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An assessment of anemia status of child-mother pairs in Bangladesh

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ABSTRACT

Anemia (e.g. iron deficiency anemia) is a serious public health concern that often coexists within the same household, particularly threatening child-mother pairs. Despite the high prevalence, there is a paucity of research to understand the anemia status of child-mother pairs in Bangladesh. This study aimed to explore the anemia status of child-mother pairs and associated factors using data from the 2011 Bangladesh Demographic and Health Survey (BDHS). Multinomial logistic regression was used to estimate the association between factors and different pairs. Among the child-mother pairs, about 26% was both anemic, followed by child anemic-mother nonanemic (25%) and child nonanemic-mother anemic (17%). Several factors were significantly associated with anemia status of child-mother pairs. Current breastfeeding status was associated with greater odds of different anemia status pairs. Mothers' undernutrition was related to greater odds of child-mother anemic pairs (adjusted odds ratio [AOR] 1.775, 95% confidence interval [CI] 1.216–2.593, p = 0.0030). Living in wealthier households was associated with lower odds of child-mother anemic pairs (AOR 0.519, 95% CI 0.320–0.842, p = 0.0080). Overall, the findings from this study show the importance of simultaneous consideration of children and mothers for anemia-related health programs as well as cohort-specific tailored interventions to reduce anemia burden.

1. Introduction

Anemia (or low concentrations of hemoglobin) is a global health concern. Anemia may be the result of many causes (World Health Organization, 2015), but previous research has estimated that about 50% of cases of anemia are owing to iron deficiency (Stoltzfus, Mullany, & Black, 2004), which is also where this study would focus. It has been found that the most vulnerable anemic cohorts are women at reproductive age (WRA) and pre-school aged children (PreSAC) (De Benoist, Cogswell, Egli, & McLean, 2008). Anemia has been found to affect cognitive, behavioural and physical performance, immune systems, and safe pregnancy outcomes (McCann & Ames, 2007; World Health Organization, 2001). Moreover, anemia affects not only people who suffer from it but society as a whole, both socially and economically (Alcazar, 2013). However, it is difficult to quantify the economic costs of anemia due to the varied settings and lack of data; a study on ten developing countries estimates the economic costs of iron deficiency anemia is about 4.05% of gross domestic product (GDP) (Horton & Ross, 2003).

According to 2011 estimates, globally about 528.4 million WRA (32.4 million pregnant (prevalence 38%) and 496 million non-pregnant (prevalence 29%)) were anemic (Stevens et al., 2013; World Health Organization, 2014). Besides, about 273 million PreSAC suffered from anemia, with the highest prevalence in central and west Africa (71%) closely followed by South Asia (58%) (Stevens et al., 2013). In SA, anemia imposes serious health concerns in forms of maternal illnesses and deaths, as well as poor birth outcomes such as newborns with low birth weight and iron deficiency. Khan, Wojdyla, Say, Gülmezoglu, and Van Look (2006) reported anemia as the second leading cause of maternal death in Asia. Anemia is also marked as a severe health issue in Bangladesh with the prevalence of anemia among WRA and PreSAC were 43% and 51% respectively (National Institute of Population Research and Training, Mitra, & Associates, 2013).

Literature suggests that children born to anemic mothers are more likely to be anemic, and they are at risk of developmental difficulties (Berner, Kamal, Bener, & Bhugra, 2014; Felt & Lozoff, 1996; Khan,

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Awan, & Misu, 2016; 28). A potential adverse effect of poor maternal functioning on infant development is observed for anemic mothers (Perez et al., 2005). Moreover, it has been shown that infants whose mothers are anemic are developmentally delayed in the hand-eye movement (Beard et al., 2005). An inter-generational linkage between mother and child creates a connection to maternal anemia with childhood anemia through poor birth outcomes, including stunting, low birth weight and the nutritional deficiency (De Benoist et al., 2008; McGuire, 2015; World Health Organization, 2014). This indicates that anemia may coexist in the same household and threaten child-mother pairs.

Earlier studies showed that different factors such as socio-demographic, dietary patterns and nutritional status are suggested to be associated with anemia. Earlier research revealed that maternal age, number of children in the household, use of contraception, breast-feeding status, place of residence, place of child delivery, education status, household economic condition, level of malnutrition, consumption of iron-rich food, and iron supplementation during pregnancy are significant determinants of anemia among WRA (Bharati, Som, Chakrabarty, Bharati, & Pal, 2008; Gebremedhin & Enquselassie, 2011; Kamruzzaman, Rabbani, Saw, Sayem, & Hossain, 2015; Rai, Fawzi, Barik, & Chowdhury, 2018). Similarly, studies have found similar factors including maternal anemia, chronic malnutrition (stunting), drinking water source, the occurrence of fever, birth spacing, household wealth and geographical locations contributed to anemia among PreSAC (Government of the Peoples Republic of Bangladesh, 2004; Khan et al., 2016). Based on separate studies, determinants of PreSAC anemia have been shown to share some common factors with the underlying determinants of anemia in WRA. However, there remains a literature gap to observe the anemia status of child and mother pairs in the same households. Joint assessment of child and mother may indicate whether shared home environment, demographics, dietary patterns, and nutritional status have an effect on anemia status of child and mother pairs.

Based on previous findings, this study hypothesised that assessing anemia status of child-mother pairs could address the co-occurrence of anemia among child and mother in Bangladesh as well as reveal common determinants. To best of our knowledge, no study in Bangladesh has explored the anemia status of child-mother pairs and associated factors. These findings could help make evidence-based policies to target vulnerable cohorts to reduce the burden of maternal and child anemia and ultimately contribute to the Sustainable Development Goal 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) and 3 (ensure healthy lives and promote well-being for all at all ages) adopted by the United Nations General Assembly (Ministry of Planning, 2018).

2. Materials and methods

2.1. Data overview

Data were extracted from the 2011 Bangladesh Demographic and Health Survey (BDHS), a national level survey designed for population health indicators, specifically maternal and child health. The enumeration areas (EAs) from population census 2011 were considered as primary sampling units (PSUs) to produce nationally representative estimates of the indicators for all seven administrative districts of Bangladesh. This survey used two-stage stratified cluster sampling design: 600 clusters (including 207 urban clusters and 393 rural clusters) in the first stage and a systematic sample of 30 households (HHs) per cluster (on average) in the second stage (National Institute of Population Research and Training, Mitra, & Associates, 2013).

In this survey, hemoglobin data were available for 2,283 PreSAC children out the originally collected 17,482 samples in the survey. Of these, 375 children were excluded due to missing data on mothers' hemoglobin measures (44), pregnant mothers (142), not a de jure households (159), missing data on mothers' body mass index (BMI) (8), and twins (22). After selecting the youngest children of the mother if a mother had more than one child, a total of 1,686 child-mother pairs were retained for the final analysis.

2.2. Outcome measure

Hemoglobin was measured for mothers and children in selected households using a HemoCue rapid testing instrument (National Institute of Population Research and Training, Mitra, & Associates, 2013). If the level of hemoglobin was below 11 g/dL in children and below 12 g/dL in non-pregnant women, they were considered anemic, according to criteria set by World Health Organization criteria (World Health Organization, 2001). The outcome variable anemia status of child-mother pairs was calculated by combining the anemia status of mothers and children resulting in four categories: (NA-NA) for 'child nonanemic - mother nonanemic', (NA-A) for 'child non-anemic - mother anemic', (A-NA) for 'child anemic-mother nonanemic', (A-A) for 'child anemic-mother anemic'.

2.3. Exposures

A set of sociodemographic, nutritional status, breastfeeding, and community level factors were considered as explanatory variables based on previous literature; such as maternal age (years), educational status of a mother ("no education", "primary", "secondary or higher"), underweight status of a mother (BMI $<$ 18.5 kg/m^2 - "yes", "no"), preceding birth interval in months ("1st birth", "0–23", "24–47", "48+"), mothers' media exposure ("yes", "no"), current breastfeeding status ("yes", "no"), number of household members, toilet facility ("improved", "non-improved"), wealth index ("poor", "middle", "rich"), place of residence ("urban", "rural") and administrative division ("Barisal", "Dhaka", "Chittagong", "Khulna", "Rajshahi", "Rangpur", "Sylhet"). The wealth index was calculated using principal component analysis (PCA) of assets owned by the households (Rutstein & Johnson, 2004). The first principal component was explained maximum variability of the data and considered as the wealth index. The wealth index was then used to classify the individuals into five equal groups based on quintiles - "poorest", "poorer", "middle", "richer", and "richest". In this study, the wealth index was categorised as "poor" ("poorest", "poorer"), "middle", "rich" ("richer" and "richest"). Exposure to media, a binary variable, was coded based on three variables - listening to the radio, reading newspapers, and watching TV in a week. In this study, women who had exposure to any of these media in a week were considered as "yes", otherwise "no" in exposure to media variable.

2.4. Statistical analysis

Distribution of selected variables was presented using descriptive statistics. Inferential analysis on the factors related to the child-mother anemia pair was conducted by fitting multinomial logistic regression model (MLR). Moreover, sampling weights were used in all analyses to account for the complex sampling design. Statistical analysis was carried out using R version 3.5.0 (R Core Team, 2018).

3. Results

Table 1 presents the weighted numbers of samples and statistics. Of the 1,686 child-mother pairs, both anemic (A-A) was about 26%, where child anemic-mother non-anemic (A-NA) and child non-anemic-mother anemic (NA-A) were about 25% and 17%, respectively. The median age of the mother was 25 years (IQR 8 years), and about 20% of mothers had no formal education (Table 1). The proportion of underweight mother was around 29%. The preceding birth interval was more than 48 months, about 35% cases. About 62% of the children were breastfed during the survey period. The proportion of mothers who had no media

Table 1
Distribution of study sample (n = 1,686).

	Weighted sample (n)	Percentage (%)
Anemic status of child-mother pairs		
Child nonanemic-mother nonanemic (NA-NA)	531	31.57
Child nonanemic-mother anemic (NA-A)	277	16.50
Child anemic-mother nonanemic (A-NA)	429	25.49
Child anemic-mother anemic (A-A)	445	26.44
Mother age (years) [median (IQR)]	25 (8)	
Mother education		
None	340	20.21
Primary	544	32.34
Secondary or higher	798	47.45
Mother underweight		
Yes	493	29.29
No	1189	70.71
Preceding birth interval		
1st birth	520	30.91
0–23	119	7.07
24–47	451	26.81
48+	592	35.20
Current breastfeeding status		
Yes	1047	62.25
No	635	37.75
Media exposure		
Yes	1073	63.82
No	608	36.18
Wealth index		
Poor	734	43.67
Middle	312	18.53
Rich	636	37.80
Number of household members [median (IQR)]	5 (3)	
Toilet facilities		
Improved	872	51.87
Non-improved	809	48.13
Place of residence		
Rural	1291	76.75
Urban	391	23.25
Division		
Barisal	91	5.43
Chittagong	336	19.99
Dhaka	525	31.20
Khulna	177	10.51
Rajshahi	228	13.56
Rangpur	210	12.49
Sylhet	114	6.81

exposure was nearly 36%. Among the selected households level characteristics, the median size of the household was 5 (IQR 3), with a majority (77%) of rural households. About 44% of the children-mother pairs lived in poor households, and almost half (48%) had no access to improved toilet facilities. Majority of the selected child-mother pairs lived in Dhaka division (about 31%) in contrast to Barisal division (about 5%) (Table 1).

The bivariate and multivariable relationship between factors and anemia status of child-mother pair are presented in Tables 2 and 3, respectively. The reference group for all analyses was child nonanemic - mother nonanemic (NA-NA) pairs, which allows us to estimate the influence of various factors on the prevalence of A-A, NA-A, and A-NA pairs.

Different factors were significantly associated with child-mother anemic (A-A) pairs. In bivariate analysis (Table 2), maternal underweight was positively (crude odds ratio [COR] 2.208, 95% confidence interval [CI] 1.548–3.149, $p < 0.001$) and exposure to media was inversely (COR 0.581, 95% CI 0.411–0.823, $p = 0.0023$) related to A-A pairs. Current breastfeeding status of children was linked to greater odds of A-A pairs (COR 3.311, 95% CI 2.419–4.531, $p < 0.001$). The odds of child-mother anemic (A-A) pairs were lower in households with improved toilet facilities (COR 0.674, 95% CI 0.496–0.915, $p = 0.0117$), and rich wealth status (COR 0.395, 95% CI 0.281–0.555, $p < 0.001$). The odds of A-A pairs were reduced by 40% among child-mother pairs from urban areas (COR 0.601, 95% CI 0.434–0.834, $p = 0.0023$). Compared to Barisal division, the odds of A-A pairs were significantly lower among the child and mother residing in Khulna division (COR 0.466, 95% CI 0.241–0.902, $p = 0.0236$). Using a multivariable model (Table 3), maternal underweight, current breastfeeding status of children, household wealth status and administrative division were predictive of A-A pairs. The odds of the A-A pairs were significantly greater among the underweight mothers (adjusted odds ratio [AOR] 1.775, 95% CI 1.216–2.593, $p = 0.0030$). Current breastfeeding status related to greater odds of A-A pairs (AOR 3.146, 95% CI 2.241–4.416, $p < 0.001$). In rich households, the odds of A-A pairs were significantly lower (AOR 0.519, 95% CI 0.320–0.842, $p = 0.0080$). Child-mother pairs of Khulna and Sylhet division showed lower odds of A-A pairs (Khulna: AOR 0.501, 95% CI 0.257–0.979, $p = 0.0431$; Sylhet: AOR 0.436, 95% CI 0.226–0.841), $p = 0.0134$).

Different factors were significantly related to child nonanemic - mother anemic (NA-A) pairs. According to bivariate analysis (Table 2), maternal media exposure was significantly associated with lower odds of NA-A pairs (COR 0.667, 95% CI 0.460–0.967, $p = 0.0327$). Current breastfeeding status was associated with greater odds of NA-A pairs (COR 1.715, 95% CI 1.215–2.421, $p = 0.0022$). The odds of NA-A pairs were significantly lower in households with improved toilet facilities (COR 0.699, 95% CI 0.492–0.993, $p = 0.0457$), and rich wealth status (COR 0.625, 95% CI 0.428–0.911, $p = 0.0145$). Living in urban areas was associated with the lower odds of NA-A pairs (COR 0.673, 95% CI 0.478–0.949, $p = 0.0240$). In the multivariable model (Table 3), current breastfeeding status positively related to significantly greater odds of NA-A pairs (AOR 1.718, 95% CI 1.196–2.467, $p = 0.0035$).

Different factors were significantly associated with child anemic - mother nonanemic (A-NA) pairs. Bivariate analysis (Table 2) reveals that greater maternal age was associated with lower odds of A-NA pairs (COR 0.970, 95% CI 0.946–0.994, $p = 0.0157$). Maternal media exposure inversely (COR 0.731, 95% CI 0.540–0.989, $p = 0.0424$) and current breastfeeding status positively (COR 2.330, 95% CI 1.704–3.187, $p < 0.001$) associated with A-NA pairs. The odds of A-NA pairs were significantly lower in households with improved toilet facilities (COR 0.693, 95% CI 0.516–0.930, $p = 0.0147$) and rich wealth status (COR 0.576, 95% CI 0.417–0.796, $p < 0.001$). The odds of A-NA pairs were significantly lower in urban areas (COR 0.657, 95% CI 0.477–0.904, $p = 0.0101$) and Dhaka division (COR 0.441, 95% CI 0.257–0.757, $p = 0.0030$). According to the multivariable model (Table 3), current breastfeeding status showed a significant positive association with A-NA pairs (AOR 2.138, 95% CI 1.520–3.007, $p = 0.0000$). Compared to Barisal division, there were a significantly lower odds of A-NA pairs in Dhaka (AOR 0.460, 95% CI 0.264–0.803, $p = 0.0064$).

4. Discussion

This study illustrated that both anemic pairs among selected child and mother pairs were highly prevalent (26%), followed by child anemic-mother non-anemic (25%) and child non-anemic-mother anemic (17%) pairs. Multivariable modelling suggested that maternal under-nutrition, breastfeeding status, wealth status of the household and administrative division were associated with anemia status of child-mother pairs.

Malnutrition is a common health problem in Bangladesh. It has been estimated that about one-third of WRAs are malnourished in Bangladesh (Ahmed et al., 2012). Anemia is one of the leading nutritional deficit conditions (Chowdhury et al., 2015). The results of the

Table 2
Bivariate association between factors and anemia status of child-mother pairs (n = 1,686).

Variables	Child nonanemic -Mother anemic (NA-A)		Child anemic -Mother nonanemic (A-NA)		Child anemic-Mother anemic (A-A)	
	COR (95% CI)	p-value	COR (95% CI)	p-value	COR (95% CI)	p-value
Maternal age	1.008 (0.982–1.036)	0.5520	0.970 (0.946–0.994)	0.0157	0.997 (0.973–1.021)	0.7921
Mother education (ref. No education)						
Primary	0.996 (0.636–1.559)	0.9853	1.279 (0.839–1.949)	0.2527	1.046 (0.682–1.605)	0.8353
Secondary or higher	0.717 (0.458–1.123)	0.1462	0.961 (0.659–1.400)	0.8347	0.699 (0.478–1.023)	0.0653
Mother underweight (ref. No)						
Yes	1.104 (0.726–1.679)	0.6420	1.298 (0.941–1.791)	0.1114	2.208 (1.548–3.149)	< 0.001
Media exposure (ref.: No)						
Yes	0.667 (0.460–0.967)	0.0327	0.731 (0.540–0.989)	0.0424	0.581 (0.411–0.823)	0.0023
Preceding birth interval (ref. 1st birth)						
0–23	1.362 (0.666–2.781)	0.3964	0.858 (0.458–1.609)	0.6329	1.292 (0.694–2.407)	0.4185
24–47	1.093 (0.673–1.775)	0.7178	0.931 (0.633–1.369)	0.7144	1.256 (0.830–1.900)	0.2800
48+	1.063 (0.697–1.621)	0.7767	0.799 (0.556–1.148)	0.2248	1.029 (0.708–1.496)	0.8802
Current breastfeeding status (ref. No)						
Yes	1.715 (1.215–2.421)	0.0022	2.330 (1.704–3.187)	< 0.001	3.311 (2.419–4.531)	< 0.001
Toilet facilities (ref. Non-improved)						
Improved	0.699 (0.492–0.993)	0.0457	0.693 (0.516–0.930)	0.0147	0.674 (0.496–0.915)	0.0117
Wealth index (ref. Poor)						
Middle	0.994 (0.633–1.560)	0.9785	0.900 (0.599–1.352)	0.6108	0.665 (0.437–1.012)	0.0569
Rich	0.625 (0.428–0.911)	0.0145	0.576 (0.417–0.796)	< 0.001	0.395 (0.281–0.555)	< 0.001
Number of household member	1.029 (0.973–1.088)	0.3125	1.020 (0.961–1.083)	0.5189	1.034 (0.980–1.091)	0.2223
Place of residence (ref. Rural)						
Urban	0.673 (0.478–0.949)	0.0240	0.657 (0.477–0.904)	0.0101	0.601 (0.434–0.834)	0.0023
Division (ref. Barisal)						
Chittagong	1.049 (0.569–1.936)	0.8777	0.768 (0.43–1.372)	0.3716	0.524 (0.269–1.023)	0.0583
Dhaka	1.097 (0.603–1.996)	0.7612	0.441 (0.257–0.757)	0.0030	0.580 (0.319–1.053)	0.0733
Khulna	0.832 (0.405–1.707)	0.6153	0.813 (0.471–1.403)	0.4560	0.466 (0.241–0.902)	0.0236
Rajshahi	1.260 (0.654–2.426)	0.4895	0.621 (0.343–1.126)	0.1163	0.630 (0.323–1.228)	0.1742
Rangpur	1.403 (0.718–2.741)	0.3210	0.889 (0.471–1.678)	0.7155	1.042 (0.558–1.946)	0.8973
Sylhet	0.989 (0.486–2.011)	0.9746	0.744 (0.433–1.278)	0.2835	0.596 (0.317–1.120)	0.1080

COR: Crude odds ratio; CI: Confidence interval; ref.: Reference category.

current study suggest that maternal undernutrition was linked to the child-mother anemia pairs. Earlier research also shows that maternal undernutrition positively related maternal anemia (Kamruzzaman et al., 2015) and child anemia (Souganidis et al., 2012). Understanding the underlying reasons is vital for the development of effective strategies for preventing anemia. The possible reasons could be that children and mothers share a common unhealthy home environment, poor care, inadequate dietary intake, and lack of access to health care. For instance, low iron supplementation among undernourished mother during pregnancy and after childbirth may affect the iron status of both the mother and the child.

The results estimated that current breastfeeding status had a substantial influence on the anemia status of child-mother pairs. It complements the issue of malnutrition discussed above, as severe maternal anemia would reduce iron content in breast milk (Pasricha et al., 2010) and, that would create scarcity in the child who depends primarily on the mother (Rohner et al., 2013). Moreover, study shows that breastfeeding mothers are more likely to be anemic, and lack of diversified diet could be the underlying reason because dietary diversity of breastfed mothers is poorer than the non-breastfeed mothers (Gebremedhin & Enquselassie, 2011). Other socio-demographic issues compliment this factor, as well. For example, poorer households, where mothers generally lack nutritional foods and suffer from iron deficiency, would also fail to provide the child with iron-rich diets and supplements (Miller, 2013; Murray-Kolb & Beard, 2009). These could lead to one in the child-mother pair or both becoming anemic and the

Table 3
Multivariable multinomial logistic regression fitted to assess the association between factors and anemia status of child-mother pairs (n = 1,686).

Variables	Child nonanemic -Mother anemic (NA-A)		Child anemic -Mother nonanemic (A-NA)		Child anemic-Mother anemic (A-A)	
	AOR (95% CI)	p-value	AOR (95% CI)	p-value	AOR (95% CI)	p-value
Maternal age	1.014 (0.976–1.054)	0.4683	0.975 (0.943–1.008)	0.1349	1.014 (0.980–1.049)	0.4278
Mother education (ref. No education)						
Primary	1.160 (0.724–1.859)	0.5358	1.192 (0.757–1.876)	0.4480	1.166 (0.719–1.889)	0.5326
Secondary or higher	0.943 (0.535–1.661)	0.8375	1.002 (0.607–1.654)	0.9943	1.095 (0.660–1.817)	0.7247
Mother underweight (ref. No)						
Yes	0.940 (0.611–1.446)	0.7770	1.045 (0.745–1.467)	0.7969	1.775 (1.216–2.593)	0.0030
Media exposure (ref.: No)						
Yes	0.836 (0.527–1.327)	0.4462	0.911 (0.623–1.331)	0.6280	0.960 (0.644–1.430)	0.8406
Preceding birth interval (ref. 1st birth)						
0–23	1.156 (0.524–2.550)	0.7187	0.899 (0.449–1.797)	0.7621	1.200 (0.604–2.384)	0.6026
24–47	0.913 (0.519–1.608)	0.7525	1.018 (0.634–1.634)	0.9418	1.134 (0.681–1.890)	0.6278
48+	0.880 (0.519–1.494)	0.6352	0.975 (0.609–1.560)	0.9151	0.981 (0.600–1.606)	0.9395
Current breastfeeding status (ref. No)						
Yes	1.718 (1.196–2.467)	0.0035	2.138 (1.520–3.007)	< 0.001	3.146 (2.241–4.416)	< 0.001
Toilet facilities (ref. Non-improved)						
Improved	0.796 (0.54–1.172)	0.2464	0.775 (0.546–1.101)	0.1547	0.944 (0.668–1.336)	0.7464
Wealth index (ref. Poor)						
Middle	1.212 (0.71–2.070)	0.4806	1.019 (0.636–1.631)	0.9386	0.824 (0.514–1.321)	0.4208
Rich	0.893 (0.518–1.539)	0.6830	0.769 (0.473–1.251)	0.2890	0.519 (0.320–0.842)	0.0080
Number of household member	1.027 (0.962–1.096)	0.4175	1.025 (0.959–1.094)	0.4660	1.050 (0.991–1.113)	0.0977
Place of residence (ref. Rural)						
Urban	0.847 (0.554–1.293)	0.4409	0.941 (0.659–1.346)	0.7402	1.084 (0.725–1.620)	0.6943
Division (ref. Barisal)						
Chittagong	1.103 (0.579–2.099)	0.7657	0.822 (0.457–1.479)	0.5121	0.545 (0.280–1.062)	0.0746
Dhaka	1.209 (0.65–2.248)	0.5478	0.460 (0.264–0.803)	0.0064	0.606 (0.330–1.114)	0.1069
Khulna	0.867 (0.415–1.808)	0.7023	0.827 (0.468–1.463)	0.5133	0.501 (0.257–0.979)	0.0431
Rajshahi	1.284 (0.655–2.516)	0.4663	0.617 (0.336–1.132)	0.1189	0.597 (0.304–1.173)	0.1342
Rangpur	1.366 (0.684–2.728)	0.3754	0.790 (0.412–1.515)	0.4771	0.875 (0.462–1.658)	0.6825
Sylhet	0.865 (0.408–1.838)	0.7064	0.680 (0.387–1.197)	0.1813	0.436 (0.226–0.841)	0.0134

AOR: Adjusted odds ratio; CI: Confidence interval; ref.: Reference category.

current status quo rarely allows them to improve their condition (Gebremedhin, 2014; Kordas et al., 2011).

Mother and children of wealthy households were less likely to be anemic compared to poorer households in the child-mother anemic group. This could be a reflection of iron-rich and nutritious food afforded by affluent families. Poor families generally consume insufficient food and endure an unhygienic residential environment (Alredaisy & Saeed, 2013; Giashuddin, Kabir, & Hasan, 2005). Women and children from these households remain far behind preventive or curative doses of vitamins and iron tablets and are common victims of anemia (Ahmed, Hasan, Ahmed, & Chowdhury, 2013). Lack of access to resources also bar mothers and subsequently children to seek treatments, both in remote locations and metropolitan (Hossen & Westhues, 2011; Rob, Rahman, & Bellows, 2010). Furthermore, in the patriarchal culture of Bangladesh, women rarely get the opportunity to voice their needs regarding adequate healthcare, which in turn harms the child as well (Biswas, Rahman, Kabir, & Raihan, 2017).

The anemia status of child-mother pairs was linked to the administrative division. In this study, children and mother from Khulna and Sylhet divisions were less likely to form anemia clustering compared to the children and mother from Barisal division. Besides, children-mother pairs from Dhaka division were less likely to form child anemia-mother nonanemic. The sociodemographic and environmental change could be the underlying reason.

Other factors such as maternal age, maternal education and exposure to media, household toilet facilities, and place of residence showed significant association with anemia status of child-mother pairs in bivariate analysis, although they were not statistically significant in the multivariable model. In future program planning and intervention, however, they should be taken into account as part of a multi-sectoral approach to reducing anemia burden. Also, more studies targeting vulnerable cohorts are necessary for a better understanding of the pathways to reduce this chronic issue.

This study had a few limitations. Firstly, cross-sectional data were used for analyses and was limited to longitudinal associations between different maternal and household characteristics and child-mother anemia. The findings warrant cautious interpretation as they lack causal inferences. Secondly, the study was limited to the factors available in the DHS. Future studies could investigate other dietary, environmental and cultural factors, such as food habit, daily nutrition intake, and access to health facilities. Thus, there could be some unrestrained confounding factors not adjusted in the model. Finally, qualitative data on mothers' level of nutritional knowledge would have given a more precise picture to compare between anemic and non-anemic mothers and their offspring, and how nutritional information gap played a role. However, this provides scopes for future research as well. Future studies would also need to assess the co-occurrence of other malnutrition.

5. Conclusion

Mother and child nexus are undoubtedly crucial in global health and development. As mothers have a significant role in their child's physical and mental growth – through the closest physical attachment and emotional bonding; we should not look at mother and child wellbeing separately. Pregnancy and childbirth period are the most vital period when maternal and newborn health overlap. In this period, mother and child wellbeing respond proportionately against some interventions or course of medications. For example, skilled birth attendance and proper antenatal care are both responsible for the reduction of maternal mortality (by reducing bleeding, infections and hypertensive diseases) as well as neonatal death (Lassi, Majeed, Rashid, Yakoob, & Bhutta, 2013; Lawn et al., 2005, 2010). Furthermore, previous studies also find an association between parental education and child health. Mothers' education was found associated with stunting of children, whereas fathers' education was associated with child immunisation in Bangladesh (Mondal, Majumder, & Rayhan, 2014). Although the majority of the existing health interventions were designed for addressing either maternal or child health aspect, the integrated approach of developing interventions is also suggested by recent literature. For example, the continuum of care for reproductive, maternal, newborn and child health (RMNCH) approach considers mother and child pair as a conjugal unit of developing and providing intervention (Kerber et al., 2007; Lassi et al., 2013). This study highlights the importance of integrating separate interventions for reducing mother and children anemia into a common area of interest through the incorporation of child-mother pair.

Although malnutrition has been decreased, the prevalence of anemia among women and children in Bangladesh is still high. This study found that the anemia status of child-mother pairs needs to be assessed to detect and intervene in the most vulnerable cohorts. Poor households, undernourished mothers, breastfeeding practice, were seemed to have a significant relationship with the greater odds of child-mother anemia clustering. There is a need to accelerate and modify the available intervention programs and initiatives to tackle countrywide malnutrition and anemia targeting mother and children simultaneously. Specifically, community-based iron supplementation program should be strengthened for lactating mothers (e.g. iron-folic acid (IFA)) and their children (e.g. micronutrient powders (MNP)). Besides, mother and children's nutritional status is closely linked, so the action is needed to empower women, ensure access to social security and services, enhance diet quality and diversification, and provide proper nutritional education. Furthermore, poor households need to be given special attention as they cannot afford expensive products such as poultry, milk, meat, fruit and other nutritious foods. In a nutshell, actions are needed through multi-sectoral approach to reducing wealth inequality, producing of bio-fortified and iron-rich crops, enhancing dietary diversity, promoting and supporting breastfeeding and age-appropriate complementary feeding, providing iron supplementation, provisioning of fortified foods, proper family planning, improving water, sanitation and hygiene practices, preventing infectious diseases, providing health and nutrition education. Specific cohort or area-based intervention policy studies in-line with the United Nations Decade of Action on Nutrition could be a way forward for Bangladesh that would require targeted data collection and ongoing monitoring.

Contributions

J.R. Khan: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Supervision, Writing - original draft, Writing - review & editing. **M.M. Islam:** Data curation, Methodology, Validation, Writing - original draft, Writing - review & editing. **R.K. Biswas:** Methodology, Validation, Writing - original draft, Writing - review & editing. **A. Sultana:** Writing - original draft, Writing - review & editing.

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Disclosure statement

The authors declare that they have no competing interests.

Ethical considerations

Bangladesh Demographic and Health Survey (BDHS) was reviewed and approved by the ICF Macro Institutional Review Board (USA) and the National Research Ethics Committee of the Bangladesh Medical Research Council (Dhaka, Bangladesh). Informed consent was taken from survey participants before the interview. In the dataset, participants were identified with unique numbers but not with any personal information.

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