PREVALENCE AND RISK FACTORS OF MALNUTRITION AMONG WOMEN OF REPRODUCTIVE AGE IN BANGLADESH: A SECONDARY DATA ANALYSIS OF BDHS 2022

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ABSTRACT

Background/Objective: Women of reproductive age (WRA) in developing countries experience a double burden of malnutrition, which adversely impacts their health and the well-being of future generations. Addressing this issue requires updated data to guide effective interventions. Therefore, this study aimed to assess the prevalence and factors associated with malnutrition among WRA in Bangladesh using recent national data. **Methodology:** This study analyzed data from the Bangladesh Demographic and Health Survey (BDHS)-2022, which included a nationally representative sample of 8,593 WRA between 15 and 49 years. The outcome variables were malnutrition: underweight (BMI< 18.5 kg/m^2), overweight (BMI 23 to<27.5 kg/m^2), and obesity (BMI ≥27.5 kg/m^2) stratified according to rural-urban residence. Multiple logistic regression was employed to identify factors associated with malnutrition. **Results:** Overall, 55.5% of WRA were overweight or obese, with a significantly higher prevalence in urban areas (63.7%) compared to rural areas (52.3%). Conversely, approximately 10% of WRA were underweight, with rural areas showing a higher prevalence (11.2%) than urban areas (6.7%). Factors associated with increased odds of overweight or obesity in both urban and rural settings included older age, higher educational attainment, having more children, and residing in wealthier households. Conversely, younger age, breastfeeding mothers, lower education, and wealth levels were associated with higher odds of being underweight in both areas. **Conclusion:** The study clearly highlights that undernutrition and overnutrition are prevalent in Bangladesh. To address the dual burden of malnutrition among WRA in Bangladesh, targeted interventions, including nutrition education, a nutritional support program, and a healthy food and nutrition environment, are required to improve nutritional status and health outcomes.

KEYWORDS: Malnutrition, Underweight, Overweight, Obesity, Women of reproductive age, Bangladesh Demographic and Health Survey (BDHS)

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Introduction

Malnutrition among women of reproductive age (WRA) remains a critical issue in many low- and middle-income countries (LMICs), with significant implications for maternal and child health. The increasing prevalence of malnutrition since 1990 represents a significant public health challenge across many nations worldwide (Khudri, Osmani, and Okunade, 2024). The double burden of malnutrition, characterized by the coexistence of undernutrition alongside overweight and obesity, remains a significant and persistent challenge globally, affecting both public health and economic stability (Tumas and López, 2024). Approximately one-fourth of the global population experienced some form of malnutrition in 2022, with 6.6% of adults classified as underweight and 15.9% as obese (FAO, 2024). The prevalence of overweight and obesity is rising rapidly, with projections suggesting that by 2030, 1.35 billion people worldwide will be overweight, and 573 million will be obese (Mathers and Loncar, 2006). Recent estimates indicate that around two-thirds of the global population affected by obesity are women living in developing countries, and their proportion is expected to increase over time (Afshin *et al.*, 2017).

Malnourished populations are more susceptible to various communicable and non-communicable diseases (Cammock *et al.*, 2021). Reproductive aged women experience higher rates of overweight and obesity compared to men and face a greater risk of complications related to obesity (Sarma *et al.*, 2016). This gender difference is mainly due to general weight gain during childbearing years, gestational weight gain and/or weight retention, adverse lifestyle, or risk factors associated with pregnancy and the postpartum (Alemu and Atnafu, 2014; Tanwi *et al.*, 2019). Malnourished women face a heightened risk of adverse obstetric and neonatal outcomes, including gestational diabetes, pre-eclampsia, eclampsia, pulmonary embolism, infant mortality, preterm birth, low birth weight, and an increased likelihood of early mortality (Flegal *et al.*, 2013). While the global prevalence of underweight is decreasing, the increase in obesity is notably more significant, particularly impacting many LMICs (Bentham *et al.*, 2017). Bangladesh, a

LMICs, faces a significant challenge with the double burden of malnutrition (Biswas *et al.*, 2021). The prevalence of underweight women decreased from 52% to 12%, while the prevalence of overweight or obesity increased from 3% to 32% between 1996 and 2018 in Bangladesh (NIPORT, 2019). This shift in nutritional status can be attributed to nutrition transition, globalization, urbanization, and related socio-economic factors (Fox, Feng and Asal, 2019). Rapid urbanization in Bangladesh has led to a lifestyle shift, with people increasingly moving from traditional home-prepared meals to calorie-dense, ready-to-eat packaged foods, resulting in a more sedentary lifestyle compared to other South Asian countries (Joshi *et al.*, 2007).

To tackle the rising prevalence of overweight or obesity among WRA requires identifying individual and household risk factors shaped by socioeconomic determinants to inform public health interventions and national policies (WHO, 2009). Several studies have identified a range of factors contributing to malnutrition, including socioeconomic factors like age, marital status, area type, education, and wealth status, as well as environmental and lifestyle factors such as housing conditions, drinking water sources, hand-washing practices, dietary intake, fortified food consumption, and food insecurity (Alemu and Atnafu, 2014; Hasan *et*., 2022; Ilyas and Parveen, 2019; Sarma *et al.*, 2016; Tanwi *et al.*, 2019). Furthermore, parity, occupation, family size, and mass-media exposure were associated with malnutrition among women (Hashan *et al.*, 2020; Gupta *et al.*, 2022; Kamal, 2022; Prithishkumar *et al.*, 2024).

Rural-urban segregation is a critical aspect of studying malnutrition among women, as it underscores disparities in access to healthcare, nutrition, and lifestyle factors (Hossain *et al.*, 2023). Variations in infrastructure, education, and socioeconomic conditions between rural and urban populations significantly influence the prevalence and risk factors of malnutrition (Anik *et al.*, 2021). However, only a limited number of studies have previously accounted for rural-urban segregation when examining the factors of malnutrition in Bangladesh (Hashan *et al.*, 2020; Khudri, Osmani and Okunade, 2024). Understanding these factors through a rural-urban lens is essential for refining food and nutrition security policies and advancing progress toward achieving Sustainable Development Goals. Therefore, this study aimed to assess the prevalence of malnutrition and its associated sociodemographic factors among WRA (15–49 years) in Bangladesh using Bangladesh Demographic and Health Survey, 2022 datasets.

Materials and Methods

The study utilized a secondary dataset extracted from the Bangladesh Demographic and Health Survey (BDHS), 2022. The survey employed a two-stage stratified sampling method. In the first stage, 438 rural enumeration units and 237 urban enumeration units were selected using a probability proportional to size sampling technique. A complete list of all households within each selected enumeration unit was prepared during this phase. In the second stage, 30 households from each enumeration unit were selected using systematic sampling. In the survey, 30,078 households were interviewed from 675 clusters (237 urban and 438 rural) in eight divisions of Bangladesh. Details of sampling procedures can be found elsewhere (NIPORT, 2023).

In this study, we included a total of 8,593 WRA after excluding women with missing information on height or weight and women who were pregnant and delivered two months prior to data collection (Figure 1).

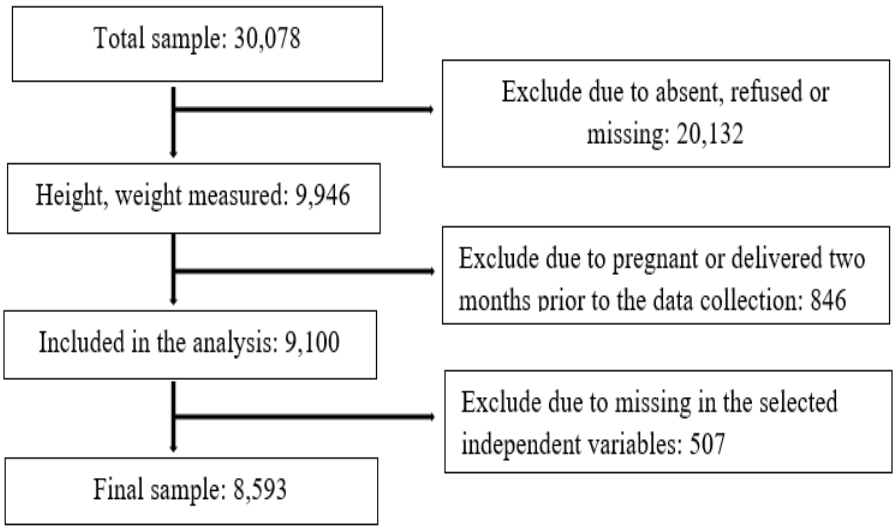

Figure 1. Schematic diagram of sample size

Outcome variables

The outcome of this study was underweight [body mass index (BMI)< 18.5 kg/m^2], overweight (23 to <27.5 kg/m^2) and obesity (≥27.5 kg/m^2), categorized according to an Asian-specific BMI cut-off (WHO Expert Consultation, 2004). BMI was obtained by dividing weight (in Kg) by height (in m^2).

Explanatory variables

The explanatory variables were chosen based on their potential influence on malnutrition, as evidenced by previous studies, and their availability in the BDHS dataset (Biswas *et al.*, 2017; Hashan *et al.*, 2020; Khudri, Osmani and Okunade, 2024).

Age in years (15-19, 20-29, 30-39, 40-49), Religion (Muslim, Non-Muslim), Level of education (No education, Primary, Secondary, Higher), Respondent occupation (Not working, Agricultural, Non-agricultural), Age of first marriage (<20 years, ≥20 years), Media exposure (Not at all, Yes), Parity (No children, 1-2 children, 3 or more children), Births in last 5 years (No, Yes), Currently breastfeeding (No, Yes), Pattern of contraceptive use (Not using, Pills, Others), Decision making autonomy (Not experienced, Experienced), Husband's education (No education, Primary, Secondary, Higher), Household size (<5 members, ≥ 5 members), Wealth index, Divisions (Barisal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, Sylhet), Area (Urban, Rural).

Definition of some variables:

Media exposure: Media exposure through television, radio and newspaper /magazine has been defined as exposure to at least one media that exposes to at least once a week (NIPORT, 2023).

Decision making autonomy: In the BDHS surveys, a woman's decision-making power is assessed on the following three themes: a) a woman who usually decides on her healthcare b) a woman who usually decides on large household purchases, and c) a woman who usually decides on visits to family or relatives (NIPORT, 2023).

Occupation: Occupation was defined based on employment in the past 12 months, categorized into agricultural and non-agricultural sectors, with the latter including professional, technical, managerial, clerical, sales, service, manual labor, and domestic roles (Croft et al., 2018).

Wealth index: Factor analysis was constructed to categorize wealth status into Poorest, Poorer, Middle, Richer, Richest (NIPORT, 2023).

Pattern of contraceptive use: In the BDHS surveys, it tracks contraceptive behaviors, including method types, prevalence, discontinuation, and switching over the past five years. It is assessed using a monthly contraceptive calendar, along with demographic factors to analyze trends and influences on family planning choices (NIPORT, 2023).

Statistical analysis

In the descriptive analysis, participant characteristics were summarized using frequencies and percentages. The prevalence of underweight, overweight, and obesity was presented separately for rural and urban areas, as well as for the total sample, based on various background characteristics. Chi-square tests were performed to assess significant differences between these groups. To explore the factors associated with underweight, overweight, and obesity, multiple logistic regression was applied, using the normal BMI range as the reference category. Variables with a significance level of <0.25 in the unadjusted analysis were included in the final multiple logistic regression model. Adjusted odds ratios (AOR), along with their 95% confidence intervals (CI), were reported. Multi-collinearity was assessed using variance inflation factors (VIF) with a threshold of <10 (Chatterjee and Price, 1992). The Hosmer-Lemeshow test was used to evaluate the model's goodness of fit. Statistical significance was set at a P-value of <0.05. All estimates accounted for sampling weights, clustering, and stratification. Data analysis was conducted using Stata version 15.0 (College Station, Texas, USA).

Results

Characteristics of study sample

A total sample of 8,593 WRA, with 5,589 from rural areas and 3,004 from urban areas were included in this study. The majority of participants were aged 30 to 49 years and predominantly Muslim. The proportion of women with secondary education was higher in both rural and urban regions. Urban women were more likely to have media exposure compared to their rural counterparts (63.2% vs. 44.3%). Nearly two-thirds of the women were unemployed and most of them got married before aged 20. The highest proportion of respondents were from Dhaka division (Table 1).

Table 1. Background characteristics of the study participants

Variables	Urban (n=3,004) n (%)	Rural (n=5,589) n (%)	Overall (n=8,593) n (%)
Age (in years)			
15–19	197 (6.9)	421 (8)	618 (7.7)
20–29	915 (30.5)	1819 (32.3)	2734 (31.8)
30–39	1126 (37.3)	1960 (35.4)	3086 (35.9)
40–49	766 (25.3)	1389 (24.3)	2155 (24.6)
Religion			
Muslim	2620 (89.6)	5063 (90.4)	7683 (90.1)
Non-Muslim	384 (10.4)	526 (9.6)	910 (9.9)
Respondent education			
No education	338 (11.2)	824 (14.5)	1162 (13.5)
primary education	650 (22)	1608 (28)	2258 (26.3)

Secondary education	1317 (45)	2588 (47.7)	3905 (46.9)
Higher education	699 (21.8)	569 (9.9)	1268 (13.3)
Respondent Occupation			
Not working	2043 (66.3)	3342 (59)	5385 (61.1)
Agricultural	255 (7.7)	1601 (29.2)	1856 (23.1)
Non-agricultural	706 (26)	646 (11.8)	1352 (15.8)
Age of first marriage			
<20 years	2343 (79.2)	4884 (88)	7227 (85.5)
≥20 years	661 (20.8)	705 (12)	1366 (14.5)
Parity			
No children	265 (9.1)	435 (7.9)	700 (8.2)
1-2 children	1809 (59.5)	2878 (51.9)	4687 (54.1)
3 or more children	930 (31.4)	2276 (40.2)	3206 (37.7)
Births in last 5 years			
Yes	1116 (37.3)	2243 (39.9)	3359 (39.2)
No	1888 (62.7)	3346 (60.1)	5234 (60.8)
Currently breastfeeding			
No	2442 (81.3)	4389 (78.7)	6831 (79.4)
Yes	562 (18.7)	1200 (21.3)	1762 (20.6)
Pattern of contraceptive use			
Not using	842 (28.6)	1752 (31.5)	2594 (30.7)
Pills	830 (27.8)	1686 (29.7)	2516 (29.2)
Others	1332 (43.6)	2151 (38.7)	3483 (40.1)
Decision making autonomy			
Not experienced	381 (11.1)	871 (14.7)	1252 (13.7)
Experienced	2623 (88.9)	4718 (85.3)	7341 (86.3)
Media exposure			
Not at all	1073 (36.8)	3208 (55.7)	4281 (50.4)
Yes	1931 (63.2)	2381 (44.3)	4312 (49.6)
Husband education			
No education	498 (16.1)	1442 (25.3)	1940 (22.7)
Primary	703 (23.9)	1717 (30.8)	2420 (28.8)
Secondary	973 (32.8)	1739 (31.5)	2712 (31.9)
Higher	830 (27.2)	691 (12.5)	1521 (16.7)
Household size			
<5 members	1489 (52.1)	2548 (46.5)	4037 (48.1)
≥5 members	1515 (47.9)	3041 (53.5)	4556 (51.9)
Wealth index			
Poorest	164 (4.2)	1377 (23)	1541 (17.7)
Poorer	303 (9.2)	1316 (23.6)	1619 (19.5)
Middle	539 (17)	1203 (22.4)	1742 (20.9)
Richer	747 (26.7)	1039 (18.9)	1786 (21.1)
Richest	1251 (42.9)	654 (12.1)	1905 (20.8)
Divisions			
Barisal	307 (3.3)	609 (7.2)	916 (6.1)

Chittagong	522 (16.9)	719 (18.5)	1241 (18.1)
Dhaka	614 (46.5)	666 (16.6)	1280 (25.1)
Khulna	355 (9.4)	745 (12.7)	1100 (11.8)
Mymensingh	219 (4)	729 (9.4)	948 (7.9)
Rajshahi	399 (10)	746 (15.2)	1145 (13.8)
Rangpur	297 (6.3)	771 (14)	1068 (11.8)
Sylhet	291 (3.7)	604 (6.4)	895 (5.6)
Area			
Urban	-	-	3004 (28.3)
Rural	-	-	5589 (71.7)

Note: Data presented as frequency (percentage)

Figure 2 illustrates significant differences in the nutritional status of rural and urban participants. Among the total sample, 9.9% were classified as underweight, with a higher prevalence observed in rural areas (11.2%) compared to urban areas (6.7%). Overweight individuals comprised 36.8% of the population, with a relatively comparable prevalence in rural (36.2%) and urban areas (38.4%). Obesity was observed in 18.7% of participants, with urban residents exhibiting a markedly higher prevalence (25.3%) than rural residents (16.1%).

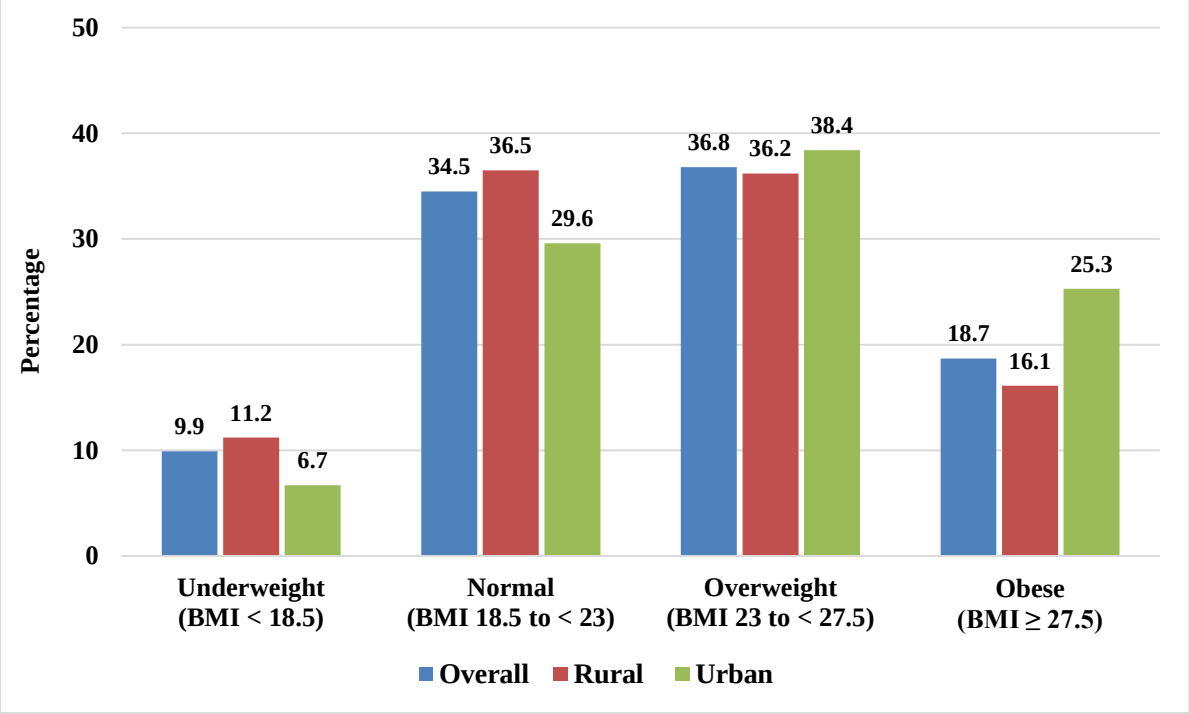

Figure 2. Prevalence of malnutrition among WRA

Table 2. Prevalence of malnutrition across background characteristics

	Urban			**Rural**			**Overall**		
	Underweight [95% CI]	**Overweight [95% CI]**	**Obese [95% CI]**	**Underweight [95% CI]**	**Overweight [95% CI]**	**Obese [95% CI]**	**Underweight [95% CI]**	**Overweight [95% CI]**	**Obese [95% CI]**
Age (in years)									
15–19	19.5 [13.8, 26.8]	23.5 [16.7, 32.1]	5.7 [2.8, 11.1]***	24.9 [20.5, 30.0]	21.4 [17.3, 26.1]	3.2 [1.8, 5.5]***	23.5 [19.9, 27.7]	21.9 [18.4, 26.0]	3.8 [2.5, 5.8]***
20–29	9.3 [7.3, 11.8]	37.3 [33.3, 41.4]	20.2 [17.1, 23.7]	13.2 [11.6, 14.9]	31.6 [29.4, 33.8]	13.3 [11.5, 15.3]	12.1 [10.8, 13.6]	33.1 [31.2, 35.1]	15.2 [13.6, 16.9]

30–39	4.2 [3.0, 5.8]	40.7 [36.8, 44.8]	27.9 [24.8, 31.2]	7.6 [6.4, 8.9]	40.5 [38.2, 42.8]	20 [18.1, 22.1]	6.6 [5.7, 7.6]	40.6 [38.6, 42.6]	22.3 [20.7, 24.1]
40–49	3.8 [2.5, 5.7]	40.3 [36.2, 44.7]	33.2 [28.8, 37.9]	9.5 [7.9, 11.2]	40.8 [38.3, 43.5]	18.4 [16.3, 20.8]	7.8 [6.6, 9.2]	40.7 [38.5, 42.9]	22.7 [20.7, 24.9]
Religion									
Muslim	6.9 [5.8, 8.2]	38.6 [35.9, 41.5]	25.1 [22.7, 27.7]	11.2 [10.3, 12.2]	35.7 [34.3, 37.2]	16.7 [15.5, 18.0]**	10 [9.3, 10.8]	36.6 [35.3, 37.9]	19.1 [18.0, 20.3]
Non-Muslim	5 [2.9, 8.4]	36.3 [31.1, 41.8]	27.3 [22.2, 33.1]	11.4 [9.1, 14.1]	40.2 [36.1, 44.4]	10.7 [7.8, 14.3]	9.5 [7.7, 11.6]	39 [35.7, 42.4]	15.7 [12.7, 19.1]
Respondent education									
No education	8.5 [5.8, 12.3]	33.3 [27.7, 39.5]	21.5 [16.7, 27.3]**	13.6 [11.3, 16.3]	38.5 [35.2, 42.0]	9.5 [7.6, 11.9]***	12.4 [10.5, 14.6]	37.3 [34.4, 40.3]	12.3 [10.4, 14.6]***
Primary	5.6 [3.9, 8.0]	35.4 [30.5, 40.6]	25.4 [21.2, 30.2]	11.8 [10.3, 13.5]	35.9 [33.4, 38.6]	16.5 [14.6, 18.5]	10.4 [9.1, 11.8]	35.8 [33.5, 38.2]	18.6 [16.8, 20.5]
Secondary	8.1 [6.7, 9.9]	38.1 [34.6, 41.6]	26.4 [23.4, 29.5]	10.7 [9.5, 12.1]	35.6 [33.6, 37.6]	17.1 [15.6, 18.8]	10 [9.0, 11.1]	36.3 [34.6, 38.0]	19.6 [18.2, 21.1]
Higher	3.9 [2.6, 6.0]	44.7 [39.5, 50.1]	25.1 [21.0, 29.7]	8.3 [6.2, 11.1]	36.2 [32.0, 40.5]	20 [16.1, 24.7]	6.3 [4.9, 8.0]	40.1 [36.8, 43.6]	22.4 [19.5, 25.6]
Respondent Occupation									
Not working	6.5 [5.3, 7.9]	36.8 [34.2, 39.5]	26.9 [24.4, 29.7]	11.9 [10.7, 13.1]	35 [33.2, 36.8]	16.8 [15.2, 18.5]*	10.2 [9.3, 11.1]	35.5 [34.1, 37.0]	19.9 [18.5, 21.3]***
Agricultural	6.9 [4.3, 10.8]	42.3 [35.5, 49.5]	21.4 [16.2, 27.8]	10.7 [9.3, 12.4]	37.2 [34.8, 39.7]	14.3 [12.5, 16.2]	10.4 [9.1, 11.9]	37.7 [35.4, 40.1]	15 [13.3, 16.8]
Non-agricultural	7.2 [5.0, 10.2]	41.2 [36.0, 46.6]	22.4 [19.1, 26.2]	9.2 [7.1, 11.7]	39.6 [35.4, 43.9]	17.5 [14.7, 20.6]	8.3 [6.7, 10.1]	40.3 [37.0, 43.7]	19.8 [17.6, 22.2]
Age of first marriage									
<20 years	7.2 [5.9, 8.6]	37.7 [34.9, 40.6]	25.3 [22.8, 28.0]	11.4 [10.5, 12.4]	36.2 [34.8, 37.7]	16.2 [15.0, 17.4]	10.3 [9.6, 11.1]	36.6 [35.3, 37.9]	18.6 [17.5, 19.7]
≥20 years	5 [3.3, 7.5]	41 [36.2, 45.9]	25.6 [21.6, 29.9]	9.6 [7.5, 12.3]	35.8 [31.9, 39.9]	15.9 [12.8, 19.6]	7.8 [6.2, 9.6]	37.9 [34.8, 41.0]	19.8 [17.3, 22.6]
Parity									
No children	14.2 [9.5, 20.5]	31.8 [24.7, 40.0]	13.2 [9.1, 18.8]***	15.6 [12.2, 19.6]	27.3 [22.6, 32.6]	11.4 [8.4, 15.1]***	15.1 [12.3, 18.4]	28.7 [24.7, 33.1]	12 [9.5, 15.0]***
1-2 children	6.3 [5.1, 7.7]	39.1 [36.0, 42.4]	24.4 [21.7, 27.3]	11.5 [10.3, 12.9]	36.1 [34.2, 38.0]	16.3 [14.7, 18.0]	9.9 [8.9, 11.0]	37 [35.4, 38.7]	18.8 [17.4, 20.2]
3 or more children	5.3 [3.9, 7.2]	38.9 [35.0, 42.9]	30.7 [27.0, 34.6]	10 [8.7, 11.3]	38.1 [36.1, 40.1]	16.9 [15.2, 18.7]	8.9 [7.8, 10.0]	38.2 [36.5, 40.1]	20.2 [18.6, 21.9]
Births in last 5 years									

Yes	8.6 [6.8, 10.7]	36.2 [32.2, 40.5]	20.9 [18.0, 24.1]***	14.7 [13.2, 16.3]	31.7 [29.7, 33.7]	12.7 [11.0, 14.5]***	13 [11.8, 14.3]	32.9 [31.1, 34.8]	14.9 [13.4, 16.4]***
No	5.6 [4.4, 7.0]	39.7 [36.8, 42.6]	28 [25.4, 30.8]	8.9 [8.0, 10.0]	39.2 [37.5, 40.9]	18.4 [17.0, 20.0]	8 [7.2, 8.8]	39.3 [37.9, 40.8]	21.2 [19.9, 22.6]
Currently breastfeeding									
No	5.7 [4.7, 6.9]	39.5 [37.0, 42.0]	27.1 [24.9, 29.5]***	9.2 [8.3, 10.1]	38.8 [37.3, 40.4]	18.1 [16.7, 19.5]***	8.2 [7.5, 8.9]	39 [37.7, 40.3]	20.7 [19.5, 21.9]***
Yes	11.1 [8.4, 14.4]	33.6 [28.3, 39.3]	17.5 [13.9, 21.8]	18.7 [16.5, 21.2]	26.4 [23.9, 29.1]	9 [7.3, 11.0]	16.8 [14.9, 18.8]	28.3 [25.9, 30.8]	11.2 [9.6, 13.0]
Pattern of contraceptive use									
Not using	5.9 [4.3, 8.0]	40.4 [36.0, 45.0]	24 [20.3, 28.1]***	11.2 [9.7, 12.9]	36.6 [34.1, 39.1]	18.7 [16.7, 20.9]**	9.8 [8.6, 11.2]	37.6 [35.4, 39.8]	20.1 [18.3, 22.1]*
Pills	7.6 [5.6, 10.4]	38.1 [34.1, 42.2]	24.3 [20.9, 28.1]	11.6 [10.0, 13.3]	35.1 [32.8, 37.5]	13.8 [12.1, 15.7]	10.5 [9.2, 11.9]	35.9 [33.9, 38.0]	16.6 [15.0, 18.4]
Others	6.7 [5.2, 8.5]	37.2 [33.6, 41.0]	26.9 [23.1, 31.1]	11 [9.6, 12.5]	36.7 [34.4, 39.0]	15.8 [14.1, 17.7]	9.6 [8.6, 10.8]	36.8 [34.9, 38.8]	19.2 [17.6, 21.0]
Decision making autonomy									
Not experienced	11.7 [8.5, 15.9]	28.2 [22.9, 34.1]	18.9 [14.7, 24.0]***	16.2 [13.7, 19.0]	30.1 [27.0, 33.4]	11.7 [9.6, 14.1]***	15.1 [13.0, 17.5]	29.6 [26.9, 32.5]	13.3 [11.4, 15.5]***
Experienced	6.1 [5.0, 7.4]	39.7 [36.9, 42.5]	26.1 [23.8, 28.6]	10.4 [9.5, 11.3]	37.2 [35.8, 38.7]	16.9 [15.7, 18.2]	9.1 [8.4, 9.9]	37.9 [36.6, 39.3]	19.6 [18.5, 20.8]
Media exposure									
Not at all	7.1 [5.5, 9.1]	37.2 [33.4, 41.2]	19.5 [16.7, 22.6]***	12.9 [11.7, 14.2]	35.4 [33.6, 37.3]	12.9 [11.6, 14.4]***	11.7 [10.7, 12.8]	35.8 [34.1, 37.5]	14.3 [13.1, 15.6]***
Yes	6.5 [5.2, 8.1]	39.1 [36.1, 42.1]	28.7 [26.1, 31.5]	9.1 [7.9, 10.4]	37.1 [35.1, 39.2]	20.1 [18.3, 22.1]	8.1 [7.2, 9.2]	37.8 [36.1, 39.6]	23.2 [21.7, 24.9]
Husband education									
No education	9.8 [7.1, 13.6]	35.2 [29.7, 41.2]	20.8 [16.2, 26.3]**	13.4 [11.6, 15.3]	36.8 [34.2, 39.4]	12.8 [10.9, 15.0]***	12.7 [11.1, 14.3]	36.5 [34.1, 38.9]	14.4 [12.6, 16.4]***
Primary	7 [5.1, 9.6]	36.5 [31.9, 41.3]	22.4 [18.6, 26.7]	12.2 [10.8, 13.9]	34.4 [31.7, 37.1]	14.4 [12.8, 16.3]	11 [9.8, 12.4]	34.9 [32.6, 37.2]	16.3 [14.7, 18.0]
Secondary	6.8 [5.2, 8.9]	38.7 [35.1, 42.4]	28.5 [24.8, 32.4]	9.7 [8.3, 11.3]	38.4 [36.2, 40.8]	18.5 [16.5, 20.7]	8.9 [7.7, 10.1]	38.5 [36.6, 40.5]	21.4 [19.6, 23.4]
Higher	4.4 [3.0, 6.4]	41.5 [36.7, 46.5]	26.9 [23.4, 30.7]	8.1 [6.2, 10.6]	33.7 [30.2, 37.4]	21.1 [17.9, 24.8]	6.4 [5.1, 8.0]	37.3 [34.3, 40.4]	23.8 [21.4, 26.4]
Household size									
<5 members	6.1 [4.7, 8.0]	39.7 [36.5, 43.0]	24.8 [21.9, 27.9]	9.9 [8.7, 11.3]	37.7 [35.6, 39.7]	17.8 [16.2, 19.6]***	8.8 [7.8, 9.8]	38.3 [36.6, 40.0]	20 [18.5, 21.5]***

≥5 members	7.3 [5.8, 9.2]	36.9 [33.3, 40.7]	25.9 [23.1, 29.0]	12.3 [11.1, 13.7]	34.9 [33.1, 36.7]	14.6 [13.2, 16.2]	11 [10.0, 12.1]	35.4 [33.8, 37.1]	17.6 [16.3, 19.0]
Wealth index									
Poorest	13.9 [8.6, 21.6]	25.7 [19.3, 33.5]	12.9 [7.6, 21.1]***	17.8 [15.8, 20.1]	28.2 [25.5, 31.0]	9.2 [7.6, 11.1]***	17.5 [15.6, 19.7]	28 [25.5, 30.7]	9.5 [7.9, 11.3]***
Poorer	14.5 [10.3, 20.0]	30.8 [25.1, 37.2]	15.2 [10.8, 21.0]	12.6 [10.9, 14.6]	38.1 [35.5, 40.7]	12.5 [10.6, 14.7]	12.9 [11.3, 14.7]	37.1 [34.8, 39.5]	12.9 [11.1, 14.9]
Middle	8.2 [5.9, 11.3]	35.7 [30.3, 41.5]	18.2 [14.3, 22.7]	9.3 [7.8, 11.1]	38.1 [35.2, 41.0]	15.2 [13.0, 17.6]	9.1 [7.8, 10.5]	37.5 [35.0, 40.2]	15.8 [14.0, 17.9]
Richer	6.4 [4.5, 9.0]	38 [34.1, 42.2]	26.9 [22.6, 31.7]	7.1 [5.6, 8.9]	39.3 [36.1, 42.5]	20.4 [18.1, 23.1]	6.9 [5.7, 8.3]	38.8 [36.3, 41.4]	22.8 [20.5, 25.1]
Richest	3.9 [2.8, 5.4]	42.5 [38.6, 46.6]	30.6 [27.5, 33.9]	5.9 [4.2, 8.2]	39.3 [35.3, 43.5]	31.4 [27.5, 35.6]	4.7 [3.7, 6.0]	41.2 [38.3, 44.1]	30.9 [28.5, 33.5]
Divisions									
Barisal	5.1 [3.2, 8.1]	38.8 [32.9, 45.2]	27.6 [21.9, 34.1]*	11.4 [9.1, 14.3]	35.6 [32.0, 39.4]	17.7 [14.8, 21.1]***	10.5 [8.4, 12.9]	36.1 [32.9, 39.5]	19.2 [16.5, 22.2]***
Chittagong	7.7 [5.5, 10.7]	34.4 [30.2, 38.8]	27.7 [23.3, 32.6]	8.7 [6.7, 11.2]	41.1 [37.7, 44.6]	18.3 [15.0, 22.2]	8.5 [6.8, 10.4]	39.3 [36.6, 42.1]	20.8 [18.0, 23.9]
Dhaka	5.1 [3.6, 7.2]	39.6 [35.0, 44.5]	24.5 [21.0, 28.4]	10.6 [8.4, 13.2]	34.5 [30.8, 38.4]	19.3 [15.9, 23.3]	7.7 [6.4, 9.3]	37.2 [34.1, 40.3]	22 [19.5, 24.7]
Khulna	6.9 [4.0, 11.8]	39.1 [33.1, 45.3]	31.8 [26.8, 37.3]	7.4 [5.6, 9.5]	38.2 [34.7, 41.8]	18.9 [16.0, 22.2]	7.3 [5.7, 9.2]	38.4 [35.4, 41.5]	21.8 [19.2, 24.6]
Mymensingh	10.6 [5.4, 19.6]	35.3 [28.8, 42.3]	17 [11.9, 23.8]	17.2 [14.5, 20.3]	30.9 [27.6, 34.3]	9.4 [7.3, 11.9]	16.2 [13.7, 19.1]	31.5 [28.6, 34.6]	10.5 [8.5, 12.8]
Rajshahi	8.4 [5.1, 13.4]	41.6 [35.5, 47.9]	23.5 [16.6, 32.2]	10.8 [8.8, 13.1]	37.2 [33.6, 40.9]	17 [14.3, 20.0]	10.3 [8.5, 12.3]	38.1 [34.9, 41.3]	18.3 [15.7, 21.3]
Rangpur	9.4 [6.4, 13.5]	37.7 [32.3, 43.4]	25.6 [20.6, 31.3]	12.5 [10.0, 15.5]	34.8 [31.2, 38.5]	11.8 [9.2, 15.0]	12 [9.9, 14.6]	35.2 [32.0, 38.5]	13.9 [11.5, 16.7]
Sylhet	9.4 [6.8, 12.9]	34.9 [27.6, 43.0]	20.5 [15.0, 27.6]	16.9 [14.0, 20.4]	31.4 [27.1, 36.0]	11.9 [9.2, 15.1]	15.5 [13.1, 18.4]	32 [28.3, 36.0]	13.5 [11.1, 16.4]
Area									
Urban	-	-	-	-	-	-	6.7 [5.7, 7.9]	38.4 [35.9, 41.0]	25.3 [23.2, 27.6]***
Rural	-	-	-	-	-	-	11.2 [10.4, 12.1]	36.2 [34.8, 37.5]	16.1 [15.0, 17.4]

Note: *p-value <0.05, **p-value <0.01, ***p-value <0.001

Prevalence of malnutrition across background characteristics

Among the youngest age group (15–19 years), underweight was most prevalent, affecting 19.5% of urban women and 24.9% of rural women. Conversely, among older women (40–49 years), the highest prevalence of overweight (40.8%, 40.7%) and obesity (18.4%, 22.7%) was observed in rural areas and the overall sample. In urban areas, overweight was more common among middle-aged women (30–39 years) at 40.7%, while obesity was most prevalent (33.2%) among older women (40–49 years). Women with no education had the highest prevalence of underweight, while those with higher education levels showed increased rates of overweight and obesity across all areas. Underweight rate was higher among women with no children, while overweight and obesity were most prevalent among women with 3–4 children in all areas, except for overweight in urban area (1-2 children). Underweight rates

were higher among women with no media access, those who had given birth in the last five years, and those currently breastfeeding, particularly among women from the poorest families. However, overweight and obesity were more prevalent among women with media exposure, those who had not given birth in the past five years, those who were breastfeeding, and those from wealthier families. The prevalence of underweight, overweight and obesity also differed according to contraceptive use and geographic locations. In this study, Mymensingh division had the highest percentage of underweight whereas the highest prevalence of overweight and obesity found in Chittagong and Dhaka respectively for rural area; For urban area, prevalence of overweight and obesity was highest in Rajshahi and Khulna respectively. Additionally, urban areas had a higher prevalence of overweight, obesity and lower prevalence of underweight compared to rural regions (Table 2).

Determinants of malnutrition among WRA in overall sample

The odds of being underweight was lower among women aged 20-49 years [20-29 years: (AOR: 0.48, 95%CI: 0.35-0.65); 30-39 years (AOR: 0.28, 95%CI: 0.20-0.40); 40-49 years (AOR: 0.37, 95%CI: 0.24-0.56)] compared to those aged 15–19 years. Conversely, the odds of being overweight [20-29 years: (AOR: 1.68, 95%CI: 1.28-2.20); 30-39 years (AOR: 2.49, 95%CI: 1.84-3.36); 40-49 years (AOR: 2.47, 95%CI: 1.79-3.42)] and obese [20-29 years: (AOR: 4.60, 95%CI: 2.68-7.89); 30-39 years (AOR: 8.05, 95%CI: 4.59-14.12); 40-49 years (AOR: 7.81, 95%CI: 4.35-14.02)] were higher in the 20–49 age group compared to the youngest group. Non-Muslim women had a 35% lower risk of being obese compared to Muslims (AOR: 0.65, 95% CI: 0.50-0.86). Higher education was associated with increased odds of obesity and decreased risk of underweight. Women engaged in agricultural activities had 31% lower odds of being obese compared to unemployed women (AOR: 0.69, 95% CI: 0.57–0.84). Having more children reduced the likelihood of being underweight while increasing the risk of being overweight and obese. Breastfeeding was linked to higher odds of underweight (AOR: 1.73, 95% CI: 1.37–2.18) and lower odds of overweight (AOR: 0.65, 95% CI: 0.54–0.79) and obesity (AOR: 0.58, 95% CI: 0.45–0.75). Women with greater decision-making power had lower odds of underweight (AOR: 0.76, 95% CI: 0.62–0.93) but higher odds of overweight (AOR: 1.31, 95% CI: 1.10–1.55) and obesity (AOR: 1.35, 95% CI: 1.08–1.68). The wealth index showed higher odds of overweight and obesity in wealthier categories and lower odds of being underweight compared to the poorest. Geographically, women in Mymensingh and Sylhet had lower odds of being overweight or obese, while those in Dhaka and Rangpur had lower odds of obesity than those in Barisal. However, women in Sylhet and Mymensingh had higher odds of being underweight than those in Barisal (Table 3).

Table 3. Factors associated with underweight, overweight, and obesity among women in the overall sample

	Underweight		Overweight		Obese	
	AOR [95%CI]	***p*-value**	**AOR [95%CI]**	***p*-value**	**AOR [95%CI]**	***p*-value**
Age (in years)						
15–19	Ref.		Ref.		Ref.	
20–29	0.48 [0.35, 0.65]	<0.001	1.68 [1.28, 2.20]	<0.001	4.60 [2.68, 7.89]	<0.001
30–39	0.28 [0.20, 0.40]	<0.001	2.49 [1.84, 3.36]	<0.001	8.05 [4.59, 14.12]	<0.001
40–49	0.37 [0.24, 0.56]	<0.001	2.47 [1.79, 3.42]	<0.001	7.81 [4.35, 14.02]	<0.001
Religions						
Muslim	Ref.		Ref.		Ref.	
Non-Muslim	-		-		0.65 [0.50, 0.86]	0.002
Level of education						
No education	Ref.		Ref.		Ref.	
Primary	0.78 [0.6, 1.02]	0.073	1.13 [0.93, 1.37]	0.227	1.63 [1.24, 2.15]	<0.001
Secondary	0.76 [0.58, 0.98]	0.038	1.21 [0.98, 1.49]	0.074	1.69 [1.25, 2.29]	0.001
Higher	0.65 [0.42, 1.00]	0.048	1.33 [0.97, 1.82]	0.073	1.58 [1.01, 2.48]	0.045
Respondent Occupation						
Not working	Ref.		Ref.		Ref.	
Agricultural	1.14 [0.94, 1.38]	0.185	0.89 [0.77, 1.03]	0.129	0.69 [0.57, 0.84]	<0.001
Non-agricultural	1.15 [0.90, 1.48]	0.254	1.02 [0.85, 1.22]	0.83	0.85 [0.70, 1.04]	0.112
Age of first marriage						
<20 years	Ref.		Ref.		Ref.	
≥20 years	1.04 [0.79, 1.38]	0.763	-		-	
Parity						

No children	Ref.		Ref.		Ref.	
1-2 children	0.65 [0.45, 0.93]	0.018	1.47 [1.10, 1.97]	0.01	1.66 [1.09, 2.51]	0.017
3 or more children	0.61 [0.40, 0.91]	0.017	1.48 [1.06, 2.06]	0.021	1.82 [1.16, 2.86]	0.009
Births in last 5 years						
Yes	Ref.		Ref.		Ref.	
No	0.83 [0.64, 1.09]	0.181	1.08 [0.90, 1.29]	0.412	1.15 [0.90, 1.46]	0.258
Currently breastfeeding						
No	Ref.		Ref.		Ref.	
Yes	1.73 [1.37, 2.18]	<0.001	0.65 [0.54, 0.79]	<0.001	0.58 [0.45, 0.75]	<0.001
Pattern of contraceptive use						
Not using	Ref.		Ref.		Ref.	
Pills	-		0.94 [0.80, 1.09]	0.405	0.89 [0.72, 1.09]	0.256
Others	-		0.95 [0.81, 1.11]	0.496	0.88 [0.72, 1.07]	0.189
Decision making autonomy						
Not experienced	Ref.		Ref.		Ref.	
Experienced	0.76 [0.62, 0.93]	0.009	1.31 [1.10, 1.55]	0.002	1.35 [1.08, 1.68]	0.008
Media exposure						
Not at all	Ref.		Ref.		Ref.	
Yes	0.96 [0.80, 1.15]	0.653	1.09 [0.96, 1.24]	0.194	1.49 [1.26, 1.75]	<0.001
Husband education						
No education	Ref.		Ref.		Ref.	
Primary	0.81 [0.65, 1.02]	0.07	0.96 [0.81, 1.14]	0.639	1.01 [0.81, 1.26]	0.899
Secondary	0.75 [0.58, 0.96]	0.021	1.18 [0.98, 1.41]	0.077	1.27 [0.99, 1.63]	0.062
Higher	0.61 [0.41, 0.90]	0.013	0.91 [0.7, 1.19]	0.478	1.07 [0.77, 1.49]	0.683
Household size						
<5 members	Ref.		Ref.		Ref.	
≥5 members	1.13 [0.94, 1.36]	0.182	0.94 [0.83, 1.06]	0.289	0.87 [0.74, 1.02]	0.084
Wealth index						
Poorest	Ref.		Ref.		Ref.	
Poorer	0.77 [0.62, 0.95]	0.016	1.50 [1.25, 1.80]	<0.001	1.32 [1.00, 1.75]	0.051
Middle	0.57 [0.45, 0.73]	<0.001	1.45 [1.19, 1.77]	<0.001	1.43 [1.08, 1.89]	0.013
Richer	0.43 [0.32, 0.57]	<0.001	1.85 [1.51, 2.28]	<0.001	2.50 [1.87, 3.33]	<0.001
Richest	0.38 [0.26, 0.55]	<0.001	2.52 [1.95, 3.26]	<0.001	3.7 [2.71, 5.04]	<0.001
Divisions						
Barisal	Ref.		Ref.		Ref.	
Chittagong	0.85 [0.61, 1.19]	0.351	1.10 [0.87, 1.38]	0.42	1.02 [0.74, 1.41]	0.885
Dhaka	1.00 [0.72, 1.39]	0.99	0.84 [0.66, 1.06]	0.142	0.70 [0.52, 0.94]	0.019
Khulna	0.81 [0.56, 1.17]	0.264	0.94 [0.74, 1.18]	0.588	0.93 [0.69, 1.24]	0.613
Mymensingh	1.49 [1.07, 2.07]	0.018	0.74 [0.58, 0.94]	0.015	0.46 [0.33, 0.65]	<0.001
Rajshahi	1.16 [0.83, 1.62]	0.381	0.95 [0.74, 1.21]	0.66	0.8 [0.58, 1.09]	0.156
Rangpur	1.10 [0.79, 1.52]	0.585	0.87 [0.68, 1.10]	0.25	0.67 [0.48, 0.92]	0.015
Sylhet	1.60 [1.15, 2.22]	0.005	0.73 [0.55, 0.97]	0.029	0.50 [0.35, 0.70]	<0.001
Area						
Urban	Ref.		Ref.		Ref.	
Rural	1.1 [0.89, 1.36]	0.378	1.02 [0.89, 1.18]	0.776	0.84 [0.7, 1.01]	0.059

Note: AOR = Adjusted Odd Ratios, CI = Confidence Interval

Determinants of malnutrition among WRA in urban area

Older women aged 30 to 49 years had 72% lower odds of being underweight compared to those aged 15–19 years. Conversely, the odds of being overweight increased significantly with age, with women aged 40–49 having 2.6 times higher odds of being overweight (AOR: 2.60, 95%CI: 1.46–4.60) and seven times higher odds of being obese (AOR: 7.08, 95%CI: 2.86–17.55) compared to the youngest group. Educational attainment was positively associated with overweight; women with higher education levels had increased odds of being overweight compared to those with no education (AOR: 1.84, 95%CI: 1.19-2.84; AOR: 1.95, 95%CI: 1.06-3.57). Parity also played a significant role, with women having three or more children showing higher odds of being overweight (AOR: 1.95, 95%CI: 1.02-3.72) and obese (AOR: 3.44, 95%CI: 1.55-7.61). Women with higher decision-making autonomy had increased odds of being overweight (AOR: 1.73, 95%CI: 1.17–2.56) and obese (AOR: 1.65, 95%CI: 1.07–2.56). Media exposure was associated with a higher risk of obesity (AOR: 1.71, 95%CI: 1.29–2.28). Women living in richest households had a lower risk of being underweight (AOR: 0.42, 95%CI: 0.19–0.92) but higher risks of being overweight (AOR: 2.92, 95%CI: 1.74–4.88) and obese (AOR: 4.36, 95%CI: 2.16–8.81) compared to those in the poorest households. Geographically, women from Dhaka, Mymensingh, and Sylhet divisions had lower odds of obesity, while Sylhet exhibited higher odds of being underweight (Table 4).

Table 4. Factors associated with underweight, overweight, and obesity among women in urban area

	Underweight		Overweight		Obese	
	AOR [95%CI]	***p*-value**	**AOR [95%CI]**	***p*-value**	**AOR [95%CI]**	***p*-value**
Age (in years)						
15–19	Ref.		Ref.		Ref.	
20–29	0.61 [0.33, 1.13]	0.116	2.18 [1.27, 3.74]	0.005	4.64 [1.97, 10.93]	0.001
30–39	0.28 [0.13, 0.61]	0.001	2.54 [1.40, 4.58]	0.002	6.01 [2.46, 14.73]	<0.001
40–49	0.28 [0.10, 0.76]	0.013	2.60 [1.46, 4.60]	0.001	7.08 [2.86, 17.55]	<0.001
Religions						
Muslim	Ref.		Ref.		Ref.	
Non-Muslim	0.74 [0.4, 1.35]	0.325	-		-	
Level of education						
No education	Ref.		Ref.		Ref.	
Primary	0.62 [0.34, 1.13]	0.117	1.31 [0.87, 1.97]	0.191	1.26 [0.79, 2.02]	0.327
Secondary	0.92 [0.54, 1.58]	0.764	1.84 [1.19, 2.84]	0.006	1.46 [0.82, 2.61]	0.195
Higher	0.59 [0.26, 1.36]	0.218	1.95 [1.06, 3.57]	0.031	1.23 [0.58, 2.60]	0.59
Respondent Occupation						
Not working	Ref.		Ref.		Ref.	
Agricultural	-		-		0.76 [0.49, 1.19]	0.235
Non-agricultural	-		-		0.8 [0.59, 1.08]	0.146
Age of first marriage						
<20 years	Ref.		Ref.		Ref.	
≥20 years	1.27 [0.73, 2.20]	0.393	-		-	
Parity						
No children	Ref.		Ref.		Ref.	
1-2 children	0.47 [0.21, 1.09]	0.077	1.38 [0.78, 2.46]	0.265	1.99 [1.01, 3.89]	0.045
3 or more children	0.49 [0.19, 1.26]	0.139	1.95 [1.02, 3.72]	0.043	3.44 [1.55, 7.61]	0.002
Births in last 5 years						
Yes	Ref.		Ref.		Ref.	
No	1.03 [0.55, 1.92]	0.927	1.18 [0.78, 1.79]	0.434	1.17 [0.76, 1.80]	0.465
Currently breastfeeding						
No	Ref.		Ref.		Ref.	

Yes	1.63 [0.98, 2.71]	0.058	0.79 [0.55, 1.13]	0.203	0.71 [0.45, 1.14]	0.156
Pattern of contraceptive use						
Not using	Ref.		Ref.		Ref.	
Pills	1.26 [0.75, 2.15]	0.383	-		-	
Others	1.31 [0.81, 2.11]	0.264	-		-	
Decision making autonomy						
Not experienced	Ref.		Ref.		Ref.	
Experienced	0.72 [0.46, 1.12]	0.142	1.73 [1.17, 2.56]	0.006	1.65 [1.07, 2.56]	0.025
Media exposure						
Not at all	Ref.		Ref.		Ref.	
Yes	-		1.19 [0.94, 1.52]	0.154	1.71 [1.29, 2.28]	<0.001
Husband education						
No education	Ref.		Ref.		Ref.	
Primary	0.67 [0.37, 1.22]	0.188	0.87 [0.57, 1.35]	0.545	1.04 [0.66, 1.63]	0.864
Secondary	0.67 [0.36, 1.28]	0.225	1.04 [0.68, 1.59]	0.839	1.42 [0.88, 2.29]	0.149
Higher	0.51 [0.20, 1.31]	0.162	0.81 [0.46, 1.44]	0.479	1.04 [0.57, 1.89]	0.898
Wealth index						
Poorest	Ref.		Ref.		Ref.	
Poorer	1.16 [0.61, 2.21]	0.639	1.36 [0.78, 2.36]	0.276	1.30 [0.6, 2.82]	0.509
Middle	0.66 [0.35, 1.21]	0.176	1.64 [1.02, 2.63]	0.039	1.58 [0.77, 3.22]	0.207
Richer	0.56 [0.28, 1.10]	0.091	2.29 [1.46, 3.58]	<0.001	3.75 [1.89, 7.44]	<0.001
Richest	0.42 [0.19, 0.92]	0.03	2.92 [1.74, 4.88]	<0.001	4.36 [2.16, 8.81]	<0.001
Divisions						
Barisal	Ref.		Ref.		Ref.	
Chittagong	1.43 [0.77, 2.65]	0.257	0.84 [0.58, 1.22]	0.361	0.83 [0.54, 1.30]	0.421
Dhaka	1.17 [0.59, 2.32]	0.656	0.81 [0.55, 1.20]	0.292	0.53 [0.33, 0.84]	0.007
Khulna	1.36 [0.64, 2.89]	0.422	1.22 [0.79, 1.86]	0.367	1.11 [0.68, 1.82]	0.679
Mymensingh	1.93 [0.85, 4.40]	0.117	0.76 [0.52, 1.11]	0.15	0.40 [0.23, 0.69]	0.001
Rajshahi	1.88 [0.96, 3.71]	0.067	1.02 [0.67, 1.55]	0.919	0.64 [0.35, 1.15]	0.135
Rangpur	1.82 [0.94, 3.54]	0.076	1.07 [0.71, 1.62]	0.731	0.94 [0.60, 1.50]	0.809
Sylhet	2.09 [1.11, 3.94]	0.023	0.73 [0.45, 1.20]	0.215	0.40 [0.22, 0.70]	0.002

Note: AOR = Adjusted Odd Ratios, CI = Confidence Interval

Determinants of malnutrition among WRA in rural area

This study found a of higher likelihood of being overweight and obese as age increases, such as older women (40-49 years) in rural areas had around 9 times higher odds of being obese (AOR: 8.99, 95%CI: 4.22-12.3) and 2.5 times higher odds of being overweight (AOR: 2.45, 95%CI: 1.66-3.61) compared to adolescent girls aged 15-19 years. However, data showed a significant reduction in the chance of being underweight with the increase of age. Similarly, higher education levels and wealth were associated with a higher likelihood of obesity and a lower chance of being underweight. Non-Muslim women had about 50% lower odds of being obese (AOR: 0.56, 95%CI: 0.39-0.81). Rural women working in agriculture had a lower risk of obesity (AOR: 0.67, 95%CI: 0.54-0.84) compared to unemployed women. Breastfeeding mothers were less likely to be overweight (AOR: 0.61, 95%CI: 0.48-0.77) and obese (AOR: 0.53, 95%CI: 0.39-0.72), but were more likely to be underweight (AOR: 1.72, 95%CI: 1.33-2.24). Women with decision-making autonomy had higher odds of being overweight (AOR: 1.23, 95%CI: 1.01-1.48) and lower odds of being underweight (AOR: 0.77, 95%CI: 0.61-0.98) compared to women without autonomy. Women with 1-2 children were more likely to be overweight than those with no children (AOR: 1.5, 95%CI: 1.07-2.09). Media exposure was linked to higher odds of being obese (AOR: 1.40, 95%CI: 1.15-1.7). Husband's higher education was associated with lower risk of being underweight and higher risk of being overweight. Women in larger households had lower odds of obesity (AOR: 0.81, 95%CI: 0.67-0.97) compared to those in smaller households. Furthermore, women residing in Mymensingh, Rangpur, and Sylhet divisions had lower odds of obesity, while women in Mymensingh and Sylhet were more likely to be underweight compared to those in Barisal. Additionally, women in

Mymensingh had 28% lower odds of being overweight than women in Barisal (AOR: 0.72, 95%CI: 0.55-0.96) (Table 5).

Table 5. Factors associated with underweight, overweight, and obesity among women in rural area

	Underweight		Overweight		Obese	
	AOR [95%CI]	***p*-value**	**AOR [95%CI]**	***p*-value**	**AOR [95%CI]**	***p*-value**
Age (in years)						
15–19	Ref.		Ref.		Ref.	
20–29	0.45 [0.31, 0.66]	<0.001	1.59 [1.16, 2.17]	0.004	4.91 [2.46, 9.80]	<0.001
30–39	0.29 [0.19, 0.43]	<0.001	2.57 [1.81, 3.66]	<0.001	10.15 [5.01, 20.54]	<0.001
40–49	0.40 [0.25, 0.64]	<0.001	2.45 [1.66, 3.61]	<0.001	8.99 [4.23, 19.10]	<0.001
Religions						
Muslim	Ref.		Ref.		Ref.	
Non-Muslim	-		-		0.56 [0.39, 0.81]	0.002
Level of education						
No education	Ref.		Ref.		Ref.	
Primary education	0.81 [0.6, 1.09]	0.167	-		1.85 [1.32, 2.58]	<0.001
Secondary education	0.72 [0.53, 0.97]	0.034	-		1.78 [1.24, 2.54]	0.002
Higher education	0.68 [0.41, 1.12]	0.128	-		1.81 [1.01, 3.24]	0.045
Respondent Occupation						
Not working	Ref.		Ref.		Ref.	
Agricultural	1.12 [0.91, 1.38]	0.28	0.88 [0.75, 1.03]	0.11	0.67 [0.54, 0.84]	<0.001
Non-agricultural	1.00 [0.74, 1.36]	0.977	1.06 [0.84, 1.34]	0.628	0.88 [0.66, 1.16]	0.366
Age of marriage						
<20 years	Ref.		Ref.		Ref.	
≥20 years	1.01 [0.73, 1.41]	0.931	-		-	
Parity						
No children	Ref.		Ref.		Ref.	
1-2 children	0.72 [0.48, 1.09]	0.122	1.50 [1.07, 2.09]	0.018	1.49 [0.9, 2.48]	0.122
3 or more children	0.66 [0.41, 1.05]	0.079	1.31 [0.9, 1.9]	0.157	1.36 [0.8, 2.31]	0.26
Births in last 5 years						
Yes	Ref.		Ref.		Ref.	
No	0.79 [0.59, 1.06]	0.119	1.04 [0.85, 1.27]	0.698	1.13 [0.84, 1.50]	0.418
Currently breastfeeding						
No	Ref.		Ref.		Ref.	
Yes	1.72 [1.33, 2.24]	<0.001	0.61 [0.48, 0.77]	<0.001	0.53 [0.39, 0.72]	<0.001
Pattern of contraceptive use						
Not using	Ref.		Ref.		Ref.	
Pills	-		0.92 [0.77, 1.11]	0.381	0.84 [0.65, 1.07]	0.156
Others	-		0.98 [0.82, 1.18]	0.844	0.85 [0.68, 1.06]	0.144
Decision making autonomy						
Not experienced	Ref.		Ref.		Ref.	
Experienced	0.77 [0.61, 0.98]	0.032	1.23 [1.01, 1.48]	0.038	1.26 [0.97, 1.63]	0.079

Media exposure						
Not at all	Ref.		Ref.		Ref.	
Yes	0.91 [0.73, 1.12]	0.357	1.04 [0.9, 1.21]	0.572	1.40 [1.15, 1.70]	0.001
Husband education						
No education	Ref.		Ref.		Ref.	
Primary education	0.85 [0.66, 1.08]	0.171	0.99 [0.82, 1.18]	0.872	1.00 [0.78, 1.30]	0.981
Secondary education	0.76 [0.58, 1.00]	0.05	1.23 [1.02, 1.47]	0.031	1.24 [0.93, 1.66]	0.15
Higher education	0.65 [0.42, 1.00]	0.051	0.94 [0.73, 1.22]	0.653	1.2 [0.8, 1.78]	0.378
Household size						
<5 members	Ref.		Ref.		Ref.	
≥5 members	1.12 [0.91, 1.38]	0.279	0.95 [0.83, 1.09]	0.45	0.81 [0.67, 0.97]	0.022
Wealth index						
Poorest	Ref.		Ref.		Ref.	
Poorer	0.75 [0.60, 0.94]	0.014	1.58 [1.30, 1.92]	<0.001	1.34 [0.99, 1.81]	0.062
Middle	0.59 [0.45, 0.77]	<0.001	1.5 [1.21, 1.87]	<0.001	1.39 [1.01, 1.89]	0.04
Richer	0.42 [0.3, 0.58]	<0.001	1.88 [1.49, 2.37]	<0.001	2.19 [1.57, 3.06]	<0.001
Richest	0.43 [0.28, 0.66]	<0.001	2.44 [1.82, 3.28]	<0.001	3.83 [2.69, 5.47]	<0.001
Divisions						
Barisal	Ref.		Ref.		Ref.	
Chittagong	0.79 [0.53, 1.15]	0.218	1.19 [0.91, 1.56]	0.194	1.11 [0.75, 1.66]	0.603
Dhaka	1.08 [0.75, 1.56]	0.663	0.85 [0.64, 1.13]	0.259	0.86 [0.61, 1.21]	0.381
Khulna	0.76 [0.51, 1.13]	0.171	0.87 [0.67, 1.13]	0.285	0.87 [0.61, 1.24]	0.442
Mymensingh	1.48 [1.04, 2.11]	0.029	0.72 [0.55, 0.96]	0.024	0.48 [0.32, 0.72]	<0.001
Rajshahi	1.11 [0.77, 1.6]	0.585	0.91 [0.68, 1.20]	0.488	0.86 [0.60, 1.23]	0.395
Rangpur	1.06 [0.74, 1.52]	0.732	0.84 [0.64, 1.10]	0.205	0.64 [0.43, 0.95]	0.025
Sylhet	1.58 [1.10, 2.26]	0.012	0.73 [0.53, 1.01]	0.061	0.53 [0.35, 0.81]	0.003

Note: AOR = Adjusted Odd Ratios, CI = Confidence Interval

Discussion

This study examined the prevalence and factors of different form of malnutrition (underweight and overweight/obesity) among Bangladeshi women. A higher prevalence of overweight or obesity was found among women (55.5%), with a significant variation in urban (63.7%) and rural (52.3%). Around one in ten women was found to be underweight, with higher prevalence in rural areas (11.2%) than urban areas (6.7%). The study identified the factors associated with malnutrition: age, education level, parity, current breastfeeding status, decision-making autonomy, and wealth index.

Our study indicated an rising trend of overweight and obesity in Bangladesh as an earlier study, utilizing the BDHS 2017–18 dataset and same cutoff of BMI, reported that 49% of WRA were overweight or obese, while 12% were underweight (Khan *et al.*, 2024). And this prevalence of overweight is consistent between urban and rural areas. Previous study by Hashan *et al.*, 2020 that used BDHS 2017–18 data, as well as a systematic review found a higher prevalence of overweight and obesity in urban areas compared to rural regions (Banik and Rahman, 2018). The higher prevalence in urban populations likely results from several factors, such as the accessibility of modern communication technologies, increased availability of energy-dense foods, decreased physical activity levels, and the adoption of sedentary lifestyles (Hashan *et al.*, 2020). However, rural areas are not immune to the effects of urbanization, as dietary and purchasing patterns are converging over time between urban and rural areas. When controlled for income, similar consumption patterns are observed in both settings. This convergence may be attributed to concurrent changes in the food value chain, including the rapid expansion of transnational retail sectors and increased consumption of packaged foods and beverages, which may explain the prevalence of overweight and obesity in both urban and rural areas (Jaacks, Slining and Popkin, 2015; Dolislager *et al.*, 2024).

Likewise earlier studies, this study found higher risk of overweight and obesity among women with more children (Hill *et al.*, 2017; Dey *et al.*, 2024). This can result from hormonal changes during childbearing, which can cause weight gain among women (Hashan *et al.*, 2020). As found in the previous studies, this study also found that older women from both rural and urban areas were more likely to be overweight or obese compared to younger women (Sarma *et al.*, 2016; Hashan *et al.*, 2020). Increasing age is a known factor associated with being overweight due to age-related changes (Al Kibria *et al.*, 2019). Additionally, a study conducted in India found that older women often lead sedentary lifestyles and tend to consume diets

that contribute to obesity, which may explain the increased likelihood of being overweight or obese (Hashan *et al.*, 2020). Furthermore, older age is linked to parity, which is another factor associated with overweight and obesity (Al Kibria *et al.*, 2019).

This study found that respondents with higher levels of education and socioeconomic status (SES) are less likely to be underweight and more likely to be overweight or obese. These findings are consistent with previous studies (Sarma *et al.*, 2016; Hashan *et al.*, 2020; Khanam *et al.*, 2021). Generally, a higher level of education is linked to better economic opportunities and access to resources. Women with higher education levels often have improved access to nutritious food, healthcare, and a higher standard of living, which reduces their chances of being underweight (Conti, Heckman and Urzua, 2010). Baecke et al. demonstrated that educational status positively influences leisure time but negatively impacts habitual physical activity (Baecke, Burema and Frijters, 1982). Women with higher socioeconomic status tend to shift from manual labor to sedentary jobs, significantly reducing their physical activity. Individuals with these characteristics may experience an increase in body weight. In contrast, the higher prevalence of underweight among women with lower socioeconomic status (SES) may be due to their consumption of fewer calories and less nutritious foods. Those with lower SES might struggle to afford enough food for themselves and their families and may also lack knowledge about proper nutrition (Al Kibria *et al.*, 2019).

The study found that decision-making autonomy is an important determinant of nutritional status in rural and urban areas. Indicating that gender equality, as measured by women's decision-making autonomy, can impact women's nutritional status (Tiruneh, Ntenda and Tamir, 2023). Study conducted in Ethiopia found a higher odds of undernutrition in low decision-making autonomy is greater than those with high decision-making autonomy (Tebekaw, 2011). Women's participation in household decision-making allows them to purchase food, improving the nutritional status of women, their children, and the entire family (Tiruneh, Ntenda and Tamir, 2023).

The data suggest that breastfeeding status is a significant factor influencing the nutritional status of women of reproductive age, particularly in rural areas, a finding that is also aligned with the previous studies (Khanam *et al.*, 2021). A study conducted in Ethiopia also found a high prevalence of underweight among lactating mothers (Berihun, Kassa and Teshome, 2017). Higher likelihood of being underweight in breastfeeding mothers may be due to physiological changes that result in significantly greater energy and nutrient needs compared to those who are not breastfeeding (Sserwanja *et al.*, 2021). This high prevalence may also results from to poor knowledge towards dietary intake during pregnancy and lactation (Berihun, Kassa and Teshome, 2017).

To address the dual burden of malnutrition, targeted interventions are essential. In rural areas, strategies should prioritize improving access to nutrient-rich foods through agricultural development, food subsidies, and nutrition education programs. In urban settings, promoting healthy diets and physical activity through community-based initiatives and regulating unhealthy food environments can help reduce the prevalence of overweight and obesity. Furthermore, integrating tailored nutritional counseling into maternal health services can address disparities related to age, wealth, and education, while breastfeeding promotion initiatives can help reduce underweight prevalence.

This study has several strengths and limitations. It is based on the most recent nationally representative survey that includes data from both rural and urban areas. A highly trained team used standardized and validated instruments to collect the data. Moreover, the survey had a substantial sample size and a high response rate, ensuring that the findings are generalizable to the target population of Bangladesh. Because this study is cross-sectional, it limits the ability to establish causal relationships between the explanatory factors and outcomes. Furthermore, the BDHS dataset lacked data on known risk factors associated with undernutrition and overall nutrition, such as dietary intake, physical activity, sedentary behavior, visceral fat, and cardiovascular disease risk factors like dyslipidemia, hypertension, and diabetes, which could not be included in the multivariable model.

Conclusion

This study underscores the dual burden of malnutrition among Bangladeshi WRA, highlighting the coexistence of underweight and overweight/obesity in both rural and urban settings. Notably, nearly two-thirds of urban WRA were overweight or obese, reflecting a growing trend, while approximately one in ten rural women were underweight. Factors such as increasing age, higher education levels, greater wealth, and having more children were significantly associated with higher odds of overweight or obesity across both urban and rural areas. Conversely, younger age, lower education and wealth status, and breastfeeding were linked to a higher likelihood of being underweight. Comprehensive policy strategies and targeted interventions tailored to different age groups and regions are essential to address dual burden of malnutrition among WRA in Bangladesh.

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