS, Whitfield KC, Yunus FM. Trends and predictors of early initiation, exclusive and continued breast-feeding in Bangladesh (2004–2018): a multilevel analysis of demographic and health survey data. *Br J Nutr*. 2022 Nov;128(9): 1857–1867.
36. Lele U, Masters WA, Kinabo J, et al. Measuring food and nutrition security: an independent technical assessment and user's guide for existing indicators [internet]. Rome: food security information network; 2024 mar. (measuring food and nutrition security technical working group). http://www.fsincop.net/topics/fns-measurement.