


# Overweight and obesity among urban women with iron deficiency anaemia in Bangladesh

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## Abstract

In this study, we aimed to determine the prevalence and factors associated with overweight and obesity among nonpregnant and nonlactating (NPNL) women of reproductive age with iron deficiency anaemia (IDA) in urban Bangladesh. We obtained data from the baseline assessment of a randomized control trial conducted among 525 women of reproductive age (18–49 years) with IDA (Hb < 12 gdl<sup>-1</sup> and serum ferritin <30 µg L<sup>-1</sup>). The study was carried out in Mirpur, Dhaka, Bangladesh, between December 2017 and January 2019. We collected information on women's socio-demographic characteristics and anthropometry. Body mass index (BMI) was calculated using the following formula: weight in kilograms per height in square metres. BMI ≥ 25–29.9 kg m<sup>-2</sup> was considered as overweight, whereas BMI ≥ 30 kg m<sup>-2</sup> as obese. A multivariable logistic regression model was used to ascertain the risk factors of overweight and obesity. The prevalence of overweight and obesity was 29.9% (95% CI: 26.0–34.0) and 13.1% (95% CI: 10.4–16.3), respectively. The combined prevalence of overweight and obesity was 43.0% (95% CI: 38.7–47.4). The multivariable analysis showed married women (aOR: 4.4; CI: 1.8–11.1), women aged 30–49 years (aOR: 7.6; CI: 2.4–24.1), unemployed women (aOR 1.5; CI: 1.0–2.4) and women from the wealthier households (aOR 3.9; CI: 2.3–6.8) had the highest risk of being overweight and obese compared with their counterparts. Both age and household wealth statuses showed dose–response relationships. Combination of overweight and obesity with IDA poses a particular challenge for public health interventions. The policymakers should consider what new interventions and policy initiatives are needed to address this combination of overweight and obesity with IDA.

## KEYWORDS

Bangladesh, iron deficiency anaemia, obesity, overweight, urban area, women of reproductive age

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## 1 | INTRODUCTION

Mounting national incomes along with significant alteration in food habits and physical activity are resulting in an accelerating prevalence of overweight and obesity across the globe (Bhurosy & Jeewon, 2014; Harding, Aguayo, & Webb, 2019). In recent years, most developing countries are experiencing a nutrition transition during the process of socio-economic developments (Popkin, 1994). Persistent high burden of undernutrition along with the increasing prevalence of overweight and obesity is creating another type of public health challenge for the developing countries: “the double burden of malnutrition” (Abdullah, 2015). Countries with a high prevalence of undernutrition today and high projected growth in overweight and obesity could suffer a considerable epidemic of noncommunicable diseases over the next 30 years (Schmidhuber & Shetty, 2005).

Overweight and obesity pose special health risks for women of reproductive age. It not only increases the risk of gestational diabetes, Type 2 diabetes, preeclampsia, premature labour, caesarean delivery and cardiovascular disease (Cnattingius et al., 2013; Leddy, Power, & Schulkin, 2008; Thrift & Callaway, 2014) but also increases the likelihood of adverse perinatal, neonatal, infant and child health outcomes (Catalano et al., 2012). Similarly, women of reproductive age suffering from iron deficiency anaemia (IDA) had a higher risk of miscarriage, preterm labour, abruption placenta and low birth weight (Kamruzzaman, Rabbani, Saw, Sayem, & Hossain, 2015; Rasmussen, 2001; Scholl, Hediger, Fischer, & Shearer, 1992). Evidence suggests that overweight and obesity increase the risk of IDA (Zhao et al., 2015). Because of the interrelationships between overweight and obesity with IDA, globally the research interests are diverting towards the examination of coexistence of overweight and obesity with IDA (Chang et al., 2014; Jones et al., 2016; Rhodes et al., 2020; Wirth et al., 2017).

Over the last two decades, Bangladesh is observing an alarming rise in the prevalence of overweight and obesity among women of reproductive age (Balarajan & Villamor, 2009; Biswas, Uddin, Al Mamun, Pervin, & Garnett, 2017; Tanwi, Chakrabarty, & Hasanuzzaman, 2019). Secondary analysis of Bangladesh Demographic and Health Survey (BDHS) Data 2014 showed that around 34% women of reproductive age in urban Bangladesh were overweight and obese (Tanwi, Chakrabarty, Hasanuzzaman, Saltmarsh, & Winn, 2019). On the other hand, the prevalence of anaemia among nonpregnant ever-married women living in urban areas was 37.2%. According to Bangladesh National Micronutrient Survey 2011, around 7% of nonpregnant and nonlactating (NPNL) women of reproductive age suffered from IDA (International Centre for Diarrheal Disease Research Bangladesh, icddr,b, 2013; Mamun & Mascie-Taylor, 2019). Although several studies in this context already examined the prevalence and correlates of overweight and obesity and anaemia among women of reproductive age independently, none of the studies examined the coexistence of overweight and obesity with IDA.

Our study aimed to determine the prevalence and factors associated with overweight and obesity among NPNL women of

### Key Messages

- The prevalence of overweight and obesity among women of reproductive age with iron deficiency anaemia (IDA) was 43.0% (95% CI: 38.7–47.4).
- Combination of overweight and obesity with IDA poses a particular challenge for public health interventions.
- Policymakers need to understand what new interventions and policy initiatives are needed to address the combination of overweight and obesity with IDA.

reproductive age with IDA. Coexistence of overweight and obesity among women of reproductive age with IDA poses a particular challenge for public health interventions. Finding from this study will help policymakers design context-specific solutions targeting population having a combination of overweight and obesity with IDA.

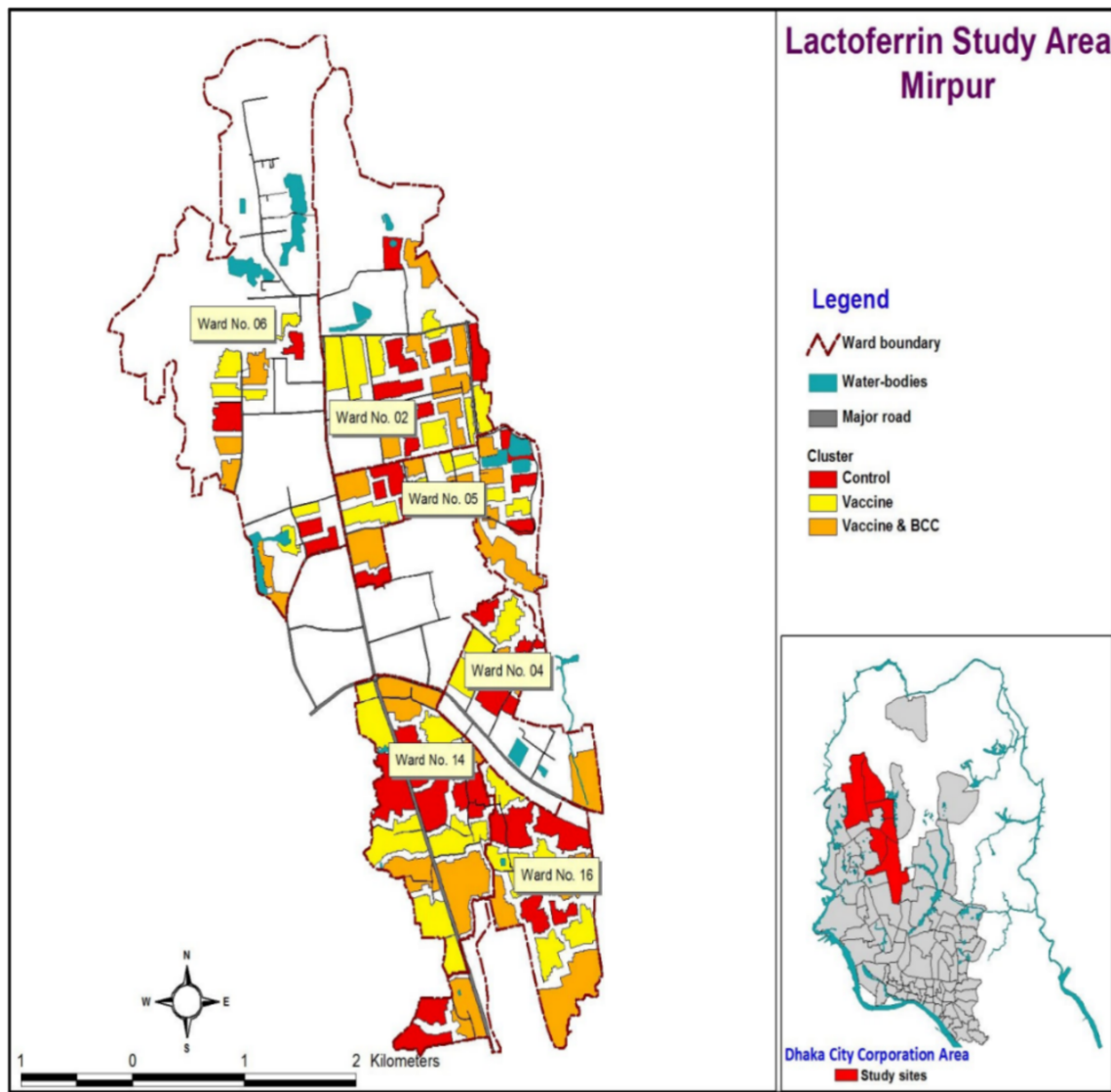
## 2 | METHODS

### 2.1 | Parent trial and sample size

A community based double-blind, randomized control study was conducted among women of reproductive age (18–49 years) with IDA in Mirpur Dhaka, Bangladesh. The objective of the study was to test the efficacy and appropriate dose of bovine lactoferrin for correction and prevention of IDA among NPNL women of reproductive age. As part of the study, screening for anaemia was done in the community. We screened 3722 NPNL women of reproductive age for IDA. The prevalence of IDA was 19.1% ( $n = 710$ ). We enrolled women who were aged between 18 and 49 years, were NPNL at the time of enrolment, had serum haemoglobin between 7 and 12 g dl<sup>-1</sup>, serum ferritin level below 30 µg L<sup>-1</sup> and provided informed consent for participation in the trial. A total of 555 women with IDA were enrolled in the study. A baseline assessment of socio-economic status and anthropometric measurements was done. We included 525 women in the analysis of this paper who participated in the baseline assessments (30 participants did not participate in baseline assessment after enrolment).

### 2.2 | Study site

We conducted the study in the Mirpur area of Dhaka, the capital city of Bangladesh (Figure 1). Mirpur is one of the 42 thanas of Dhaka City with a population of about 1 million in an area of 39 km<sup>2</sup>. The area is densely populated and divided into 16 sections/wards for administrative purposes. Mirpur has both slum and nonslum areas. The majority



**FIGURE 1** Study area map

of the population belongs to low socio-economic conditions. The average income of the slum areas of Mirpur was Tk 4,200 (about USD 55) per month per family.

### 2.2.1 | Data collection and quality assurance measures

Baseline data collection was done between March 2018 and September 2018. We used CommCare for data collection. Commcare is a tab-based data collection system with range checks and skips options inbuilt to minimize error during data collection. The tab-based system also enabled us to monitor data quality in real time. We recruited data collectors who had prior experience in survey data collection and anthropometric measurements. Data collectors received 10-day in-house training by expert trainers, including 2-days field

practice. An expert nurse collected the blood samples under supervision of a study physician. All the biomarker assessments were done in icddr,b lab following standard procedures for biomarker analysis. icddr,b lab has ISO certification (ISO 15189:2012 and ISO 15190:2003).

### 2.3 | Socio-economic characteristics

We collected socio-economic information using a structured questionnaire adopted from the BDHS 2014 (National Institute of Population Research and Training (Bangladesh), Mitra and Associates (Firm), & MEASURE DHS (Program), 2019). In order to understand the respondent background, information regarding age of the respondent, marital status, parity, educational attainment and current employment status were explored. For household

characteristics, we examined the household size and household wealth status (Chowdhury, Adnan, & Hassan, 2018). We used principle component analysis (PCA) to generate household wealth indexes using variables types of dwelling, source of drinking water, access to sanitary latrine, household's ownership of land, domestic animals, transports (autobike, rickshaw, van, bicycle, motorcycle, scooter, tempo and CNO) and 14-item household affects. Household wealth indexes were classified into three (low, medium and high) (Islam et al., 2018; Kamruzzaman et al., 2015).

## 2.4 | Anthropometry

Anthropometric information was collected using standard tools following the WHO guideline. We used stadiometer with a precision level of 0.1 cm for height measurement. We measured the weight of our study participants using a digital bathroom scale (Tanita) with a precision level of 0.1 lb/50 g. We also assessed the mid-upper arm circumference using a MUAC tape. All the scales were calibrated daily before data collection. Body mass index (BMI) was calculated using formula (weight [kg]/height [m]<sup>2</sup>); BMI  $\geq 25$ –29.9 kg m<sup>-2</sup> was classified as overweight, whereas BMI  $\geq 30$  kg m<sup>-2</sup> was defined as obesity. Participants having BMI  $\leq 18.5$  kg m<sup>-2</sup> were defined as underweight).

## 2.5 | Haemoglobin and iron status

We measured serum haemoglobin and serum ferritin of all our participants. The study nurse collected 5 ml of blood at the field clinic by study nurse following aseptic precautions. One millilitre of blood was stored in EDTA tube, and the rest of the 4 ml was centrifuged for aliquots formation. All samples were then transferred to icddr,b lab for testing of serum haemoglobin and serum ferritin. Participants who had serum haemoglobin  $<12$  g dl<sup>-1</sup> and serum ferritin level  $<30$   $\mu$ g L<sup>-1</sup> were classified as IDA.

## 2.6 | Ethical approval

The study was approved by the Institutional Review Boards (IRBs) and Independent Ethics Committees (IECs) in Bangladesh and Australia.

## 2.7 | Informed consents

We took written informed consents from the study participants before the screening and during enrolment into the study. During the consent process, trained data collectors read out the consent form in the local language (Bangla). They explained the purpose of the study, voluntary nature of participation, possible risk, benefits and use of information to the participants before obtaining signature/thumb impression (for illiterate participants).

## 2.8 | Data analysis

Our primary outcome of interest was the prevalence and factors associated with overweight and obesity among women of reproductive age (18–49 years) with IDA. For the descriptive statistics, we reported the mean and standard deviations for continuous variables and proportions with 95% confidence intervals for categorical variables. We did multivariable logistic regression to understand the factors associated with overweight and obesity among women of reproductive age with IDA. We selected the explanatory variables based on prior literature review. Variables found to have significant associations in bivariate analysis were included in the multivariable logistics regression model in a stepwise fashion. During the modelling exercise, we tested possible interactions among explanatory variables using interaction terms in multivariable logistics regression. We found no significant interaction effect among the possible explanatory variables. All analysis was done using STATA 14.

## 3 | RESULTS

### 3.1 | Socio-demographic and socio-economic characteristics of study participants

About two thirds of the study participants were aged between 30 and 49 years. Eighty-seven percent of the women were married. One in 10 married women had no children. Around one third of women did not receive any formal schooling. More than two thirds of women were unemployed at the time of the survey. The average household size was 4.3. Households were equally distributed across three wealth indexes (low, medium and high) (Table 1).

### 3.2 | Prevalence of overweight and obesity

The prevalence of overweight and obesity was 29.9% (95% CI: 26.0–34.0) and 13.1% (95% CI: 10.4–16.3), respectively, among our study participants (Table 2). The combined prevalence of overweight and obesity was 43.0% (95% CI: 38.7–47.4).

### 3.3 | Prevalence of overweight and obesity by socio-economic factors

Table 3 shows the prevalence of overweight and obesity among NPWL women of reproductive age with IDA by socio-economic categories. The prevalence of overweight and obesity was more than 50% among women above 30 years of age compared to the younger women. Around half of the married women were overweight or obese. The prevalence of overweight and obesity was higher among women who accomplished secondary or higher level education compared to the women with no education. The burden of overweight

**TABLE 1** Socio-demographic characteristics of nonpregnant and nonlactating (NPNL) women of reproductive age (18–49 years) with iron deficiency anaemia (IDA) in Mirpur, Dhaka, Bangladesh, 2018

Background characteristics	n = 525	Percentage (%)
Women's characteristics		
Age in years		
18–19	54	10.3
20–29	157	29.9
30–49	336	60.5
Marital status		
Unmarried	69	13.1
Married	456	86.9
Parity (n = 456)		
None	51	11.2
1 or more children	405	88.8
Women's education		
No schooling	155	29.5
Primary (1–5 years)	153	29.1
Secondary and higher (+6 years)	217	41.3
Women's employment		
Unemployed	336	64.0
Employed	189	36.0
Household characteristics		
Household wealth index		
Low	175	33.3
Medium	175	33.3
High	175	33.3
Household size		
Mean household size	525	4.3
1–4 persons	308	58.7
≥5 persons	217	41.3

and obesity increased with increasing wealth status of the households (25% in low wealth group vs. 61% in high wealth group).

### 3.4 | Factors associated with overweight and obesity among NPNL women of reproductive age with IDA

Table 4 describes the adjusted and unadjusted associations of different socio-economic factors with overweight and obesity among NPNL women of reproductive age with IDA. After adjustment, dose-response relationships were observed between overweight and obesity with the age of the women and household wealth indexes. Married women were more likely to be overweight or obese compared with unmarried women (adjusted odds ratio: 4.4; 95% CI: 1.8–11.1). The risk of being overweight or obese was higher among women having secondary and higher educational attainment compared with the women having no schooling (adjusted odds ratio: 1.9; 95% CI: 1.1–3.3). Unemployed women were more likely to be overweight or obese (adjusted odds ratio: 1.5; 95% CI: 1.0–2.4). We did not observe any association between overweight and obesity with household size.

## 4 | DISCUSSION

Our study has reported a high burden of overweight and obesity among NPNL women of reproductive age with IDA. Our findings suggest that the prevalence of overweight and obesity among NPNL women with IDA is 43% (95% CI: 39–47) higher than the prevalence of overweight and obesity among any women of reproductive age at 34% (95% CI: 30–38) in urban Bangladesh (Tanwi, Chakrabarty, & Hasanuzzaman, 2019). According to National Micronutrient Survey Bangladesh 2013, around 7% of nonpregnant nonlactating women of

**TABLE 2** Nutritional characteristics of NPNL women of reproductive age (18–49 years) with IDA in Mirpur, Dhaka, Bangladesh, 2018

	Underweight (BMI ≤ 18.4 kg m <sup>-2</sup> ) n = 58	Normal weight (BMI 18.5–24.9 kg m <sup>-2</sup> ) n = 241	Overweight (BMI 25–29.9 kg m <sup>-2</sup> ) n = 157	Obesity (BMI ≥ 30 kg m <sup>-2</sup> ) n = 69
Prevalence's (%) with 95% CI)	11.0 (8.5–14.0)	45.9(41.6–50.3)	29.9 (26.0–34.0)	13.1(10.4–16.3)
Anthropometric measurement (mean ± sd)				
Height in cm	150.9 ± 6.3	150.0 ± 5.9	149.9 ± 5.9	149.7 ± 7.1
Weight in kg	38.9 ± 4.2	48.8 ± 5.1	61.6 ± 5.6	73.8 ± 7.5
MUAC in cm	22.2 ± 1.7	26.1 ± 2.0	30.1 ± 3.2	33.5 ± 2.7
BMI in kg m <sup>-2</sup>	17.0 ± 1.1	21.7 ± 1.8	27.4 ± 1.5	32.9 ± 2.9
Biomarkers of IDA (mean ± sd) <sup>a</sup>				
Haemoglobin in g dl <sup>-1</sup>	11.2 ± 1.5	11.2 ± 1.3	11.4 ± 1.3	11.4 ± 1.3
Serum ferritin in µg L <sup>-1</sup>	26.7 ± 22.6	24.9 ± 19.5	23.7 ± 15.7	27.1 ± 26.5

<sup>a</sup>Anaemia is defined as serum haemoglobin concentration <12 g dl<sup>-1</sup>; iron deficiency is defined as serum ferritin concentration <30 µg L<sup>-1</sup>. Abbreviations: BMI, body mass index; IDA, iron deficiency anaemia; NPNL, nonpregnant and nonlactating.

**TABLE 3** Prevalence of overweight and obesity among nonpregnant and nonlactating (NPNL) women of reproductive age (18–49 years) with iron deficiency anaemia (IDA) by socio-economic characteristics in Mirpur, Dhaka, Bangladesh, 2018

Background characteristics	Total number of participants N = 525	Number of participants with overweight and obesity N = 226	Proportion of participants with overweight and obesity % (95% CI)
<b>Women's characteristics</b>			
Age in years			
15–19	54	4	7.4(2.1–17.9)
20–29	157	54	34.4(27.0–42.4)
30–49	314	168	53.5(47.8–59.1)
Marital status			
Unmarried	69	8	11.6(5.1–21.6)
Married	456	218	47.8(43.1–52.5)
Parity (n = 456)			
None	51	19	37.3(24.1–51.9)
1 or more children	405	199	49.1(44.2–54.1)
<b>Women's education</b>			
No schooling	155	56	36.1(28.6–44.2)
Primary (1–5 years)	153	63	41.2(33.3–49.4)
Secondary and higher (+6 years)	217	107	49.3(42.5–56.1)
<b>Women's employment</b>			
Unemployed	336	163	48.5(43.1–54.0)
Employed	189	63	33.3(26.7–40.5)
<b>Household characteristics</b>			
Household wealth index			
Low	175	44	25.1(18.9–32.2)
Medium	175	76	43.4(35.9–51.1)
High	175	106	60.6(52.9–67.9)
Household size			
1–4 persons	308	140	45.5(39.7–51.2)
≥5 persons	217	86	39.6(33.1–46.5)

reproductive age suffered from IDA (International Centre for Diarrheal Disease Research Bangladesh, icddr,b, 2013). Similar to our findings, studies conducted in other settings like India, United States, Malawi, Taiwan, Morocco and Tunisia also confirmed the coexistence of overweight and obesity with IDA (Adib Rad et al., 2019; Chang et al., 2014; Fongar, Godecke, & Qaim, 2019; Gartner et al., 2014; Keding, 2016; Neymotin & Sen, 2011; Rhodes et al., 2020).

Overweight and obesity is a risk factor for IDA (Cepeda-Lopez et al., 2011; Chang et al., 2014; Zhao et al., 2015). Findings from a meta-analysis including data from 26 cross-sectional and case-control studies (13,393 overweight/obese vs. 26,621 nonoverweight individuals) reported that overweight and obese individuals had 31% higher odds of developing iron deficiency (OR: 1.31; 95% CI: 1.01–1.68) (Zhao et al., 2015). Another study looking at the interaction effect of diet, BMI and IDA among Taiwanese women showed that overweight and obese women having high fat/low CHO diet had 10.11

(1.267–80.797) times higher risk of developing IDA (Chang et al., 2014). Despite having similar iron intake, obese women in Mexico had lower serum iron level ( $62.6 \pm 29.5$  vs.  $72.4 \pm 34.6 \mu\text{g dl}^{-1}$ ;  $P = 0.014$ ) and iron binding capacity ( $399 \pm 51$  vs.  $360 \pm 48 \mu\text{g dl}^{-1}$ ;  $P < 0.001$ ) compared with normal weight women (Cepeda-Lopez et al., 2011). Potential explanations of increased risk of IDA among obese individuals include higher iron requirement, increased intake of energy-dense food, dilutional hypoferrremia and/or impaired iron absorption because of obesity-induced inflammation (Cepeda-Lopez, Aeberli, & Zimmermann, 2010; Cepeda-Lopez et al., 2011; Chang et al., 2014). Biologically, obese individuals have a high level of obesity-induced inflammatory biomarkers: serum hepcidin, interleukin-1 (IL-1), IL-6 and tumour necrosis factor  $\alpha$  (TNF- $\alpha$ ) (Aigner, Feldman, & Datz, 2014). These inflammatory biomarkers are strong modulators of iron availability. Elevated serum hepcidin level reduces dietary iron absorption as well as decreases systematic iron



**TABLE 4** Factors associated with overweight and obesity among NPNL women of reproductive age (18–49 years) with IDA in Mirpur, Dhaka, Bangladesh, 2018

Background characteristics	Unadjusted <sup>a</sup>		Adjusted <sup>b</sup>	
	Odd ratios	95% CI	Odd ratios	95% CI
Women's characteristics				
Age in years				
18–19	Ref		Ref	
20–29	5.0**	(1.7–15.1)	4.1*	(1.3–12.9)
30–49	10.3***	(3.5–29.8)	7.6***	(2.4–24.1)
Marital status				
Unmarried	Ref		Ref	
Married	6.4***	(2.9–13.9)	4.4**	(1.7–11.1)
Parity <sup>c</sup>				
None	Ref			
1 or more children	1.3	(0.7–2.4)		
Women's education				
No schooling	Ref		Ref	
Primary (1–5 years)	1.1	(0.7–1.7)	1.1	(0.6–1.8)
Secondary and higher (+6 years)	1.6*	(1.0–2.5)	1.9*	(1.1–3.3)
Women's employment				
Employed	Ref		Ref	
Unemployed	2.1***	(1.4–3.1)	1.5*	(1.0–2.4)
Household characteristics				
Household wealth index				
Low	Ref		Ref	
Medium	2.3**	(1.4–3.7)	2.3**	(1.4–3.9)
High	4.6***	(2.9–7.5)	3.9***	(2.3–6.8)
Household size <sup>c</sup>				
1–4 persons	Ref			
≥5 persons	0.9	(0.6–1.3)		

<sup>a</sup>Unadjusted odds are reported from bivariate logistic regression.

<sup>b</sup>Adjusted odds are reported from multivariable logistic regression.

<sup>c</sup>Parity and household size were omitted from multivariable logistic regression as the variables were not found significant in bivariate logistic regression.

\*P value < 0.05.

\*\*P value < 0.001.

\*\*\*P value < 0.000.

bioavailability (Camaschella, Nai, & Silvestri, 2020; Sanad, Osman, & Gharib, 2011; Tussing-Humphreys, Pusatcioglu, Nemeth, & Braunschweig, 2012).

While looking at the socio-economic factors associated with overweight and obesity among NPNL women of reproductive age with IDA, we found that household wealth status had a positive dose–response relationship with overweight or obesity. Several other studies reported similar associations (Ahirwar & Mondal, 2019; Khan & Kraemer, 2009; Neupane, Prakash, & Doku, 2016; Sarma et al., 2016; Tanwi, Chakrabarty, Hasanuzzaman, Saltmarsh, et al., 2019). Bangladesh is observing a fast-paced economic growth along with a shift towards western culture of food intake, especially

processed foods or diets containing more fats and refined sugars (Drewnowski & Popkin, 1997; Naicker, Venter, MacIntyre, & Ellis, 2015). Increased consumption of calorie-dense fast food and a sedentary lifestyle among the richest in urban areas may result in an increased prevalence of overweight and obesity (Das et al., 2019; Morgan & Sonnino, 2010; Rahman, 2013).

Our study found a significant positive association between overweight and obesity with higher educational attainment among women with IDA. Studies looking at the association of education with overweight and obesity found a positive relationship between education and obesity in developing countries, whereas an inverse association was mostly found in developed countries (Ball & Crawford, 2005;

Cohen, Rai, Rehkopf, & Abrams, 2013; Kim, Roesler, & von dem Knesebeck, 2017). One possible explanation could be that education may be linked with better access to food in developing countries.

Married women with IDA have five times higher risk of being overweight or obese compared with unmarried women. Our result is consistent with findings from other studies (Mkuu, Epnere, & Chowdhury, 2018; Sarma et al., 2016; Subramanian, Perkins, & Khan, 2009; Tanwi, Chakrabarty, & Hasanuzzaman, 2019; Tanwi, Chakrabarty, Hasanuzzaman, Saltmarsh, et al., 2019). The use of hormonal contraceptives could be one of the reasons for the higher risk of overweight and obesity among married women (Mkuu et al., 2018; Morotti et al., 2017). Hormonal contraceptives increase fluid retention that may lead to increase weight gain (Morotti et al., 2017).

Unlike other studies, we found unemployment as a risk factor for overweight or obese. Several studies conducted in similar settings refute this association (Mkuu et al., 2018; Tanwi, Chakrabarty, & Hasanuzzaman, 2019; Tanwi, Chakrabarty, Hasanuzzaman, Saltmarsh, et al., 2019). One possible explanation could be that majority of our study population are from the lower socio-economic group and are involved in unskilled work, such as housekeeping and construction work, which requires lots of physical labour resulting in a low level of overweight and obesity among employed women.

A combination of overweight and obesity with IDA poses major challenges for public health interventions. One particular challenge is the lower efficacy of standard oral IDA treatment in presence of overweight or obesity (Camaschella et al., 2020). Although we were unable to find any study among adult women showing the efficacy of standard IDA treatment in presence of overweight or obesity, a randomized controlled trial conducted among South African children with IDA reported that children with high BMI for age had a twofold higher risk of remaining iron deficient after standard iron supplementation compared to children with normal weight (Baumgartner et al., 2013; Li, Dai, Jackson, & Zhang, 2008). A recent systematic review of literatures exploring genetic and molecular biology of iron metabolism and IDA recommends to revisit the standard treatment options of IDA (oral iron treatment and the choice of oral vs. intravenous iron) and suggested development of targeted therapies in presence of inflammation (Camaschella et al., 2020). In countries like Bangladesh where the prevalence of IDA is moderate to severe, our findings will help design context-specific solutions for national health programming targeting anaemia and overweight or obesity.

#### 4.1 | Limitations

One limitation of the study is the use of cross-sectional data, which limits the ability to draw causal inferences among observed associations. Moreover, there was no comparison group with overweight and obese NPWL women without IDA, which is recommended for future exploration. Also, we were unable to examine dietary patterns, level of physical activity, food security and use of hormonal contraceptives among the study participants that are intermediate in the causal pathways. Future studies looking at the association of dietary intake,

physical activity, food security and the use of hormonal contraceptives with overweight and obesity are suggested.

## 5 | CONCLUSION

Bangladesh is undergoing an epidemiologic transition with an increasing burden of overweight and obesity in the presence of a high level of micronutrient deficiencies. The growth in the prevalence of overweight and obesity outweighs the reduction in the prevalence of undernutrition in the country. In countries like Bangladesh where the prevalence of IDA is moderate to severe for public health significance, our findings illuminate the high burden of overweight and obesity among NPWL women with IDA and socio-economic factors associated with this. Findings from this study will help design context-specific solutions for national health programming targeting anaemia in presence of overweight and obesity.

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### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

### CONTRIBUTIONS

TMH and MJD designed the study and sought funding. NBA and TMH conceptualized the manuscript and prepared the first draft. NBA, MJD, SI, MMR, SR, SET, QSR, MHR, SEA and TMH contributed to the revisions.

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