



Original Article

Comparison of WHO and Indian Consensus BMI Criteria for Predicting Maternal Outcomes in a North Indian Population

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Abstract

Introduction: Gestational weight and maternal adiposity are important determinants of obstetric outcomes. This study evaluates the utility of Indian consensus BMI criteria, in combination with waist circumference, for predicting adverse maternal outcomes in a North Indian population. The aim of this study was to assess the association of maternal BMI and waist circumference with maternal outcomes in North Indian pregnant women, using the WHO and Indian consensus BMI criteria for comparison.

Methods: In this prospective observational study at a tertiary care hospital in North India, 943 pregnant women in their first trimester (8–13 weeks gestation) were enrolled. Participants were classified according to WHO and Indian consensus BMI criteria, and waist circumference was measured. Maternal outcomes—including mode of delivery, labour onset, and live birth—were recorded. Associations between anthropometric measures and outcomes were analyzed using chi-square tests.

Results: Using WHO criteria, 54.7% of participants had normal BMI and 27.8% were overweight, whereas under the Indian consensus definition, 41.4% were normal and 37.2% were obese. Waist circumference exceeded 80 cm in 66.8% of participants. BMI was significantly associated with mode of delivery ($P < 0.001$), with higher BMI linked to increased rates of caesarean section. Using WHO BMI classification, LSCS rates were 26.5% (13/49) in underweight, 38.5% (155/403) in normal BMI, 47.5% (97/204) in overweight, 52.4% (33/63) in obese, and 90.9% (10/11) in morbidly obese women. A similar increasing trend was observed using the Indian consensus BMI classification, with LSCS rates of 27.3% (9/33) in underweight, 35.5% (109/307) in normal BMI, 44.6% (50/112) in overweight, and 50.4% (140/278) in obese women. When BMI was categorized using the Indian consensus definition, a higher proportion of women in the overweight and obese categories underwent induced labour compared to those with normal BMI. Specifically, induced labour was observed in 16.0% (13/60) of overweight and 22.1% (30/136) of obese women, compared to 16.0% (31/194) in the normal BMI group. This distribution resulted in a statistically significant association between BMI category and onset of labour (χ^2 test, $P = 0.001$). In contrast, the association was not statistically significant when BMI was classified using WHO criteria ($P = 0.072$).

Conclusion: Maternal BMI classified using Indian consensus criteria more accurately predicts labour onset and mode of delivery than WHO BMI in this North Indian population. Use of region-specific BMI cut-offs may enhance risk stratification and guide obstetric care in Indian settings

Keywords: Body mass index, Indian consensus BMI, Pregnancy outcomes, Caesarean section, Labour induction, Waist circumference

Received: October 29, 2025, Revised: January 21, 2026, Accepted: February 3, 2026, ePublished: March 27, 2026

Introduction

Gestational weight gain has been widely reported to influence gestational complications, adverse pregnancy outcomes, and long-term health risks in offspring.¹ Obesity during pregnancy is linked to an increased risk of perinatal complications, including gestational diabetes mellitus, preeclampsia, infections, caesarean deliveries, wound infections, endometritis, and a higher likelihood of childhood obesity.² A higher maternal body mass index (BMI) has also been associated with increased maternal morbidity and mortality.³

In 1997, the World Health Organization (WHO) defined BMI cut-offs as follows: 18.5–24.9 kg/m² as normal, 25.0–29.9 kg/m² as overweight, 30.0–34.9 kg/m² as obese,

and ≥ 35.0 kg/m² as morbid obesity.⁴ Since then, several studies have demonstrated associations between elevated BMI and adverse pregnancy outcomes.⁵ Recognizing ethnic differences in body composition and metabolic risks, revised BMI guidelines for Asian Indians were developed by the Prevention and Management of Obesity and Metabolic Syndrome group through expert consensus.⁶ According to this consensus, BMI cut-offs are defined as follows: 18.0–22.9 kg/m² as normal, 23.0–24.9 kg/m² as overweight, and ≥ 25.0 kg/m² as obese. In 2009, ethnicity-specific BMI cut-offs were proposed for Asian population due to the increased risk of obesity-related comorbidities at lower BMI and waist circumference (WC) levels among Indian individuals.⁷ Thus ethnic specific criteria of BMI



cut off for the Asian ethnic specific population were proposed one and a half decade ago. As per these obesity criteria the BMI was lowered by 5 units because of the fact that the Indian population is at higher risk of metabolic issues even at lower BMI.⁸ These revised cut off criteria are still not in much use even now in large scale studies.⁸ The implications of applying these revised BMI criteria in clinical obstetric practice were highlighted by Aziz et al. (2014), who demonstrated that using the Indian consensus BMI cut-offs resulted in a substantial upward reclassification of pregnant women into overweight and obese categories compared to WHO criteria.⁹ This reclassification identified a greater proportion of women at risk for gestational diabetes, hypertensive disorders, and cesarean delivery; conditions that were often under-recognized when using international standards. The authors concluded that Indian women develop metabolic and obstetric complications at lower BMI thresholds, highlighting the need for ethnicity-specific BMI cut-offs to improve early risk detection and management in pregnancy.

Recent evidence from a North Indian pregnancy cohort further emphasizes the importance of maternal nutritional status during pregnancy.⁸ Chowdhury et al. (2021) examined gestational weight gain (GWG) patterns and their associations with pregnancy outcomes using the Institute of Medicine (IOM) guidelines. The majority of women had inadequate GWG, reflecting widespread maternal undernutrition. Inadequate GWG was significantly associated with higher risks of low birth weight and small-for-gestational-age infants, whereas excessive GWG was linked to an increased likelihood of caesarean delivery and large-for-gestational-age neonates. Although pre-pregnancy BMI was used to define GWG categories, the study did not independently evaluate BMI or waist circumference as predictors of adverse outcomes. These findings highlight the dual burden of undernutrition and emerging obesity among Indian women and emphasize the need for context-specific nutritional guidelines and interventions during pregnancy.

Given these gaps in the literature, the present study was undertaken to investigate the association of BMI (using both WHO and Indian consensus definitions) and waist circumference with adverse maternal outcomes in a North Indian population. The primary objective was to correlate maternal BMI in the first trimester with adverse maternal outcomes, while the secondary objective was to examine the association between maternal waist circumference and adverse outcomes.

Materials and Methods

Participants and Procedures

This study was approved by the Institutional Ethics Committee (IEC) vide letter number GMCH/IEC/2019/264. Pregnant women attending the antenatal clinic at the Department of Obstetrics & Gynecology, Government Medical College and Hospital (GMCH), during their first trimester (8–13 weeks of gestation) were

considered for inclusion. After taking written informed consent, eligible participants were enrolled in the study. In this study 943 pregnant women were enrolled between April 1, 2019, and March 19, 2020. Notably, due to the nationwide lockdown imposed during the COVID-19 pandemic, recruitment had to be halted prematurely. Each participant was furnished with detailed information about the study. A detailed clinical history was recorded, and written informed consent was obtained from the subject prior to data collection. Plan of the study is shown in [Figure 1](#). Pregnant women with known pre-existing medical conditions such as diabetes mellitus, hypertension, thyroid disorders, epilepsy, or other chronic illnesses requiring continuous medication were excluded from the study. Women with incomplete clinical data were also excluded. Additionally, Data pertaining to assessment of pregnancy outcomes (mode of delivery, onset of labor and live births) at follow up was obtained through a review of hospital records if available or telephonic communication with the participants.

Anthropometric Measurements

All anthropometric measurements were obtained during the first trimester at the time of enrollment. Weight was determined with an electronic balance. Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer, with participants standing barefoot, in an upright position, heels together, arms at the sides, and head positioned in the Frankfort horizontal plane. Weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, with participants wearing light clothing and no footwear. All measurements were taken by trained personnel following standardized protocols. Waist circumference (WC) was measured to the nearest 0.1 cm using a non-stretchable measuring tape at the level of the umbilicus. Measurements were taken with the participant standing erect, feet placed close together, arms relaxed at the sides, and abdomen relaxed. The tape was positioned horizontally around the abdomen, ensuring it was snug but not compressing the skin. Measurements were recorded at the end of a normal expiration. BMI was calculated using the standard formula: $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$.

Participants were categorized into BMI groups using two classification systems. The WHO Classification includes underweight ($< 18.50 \text{ kg/m}^2$), normal ($18.50\text{--}24.99 \text{ kg/m}^2$), overweight ($25.00\text{--}29.99 \text{ kg/m}^2$), obese ($30.00\text{--}34.99 \text{ kg/m}^2$), and morbidly obese ($\geq 35.00 \text{ kg/m}^2$). The Indian Consensus definition includes underweight ($< 18.00 \text{ kg/m}^2$), normal ($18.00\text{--}22.99 \text{ kg/m}^2$), overweight ($23.00\text{--}24.99 \text{ kg/m}^2$), and obese ($\geq 25.00 \text{ kg/m}^2$). Waist circumference was interpreted based on the consensus criteria for metabolic syndrome in Indian females, with $WC < 80 \text{ cm}$ was considered normal.

Assessment of Pregnancy Outcomes

Maternal outcomes were assessed using the following criteria: mode of delivery (normal vaginal delivery

vs. lower segment caesarean section), onset of labor (spontaneous vs. induced), and live births (number of neonates born alive).

Statistical Analysis

This prospective observational study enrolled participants consecutively during the study period; a formal a priori sample size calculation was not performed due to the evaluation of multiple outcomes. Data were analyzed using both descriptive and inferential statistical methods. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean $\pm$ standard deviation. Associations between BMI, waist circumference, and pregnancy outcomes were assessed using the chi-square test for categorical variables. A p-value of <0.05 was considered statistically significant. Results, including maternal outcomes and anthropometric data, are presented using tables and appropriate statistical comparisons. Analyses were conducted across BMI categories (as per WHO and Indian consensus definitions), as well as waist circumference, in relation to maternal outcomes.

Results

The mean age of the study population was 26.8 ± 3.2 years. The mean weight was 57.2 ± 8.8 kg, mean BMI was 23.9 ± 3.5 kg/m², and mean waist circumference was

84.88 ± 11.02 cm. Based on the consensus definition, 630 (66.8%) participants had a waist circumference ≥ 80 cm, while 313 (33.2%) had a normal waist circumference (< 80 cm). According to WHO BMI classification, 516 (54.7%) participants were in normal category, 262 (27.8%) were overweight, 75 (8.0%) obese and 76 (8.1%) were underweight. Using the Indian consensus BMI criteria, 390 (41.4%) participants were normal weight, 351 (37.2%) were obese, 150 (15.9%) were overweight, and 52 (5.5%) were underweight (Table 1). Application of the Indian consensus BMI criteria resulted in reclassification of a larger proportion of women into higher BMI categories

Table 1. Mean BMI of participants using BMI (WHO classification) and BMI (Consensus definition)

BMI (WHO classification)		
Categories	N (Percent)	Mean $\pm$ SD
Underweight, < 18.50 kg/m ²	76(8.1)	17.24 $\pm$ 0.89
Normal, 18.50-24.99 kg/m ²	516(54.7)	21.77 $\pm$ 1.85
Overweight, 25.00-29.99 kg/m ²	262(27.8)	27.01 $\pm$ 1.33
Obese, 30.00-34.99 kg/m ²	75(8.0)	31.85 $\pm$ 1.33
BMI (Consensus definition)		
Underweight, < 18.00 kg/m ²	52(5.5)	16.79 $\pm$ 0.71
Normal, 18.00-22.99 kg/m ²	390(41.4)	20.67 $\pm$ 1.40
Overweight, 23.00-24.99 kg/m ²	150(15.9)	24.05 $\pm$ 0.58
Obese, ≥ 25.00	351(37.2)	28.46 $\pm$ 3.01

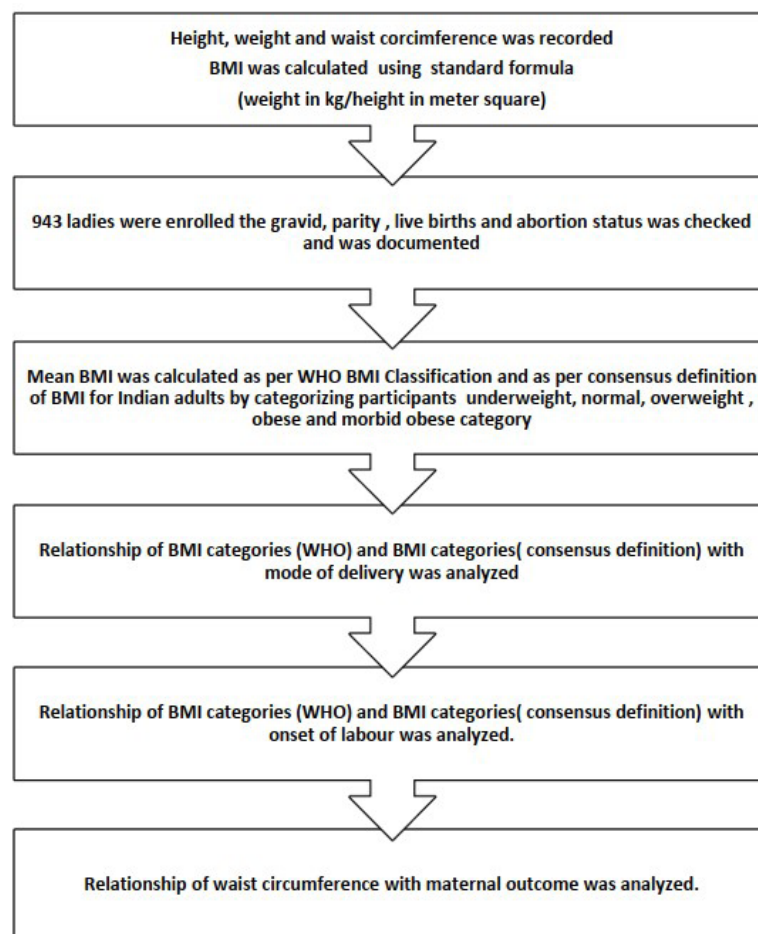


Figure 1. Plan of study

compared to WHO criteria, highlighting the impact of ethnicity-specific cut-offs in this population. The Indian consensus criteria set lower thresholds for BMI, reflecting the increased risk of metabolic disorders at lower BMI levels in the Indian population.

No statistically significant association was observed between BMI category and maternal outcome (expired vs live birth) using the WHO BMI classification ($P=0.497$) or the Indian consensus BMI criteria ($P=0.338$) (Table 2). Among the study participants, 726(77%) had live births, while deaths (neonatal and intrauterine) occurred in 19 (2%) deliveries and abortions reported in 21 (2.2%) cases. Outcome data were unavailable for 208 participants as they were not reachable.

Mode of delivery was normal vaginal delivery (NVD) in 422 (44.8%) participants and lower segment caesarean section (LSCS) in 308 (32.7%). A statistically significant association was observed between BMI category and mode of delivery using both WHO and Indian consensus BMI classifications ($P\leq 0.001$ and $P=0.001$, respectively). The proportion of LSCS increased with higher BMI

categories under both classification systems. Women classified as overweight, obese, and morbidly obese had a higher likelihood of LSCS compared to those with normal BMI, whereas normal and underweight women were more likely to have a normal vaginal delivery (Table 3). No statistically significant association was observed between BMI category and mode of onset of labour using the WHO BMI classification ($P=0.072$). However, using the Indian consensus BMI classification, a significant association was observed ($P=0.001$), with a higher proportion of induced labour among overweight and obese women compared to those with normal BMI (Table 4).

No statistically significant association was observed between waist circumference and maternal outcomes (Table 5).

Discussion

The impact of maternal obesity on pregnancy outcomes has been a subject of considerable research, with numerous studies investigating the role of body mass index (BMI) in predicting maternal health.^{1,2,9} Obesity during

Table 2. Relationship of BMI with maternal outcome (number of live births) using WHO versus consensus definition cut offs of BMI.

BMI WHO classification			BMI Consensus definition		
Categories	Expired	Live Birth	Categories	Expired	Live Birth
Under weight	2	51	Under weight	1	35
Normal	26	398	Normal	17	303
Overweight	11	201	Overweight	10	111
Obese	1	65	Obese	12	277
Morbid obese	0	11	-	-	-
Chi-square test, P -value=0.497			Chi-square test, P -value=0.338		

Table 3. Relationship of BMI categories (WHO and consensus definition) with mode of delivery

BMI WHO classification			BMI consensus definition		
Categories	Mode of delivery		Categories	Mode of delivery	
	LSCS	NVD		LSCS	NVD
Under weight	13	36	Under weight	9	24
Normal	155	248	Normal	109	198
Overweight	97	107	Overweight	50	62
Obese	33	30	Obese	140	138
Morbid obese	10	1	-	-	-
Chi-square test, P -value<=0.001			Chi-square test, P -value=0.001		

LSCS: lower segment caesarian section

NVD: Normal vaginal delivery

Table 4. The relationship of BMI (WHO category) and BMI (Consensus definition) with onset of labour

BMI WHO classification			BMI Consensus definition		
Categories	Labour		Categories	Labour	
	Induced	Spontaneous		Induced	Spontaneous
Under weight	4	31	Under weight	0	24
Normal	40	203	Normal	31	163
Overweight	25	81	Overweight	13	47
Obese	4	25	Obese	30	106
Morbid obese	1	0	-	-	-
Chi-square test, P -value=0.072			Chi-square test, P -value=0.001		

Table 5. The Relation of Waist circumference with maternal outcome (Expired versus live births)

		Waist circumference		
		Normal	Raised	Total
Maternal outcome	Expired	12	28	40
	Live birth	236	490	726
Total		284	518	766

pregnancy has been consistently linked to a higher risk of complications such as gestational diabetes, preeclampsia and preterm birth. BMI, which categorizes women as underweight, normal weight, overweight, or obese, has been widely used in clinical settings to assess maternal health risks.¹⁰ A study which explored the relationship between maternal BMI and pregnancy outcomes, showed that obese mothers are more likely to experience gestational complications and give birth to larger babies, which are associated with higher rates of labor and delivery complications.³ Similarly, another research, highlights the importance of waist circumference as an indicator of central obesity, finding that waist circumference may be more predictive of complications like preeclampsia and gestational hypertension than BMI alone.⁴

In yet another study, it was noted that women with higher BMI were not only at risk for physical complications such as gestational diabetes but also experienced increased psychological stress, including perinatal depression, underscoring the complex effects of maternal obesity on both physical and mental health.¹¹ Studies have also shown that that maternal obesity not only impacts pregnancy outcomes but may also have long-term cardiovascular implications for women, such as an increased risk of premature mortality and major cardiovascular events later in life.⁵ While these studies focus on the general relationship between obesity and pregnancy, research also stresses the importance of waist circumference, with findings suggesting that central obesity is a more precise indicator for predicting pregnancy complications, such as gestational hypertension and preterm birth.⁷

In our study by exploring the combined impact of BMI and waist circumference on pregnancy outcomes among North Indian women on a specific demographic population, we have provided valuable insights into the ethnic and cultural variations in obesity-related pregnancy complications, thereby offering a more regionally relevant understanding of how these factors influence maternal and neonatal health. The null association between waist circumference and pregnancy outcomes in our study may reflect measurement during early pregnancy, when physiological changes in abdominal contour limit its validity as a marker of central adiposity. In addition, strong correlation with body mass index and population-specific fat distribution patterns among North Indian women may have attenuated any independent effect of waist circumference, thereby limiting its discriminatory value in this setting.

Our study will help to advance current knowledge by

providing data specific to a population that has been less represented in global research. It will also offer guidance for public health interventions aimed at reducing pregnancy complications through the management of both BMI and waist circumference, especially in regions where obesity is becoming an increasingly significant health concern.

The generalizability of the present findings should be interpreted in light of the study setting and population. This prospective study was conducted at a single tertiary care center and included pregnant women from a North Indian population, which may limit extrapolation to other ethnic, geographic, or healthcare settings. However, the large sample size and prospective design enhance the internal validity of the findings. Given the increasing prevalence of altered anthropometric profiles in similar low- and middle-income settings, the observed associations may be relevant to comparable populations, although confirmation through multicenter and ethnically diverse studies is warranted. Consecutive recruitment of participants reduces selection bias and supports applicability to routine clinical populations. These findings may inform risk stratification and preventive strategies in antenatal care settings with similar demographic profiles.

Limitations: Although the study included a large sample, the absence of a priori sample size or power calculation should be considered when interpreting the findings. The study reports p-values for chi-square analyses without accompanying effect size estimates, which may limit interpretation of the strength of observed associations. This study also reports unadjusted associations between anthropometric measures and pregnancy outcomes, a lack of adjustment for potential confounders may limit causal interpretation and introduces the possibility of residual confounding. The high proportion of missing data is a major limitation. So, these findings should not be interpreted as causal and future studies incorporating multivariable adjustment with complete follow-up and adjustment for confounders are warranted to confirm and extend these results.

Conclusion

Maternal BMI classified using the Indian consensus definition reliably predicts labour onset and mode of delivery, whereas WHO BMI cut-offs are less predictive in this population. Waist circumference was not a significant predictor of the outcomes assessed. These findings support the use of ethnicity-specific BMI criteria for risk stratification in Indian obstetric care.

Acknowledgements

Ms Kamini, Laboratory attendant, Department of Physiology, GMCH, Chandigarh, provided help in data entry and tracking patients for post pregnancy outcomes.

Authors' Contribution

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Competing Interests

The authors declare they have no conflict of interest.

Ethical Approval

This study was approved by the Institutional Ethics Committee (IEC) vide letter number GMCH/IEC/2019/264. All procedures performed in this study were in accordance with the ethical standards of the institutional and national committee and with the 1964 Helsinki Declaration amendments or comparable ethical standards. Written informed consent was obtained from participants before including them in the study.

Funding

This manuscript was funded by the Department of Science and Technology- UT, Chandigarh, India sanction letter no. S&T&RE/RP/147(18-19)/Sanc/02/2019/232-242 dated- 07.02.19.

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