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Association of excess body weight above ideal body weight with gestational diabetes mellitus in Bangladesh: A single-center cross-sectional study

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Abstract

Background: Gestational diabetes mellitus (GDM) is an increasing public health concern in South Asia, where women may develop dysglycemia at lower body mass indices (BMI) than in Western populations. Excess weight above ideal body weight (EW-IBW) may provide additional anthropometric information associated with GDM risk.

Objective: To evaluate the association between EW-IBW and GDM among Bangladeshi women and compare the discriminatory performance of EW-IBW and BMI.

Methods: This hospital-based cross-sectional study included 993 pregnant women attending antenatal care at Ad-din Women's Medical College Hospital, Dhaka, Bangladesh, between January and December 2024. GDM was diagnosed according to the IADPSG criteria. EW-IBW was calculated using the Broca and Modified Devine methods. Multivariable logistic regression adjusted for maternal age, parity, residence, family history of diabetes, previous GDM, obesity, and history of PCOS.

Results: Women with GDM had significantly higher overweight/obesity prevalence than non-GDM women (67.25% vs 54.29%, $p<0.001$). Previous history of GDM and urban residence were also significantly associated with GDM. ROC analysis showed poor discriminatory performance for BMI (AUC 0.577) and EW-IBW [Broca Index (AUC 0.576), Modified Devine method (AUC 0.576)].

Conclusion: Although obesity was significantly associated with GDM, BMI and EW-IBW alone demonstrated poor discriminatory performance and should not be considered independent screening tools. *[J Assoc Clin Endocrinol Diabetol Bangladesh,* July 2026; 5 (2): e89524*]*

Keywords: Gestational Diabetes Mellitus, Bangladesh, South Asia, Ideal body weight, Obesity, BMI, Pregnancy

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Introduction

Gestational diabetes mellitus (GDM) increases risks of pre-eclampsia, cesarean delivery, fetal overgrowth, neonatal hypoglycemia, and later maternal type 2 diabetes.[1,2] South Asian women-including Bangladeshis-develop dysglycemia and GDM at a lower body mass index (BMI) than White populations, likely due to higher visceral adiposity and ectopic fat at a given BMI.[3-5] The prevalence of GDM in the Southeast Asia region is very high compared to other regions in the world.[6] Among the countries in this region, Bangladesh has one of the highest GDM prevalence rates.[7]

Excess weight above ideal body weight (EW-IBW) may better reflect adiposity beyond conventional BMI and could improve risk stratification in South Asian populations, where metabolic risk occurs at relatively lower BMI values. The primary objective of this study was to evaluate the association between EW-IBW and GDM among Bangladeshi women. Secondary objectives were to compare the discriminatory performance of EW-IBW and BMI and to explore clinically relevant thresholds.

Methods

This hospital-based cross-sectional study was conducted at Ad-din Women's Medical College, Dhaka, Bangladesh, from 01.01.2024 to 31.1 2.2024. A consecutive antenatal screening approach was followed. Of 2000 women approached, 1376 consented to participate, and 993 women were included after exclusions for pre-existing diabetes, incomplete oral glucose tolerance test (OGTT), steroid use, acute illness, and incomplete anthropometric data. Weight was measured at the time of OGTT rather than before pregnancy; therefore, gestational weight gain may have influenced BMI and EW-IBW measurements.

Data were collected through a semi-structured questionnaire. Anthropometric measurements were done - height (stadiometer, no shoes) and weight at the time of undertaking the OGTT.

Ideal body weight (IBW) was calculated by following:

- According to "Broca Index": [Height (cm)- 100] x 0.9
- According to the "Modified Devine Formula": 45.5 kg + 2.3 kg for each inch over 5 feet. Women shorter than 5 feet were assessed by subtracting 2.3 kg per inch below 5 feet.

Thereafter, EW-IBW was calculated as: EW-IBW (kg) = Actual weight − IBW.

Patients were categorized according to their EW-IBW and BMI:

- EW-IBW = ≥5 kg, ≥10 kg, ≥15 kg.
- BMI = ≥23 kg/m², ≥25 kg/m², ≥27 kg/m².

Pregnant women who met the IADPSG thresholds (fasting ≥5.1, 1-h ≥10.0, or 2-h ≥8.5 mmol/L) were counted as GDM patients.[8] The cases were sorted according to the maternal age and age group, address – Urban (City corporation area); Sub-urban (District town); Rural (Thana towns, villages), parity, family history of diabetes, prior GDM, history of polycystic ovarian syndrome (PCOS), unexplained abortion, previous baby's birthweight ≥3.5 k,g and obesity.[9,10]

The sample size was calculated based on an exposure prevalence of 13% among controls (P_0 = 0.13), an expected odds ratio of 2.14, a 95% confidence level ($Z\alpha/2$ = 1.96), 80% power ($Z\beta$ = 0.842), and a case-to-control ratio of 3:1. Based on these assumptions, the expected exposure prevalence among cases was estimated to be approximately 24.23% ($P_1 \approx 0.2423$). The minimum required sample size was 390 cases and 130 controls, giving a total of 520 participants. After allowing for an approximately 10% non-response rate or unusable data, the final target sample size was increased to 430 cases and 143 controls, resulting in a total sample of 573 participants.[11,12]

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were compared using the independent-samples t-test, while categorical variables were compared using the chi-square test. Multivariable logistic regression models adjusted for maternal age, parity, residence, family history of diabetes, previous GDM, and history of PCOS. Missing data were handled using complete-case analysis. Multicollinearity was assessed using variance inflation factors. A two-sided p-value <0.05 was considered statistically significant.

Written informed consent was obtained from all participants. Data were de-identified and analyzed in accordance with the Declaration of Helsinki. Ethical approval has been obtained from the Institutional Review Board of Ad-Din Women's Medical College (Reference no: AWMC/IRB-10 June, 2026/16).

Results

Of the 2000 women approached, 1376 consented to participate. After exclusion of women with pre-existing diabetes, steroid use, incomplete OGTT results, acute illness, and incomplete anthropometric data, 993 women were included in the final analysis, where 737 women had GDM, and the remaining 256 women were without GDM.

The mean age of women with GDM was slightly higher than that of non-GDM women (27.81±4.36 vs. 27.21±4.39 years), although the difference was not statistically significant (p=0.058). Most women with GDM belonged to the 26–30 years age group, followed by the 31-35 years age group. Multiparous women were more common among the GDM group than the non-GDM group, although parity was not significantly associated with GDM. Urban residence showed a significant association with GDM, with a higher proportion of women with GDM residing in urban areas compared with women without GDM (67.66% vs. 57.81%, p=0.011) **(Table-I)**.

Family history of diabetes, both paternal and maternal, was more common among women with GDM, although these associations did not reach statistical significance. Similarly, women with GDM more frequently reported a history of PCOS, previous abortion, and previous delivery of a baby weighing ≥3.5 kg; however, these associations were not statistically significant. In contrast, a previous history of GDM showed a statistically significant association with current GDM (6.37% vs. 2.73%, p=0.027). Overweight/obesity was also significantly more prevalent among women with

Table-I: **Baseline characteristics of the study participants (n=993)**

Particulars of the cases		GDM (n=737)	Non-GDM (n=256)	p-value
Age (years; mean≥SD)		27.81±4.36	27.21±4.39	0.058
Age group n (%)	15-20	37 (5.02.%)	15 (5.85%)	0.286
	21-25	192 (26.05%)	79 (30.85%)	
	26-30	327 (44.36%)	114 (44.53%)	
	31-35	154 (20.89%)	39 (15.23%)	
	>35	27 (3.66%)	9 (3.51%)	
Parity n (%)	Primi	223 (30.26%)	87 (33.98)%	0.268
	Multi	514 (69.74%)	169 (66.02%)	
Address n (%)	Urban	499 (67.66%)	148 (57.81%)	**0.011**
	Sub-urban	205 (27.85%)	89 (34.76%)	
	Rural	33 (4.48%)	19 (7.42%)	
	Father’s	148 (20.10%)	43 (16.79%)	0.251
Family history of DM n (%)	Mother’s	168 (22.82%)	47 (18.35%)	0.138
History of PCOS n (%)		127 (17.25%)	31 (12.10%)	0.054
History of abortion n (%)		154 (20.92%)	64 (25.00%)	0.172
History of GDM n (%)		47 (6.37%)	7 (2.73%)	0.027
Previous baby’s birth weight ≥3.5 kg n (%)		57 (7.74%)	11 (4.29%)	0.061
Obesity/Overweight (BMI≥23 kg/m2) n (%)		495 (67.25%)	139 (54.29%)	**0.001**

Percentages were calculated within each study group. The independent-samples t-test was used to compare continuous variables, and the chi-square test was used to compare categorical variables. GDM: gestational diabetes mellitus; DM: diabetes mellitus; PCOS: polycystic ovary syndrome; BMI: body mass index; SD: standard deviation.

Table-II: **Diagnostic performance and association of BMI and EX-IBW with GDM**

Measurement method	Cut-off value	Sensitivity	Specificity	aOR	95% CI	p-value
BMI (kg/m2)	≥21.5	97.7%	4.7%	0.281	0.030-2.611	0.264
	≥22	97.3%	7.0%	2.450	0.359-16.718	0.361
	≥22.5	96.5%	9.4%	0.750	0.143-3.935	0.733
	≥23	95.4%	14.1%	2.540	0.808-7.983	0.111
	≥25	87.0%	30.5%	1.989	0.830-4.766	0.123
	≥27	68.9%	44.5%	0.973	0.331-2.858	0.961
EW-IBW according to Broca index (Kg)	≥3	97.6%	5.9%	0.710	0.080-6.275	0.758
	≥5	96.1%	9.8%	0.299	0.063-1.428	0.130
	≥10	89.0%	27.0%	1.293	0.498-3.352	0.598
	≥15	70.8%	43.0%	0.901	0.269-3.020	0.866
EW-IBW according to Modified Devine formula (Kg)	≥3	98.2%	3.1%	0.643	0.117-3.537	0.611
	≥5	97.3%	7.8%	4.679	0.604-36.262	0.140
	≥10	92.3%	19.9%	0.994	0.420-2.355	0.989
	≥15	78.0%	37.9%	1.173	0.533-2.582	0.692

Data are presented as percentages, adjusted odds ratios (aORs), and 95% confidence intervals (CIs). Sensitivity and specificity were calculated for each specified cut-off value.

Each cut-off was evaluated in a separate multivariable logistic regression model adjusted for maternal age, parity, residence, family history of diabetes mellitus, previous gestational diabetes mellitus, and history of polycystic ovary syndrome. Values below the respective cut-off were used as the reference category.

BMI: body mass index; CI: confidence interval; EW-IBW: excess weight above ideal body weight; GDM: gestational diabetes mellitus; aOR: adjusted odds ratio.

GDM compared with non-GDM women (67.25% vs. 54.29%, p=0.001).

BMI thresholds demonstrated very high sensitivity (>95%) at lower cut-offs (≥21.5–22.5 kg/m²), although specificity was extremely poor (<10%). Higher BMI thresholds improved specificity, but none of the adjusted odds ratios were statistically significant. Similar findings were observed for EW-IBW calculated by both the Broca and Modified Devine methods. Lower EW-IBW thresholds demonstrated very high sensitivity with poor specificity, whereas higher thresholds moderately improved specificity but remained weak discriminators for GDM (**Table-II**).

Table-III: Discriminative ability of BMI and EW-IBW for GDM

Measurement method	AUC	95% CI	p-value
BMI	0.577	0.534-0.621	<0.001
EW-IBW according to the modified Devine formula	0.576	0.533-0.620	<0.001
EW-IBW according to the Broca index	0.576	0.533-0.620	<0.001

The area under the ROC curve was used to assess the ability of each measurement method to discriminate between women with and without GDM. The p-value tests the null hypothesis that the AUC equals 0.50.

AUC: area under the receiver operating characteristic curve; BMI: body mass index; CI: confidence interval; EW-IBW: excess weight above ideal body weight; GDM: gestational diabetes mellitus; ROC: receiver operating characteristic.

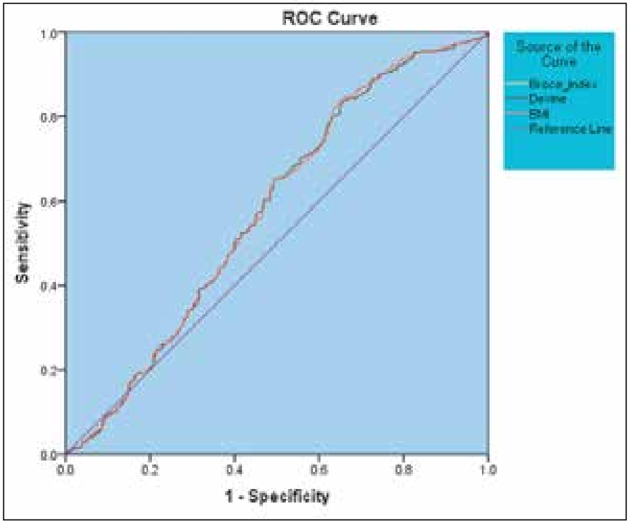

Figure-1: ROC curves showing the discriminative ability of BMI and EW-IBW calculated using the Broca index and modified Devine formula for GDM

ROC: receiver operating characteristic; BMI: body mass index; EW-IBW: excess weight above ideal body weight; GDM: gestational diabetes mellitus;

ROC analysis demonstrated similarly poor discriminatory performance for BMI and EW-IBW by Broca Index and Modified Devine methods, with AUC values ranging from 0.576 to 0.577 (**Table-III**, **Figure-1**).

Discussion

This study demonstrated that obesity and selected maternal characteristics were associated with GDM among Bangladeshi women, whereas BMI and EW-IBW alone showed poor discriminatory performance. Lower thresholds demonstrated high sensitivity but very poor specificity, indicating substantial over-classification of women as being at risk for GDM. These findings suggest that anthropometric measures alone are insufficient for accurate GDM screening. These findings indicate that although obesity was associated with GDM, BMI and EW-IBW alone had limited ability to discriminate women with and without GDM independently.

Consistent with global evidence, we observed that obesity was markedly higher among women with GDM compared to their non-GDM counterparts. Previous studies across diverse populations have reported similar associations, where increased pre-pregnancy BMI was a strong predictor of GDM risk.[13,14] In our study, a significant number of the women with GDM were overweight/obese (67.25%), compared to 54.29% of non-GDM participants, underscoring obesity as a prominent risk marker in the Bangladeshi context.

However, when BMI was analyzed across thresholds, the results did not demonstrate statistically significant adjusted odds ratios. While women in the lower overweight range (BMI ≥21.5 kg/m² - <23 kg/m²) showed a trend toward higher risk, the association did not reach statistical significance. This suggests that the relationship between incremental BMI categories and GDM risk in this population may not be as strong as observed in Western cohorts, where BMI cutoffs often show clear dose-response relationships.[15] One plausible explanation is that Asian women, including Bangladeshis, may develop GDM at lower BMI values due to differences in fat distribution and metabolic profiles.[16,17]

The application of EW-IBW using both the Modified Devine and Broca indices also revealed similar findings: high sensitivity but poor specificity, with no significant risk association across thresholds. While excess weight relative to ideal standards has theoretical appeal for quantifying individualized risk, our findings indicate that it may not be a practical tool for clinical prediction of GDM.

Several factors may explain the weak discriminatory performance of BMI and EW-IBW in predicting GDM in this population. First, GDM is a multifactorial condition, with genetic, metabolic, and environmental determinants beyond excess weight alone.[8-10] Second, the relatively younger age profile of participants (mean ~27 years) and the distribution of parity may have diluted the weight-specific effects. Third, reliance on generalized formulae (Devine, Broca) for calculating IBW, originally developed for Western populations, may not adequately reflect the body composition of South Asian women, who typically have higher body fat percentage at lower BMI.[18,19]

Urban residence emerged as a significant factor associated with GDM, consistent with reports linking urbanization, sedentary lifestyles, and dietary transitions to increased metabolic risks.[20] A higher prevalence of GDM among women with a history of PCOS, abortion, and macrosomia, though not always statistically significant, suggests clustering of reproductive and metabolic risk factors that warrant further exploration. Importantly, the history of previous GDM was strongly associated with current GDM, reinforcing its role as a key risk marker.

Our findings highlight the limitations of using BMI or EW-IBW cutoffs as independent predictors for GDM screening in Bangladeshi women. While obesity remains an important risk factor, reliance on anthropometric thresholds alone risks over-classifying women, given their poor specificity. In practice, this may unnecessarily burden health systems with false positives while failing to capture women at risk due to non-weight-related factors.

There is a need to develop population-specific risk assessment models that integrate BMI with additional parameters, such as waist circumference, dietary patterns, family history, and biochemical markers, to improve predictive accuracy. Considering the higher metabolic vulnerability of South Asian women, adopting lower BMI cutoffs for risk stratification may still be clinically relevant, but should be supported by locally validated evidence.

The study benefits from a relatively large sample size and the use of multiple anthropometric measures for assessing EW-IBW. However, the present study has several limitations. First, because of its cross-sectional design, causal relationships between EW-IBW and GDM cannot be established. Second, the IBW formulas (Broca and Modified Devine) were originally developed in Western populations and may not accurately reflect the body composition of South Asian women. Third, important lifestyle-related variables, including dietary intake, physical activity, and socioeconomic status, were not available and may have acted as residual confounders. Finally, information on gestational age at the time of OGTT and anthropometric measurements was not consistently available in the study records. Consequently, we were unable to evaluate whether the timing of OGTT or anthropometric assessment influenced the association between EW-IBW and GDM. Future prospective studies should incorporate standardized gestational-age-specific anthropometric measurements and OGTT assessments to better characterize these relationships.

Conclusions

Obesity was significantly associated with GDM in this cohort of Bangladeshi women. However, BMI and EW-IBW thresholds demonstrated weak discriminatory performance with poor specificity. Therefore, these anthropometric measures should not be used as independent screening tools for GDM. Population-specific multidimensional risk models are needed for improved screening.

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Conflict of interest

The authors have no conflicts of interest to disclose.

Disclosure of generative AI and AI-assisted technologies

During the preparation of this work, the author used ChatGPT to improve the language. After using this tool, the author thoroughly reviewed, edited, and modified the content as needed and takes full responsibility for the accuracy, originality, and integrity of the final work.

Ethical approval

Ethical approval has been obtained from the Institutional Review Board of Ad-Din Women's Medical College (Reference no: AWMC/IRB-10 June, 2026/16).

Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author, and are available from the corresponding author on reasonable request.

Author contributions

Idea, Planning, data collection, data processing, calculation, writing, and reviewing: MMS

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