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Original Research Article

Association of Body Mass Index with Menstrual Irregularities and Infertility among Women of Reproductive Age Group

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Abstract

Background: Both undernutrition and obesity have been implicated in menstrual disturbances and infertility; however, evidence from Indian settings remains limited.

Objectives: To assess the association of BMI with menstrual irregularities and infertility among women of reproductive age group.

Material & Methods: A hospital-based cross-sectional study was conducted among 300 women aged 18–45 years attending a tertiary care hospital. BMI was calculated using standard anthropometric measurements and classified as per WHO criteria. Menstrual patterns and infertility status were recorded using a structured questionnaire. Associations were analyzed using Chi-square test, and multivariate logistic regression was performed to identify independent predictors.

Results: Menstrual irregularities were observed in 41.3% of participants, while infertility was present in 28.7%. Menstrual irregularities and infertility were significantly higher among underweight and obese women compared to those with normal BMI ($p<0.001$). On multivariate analysis, underweight, overweight, and obesity were independently associated with menstrual irregularities. Obesity (AOR 3.0; 95% CI: 1.5–5.9) and menstrual irregularity (AOR 3.9; 95% CI: 2.2–6.8) emerged as strong independent predictors of infertility.

Conclusion: Maintaining optimal BMI may play a key role in improving menstrual health and fertility outcomes among women of reproductive age.

Keywords: Body Mass Index, Menstrual irregularities, Infertility, Reproductive age group, Obesity.

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Introduction

Body Mass Index (BMI), a simple anthropometric measure of weight relative to height, is widely used to classify individuals into underweight, normal weight, overweight, and obese categories. In women of reproductive age, deviations from normal BMI have been increasingly recognized as important determinants of reproductive health, particularly menstrual regularity and fertility outcomes. [1]

Menstrual regularity is an essential indicator of normal hypothalamic–pituitary–ovarian (HPO) axis functioning. Normal ovulatory cycles require balanced interaction among gonadotropins and sex steroids, which can be perturbed by abnormal adiposity. [2] Physiologically, adipose tissue secretes adipokines and alters levels of insulin, leptin, and sex hormone-binding globulin, thereby influencing gonadotropin releasing hormone pulsatility, follicular development, and ovulation. Excess adiposity may increase peripheral aromatization of androgens to estrogens, exerting negative feedback on the HPO axis and contributing to anovulation. Conversely, very low BMI associated with insufficient body fat may reduce leptin levels, impair kisspeptin signaling, and lead to hypothalamic amenorrhea. [3]

Menstrual irregularities encompass a range of disorders including oligomenorrhea, amenorrhea, and irregular cycle lengths, and they serve as a key clinical marker for fertility issues. Women with irregular menstrual cycles often demonstrate oligo-ovulation or anovulation, which directly reduces

the likelihood of conception. [4] Moreover, irregular cycles not only reflect endocrine disruption but are associated with reduced fecundity and increased time to pregnancy.

Infertility, defined as the inability to achieve pregnancy after 12 months of unprotected intercourse in women under age 35, is a significant public health concern worldwide. The global prevalence of infertility among women of reproductive age is estimated to affect approximately 10–15% of couples. [5] Elevated BMI has been consistently identified as a risk factor for infertility. Epidemiological studies show that increasing BMI is positively associated with infertility risk in a dose-response manner, persisting even in metabolically healthy overweight and obese women. [6]

The mechanisms underpinning the association between BMI, menstrual irregularities, and infertility are complex and multifactorial, involving hormonal dysregulation, metabolic disturbances including insulin resistance, altered adipokine profiles, and chronic inflammation. [7] Given the modifiable nature of BMI through lifestyle and therapeutic interventions, understanding these associations has significant clinical implications.

Materials and Methods

Study Setting & Design: A hospital-based cross-sectional observational study was conducted in the Outpatient Department (OPD) of Obstetrics and Gynecology at a tertiary care teaching hospital to assess the association of Body Mass Index (BMI) with menstrual irregularities and infertility among women of reproductive age group over a period of nine months.

The study population comprised women of reproductive age group (18–45 years) attending the gynecology OPD for routine consultation, menstrual complaints, or infertility evaluation during the study period.

Inclusion & Exclusion Criteria: Women aged 18–45 years presenting with primary or secondary infertility with a history of regular or irregular menstrual cycles were included in the study. However Pregnant or Lactating women (within 6 months postpartum) or women with known endocrine disorders such as thyroid disease, Cushing's syndrome, or hyperprolactinemia and women on hormonal therapy (oral contraceptive pills, steroids) in the last 3 months were excluded from the study.

A total of 300 study subjects were included in the study based on convenient sampling technique method wherein all eligible women attending the OPD during the study period and fulfilling inclusion criteria were enrolled until the desired sample size was achieved.

Data Collection Tools and Procedure: Data was collected using a pre-designed, pre-tested structured questionnaire through face-to-face interviews and clinical examination. The questionnaire included information on:

- Socio-demographic characteristics
- Menstrual history (cycle length, regularity, duration, flow)
- Obstetric and infertility history
- Lifestyle factors (physical activity, diet)

Anthropometric Measurements

- Weight was measured using a calibrated digital weighing scale to the nearest 0.1 kg, with the participant wearing light clothing and no footwear.
- Height was measured using a stadiometer to the nearest 0.1 cm.
- Body Mass Index (BMI) was calculated using the formula:

$$BMI = Weight\ (kg)/Height(m)^2$$

BMI was categorized as per WHO classification [8]

- **Underweight:** <18.5 kg/m²
- **Normal weight:** 18.5–24.9 kg/m²
- **Overweight:** 25.0–29.9 kg/m²
- **Obese:** ≥30 kg/m²

Assessment of Menstrual Irregularities: Menstrual irregularities were defined as:

- **Oligomenorrhea**: cycle length >35 days
- **Polymenorrhea**: cycle length <21 days
- **Amenorrhea**: absence of menstruation for ≥3 months
- **Irregular cycles**: variation in cycle length >7 days

Assessment of Infertility: Infertility was defined as failure to conceive after 12 months of regular unprotected intercourse and was classified as:

- **Primary infertility**: Infertility in a woman who has never conceived despite regular unprotected intercourse for one year. [9]
- **Secondary infertility**: Infertility in a woman who has previously conceived but is unable to conceive again after one year of unprotected intercourse. [9]

Statistical Analysis: Data obtained was entered into Microsoft Excel and analyzed using SPSS version 21. Categorical variables were expressed as frequency and percentage while continuous variables were expressed as mean ± standard deviation. Association between BMI and menstrual irregularities/infertility was assessed using Chi-square test. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Socio-Demographic Characteristics of Study Participants (n = 300)

Variable	Frequency	Percentage (%)
Age Group (years)		
18–25	72	24.0
26–35	156	52.0
36–45	72	24.0
Marital Status		
Married	268	89.3
Unmarried	32	10.7

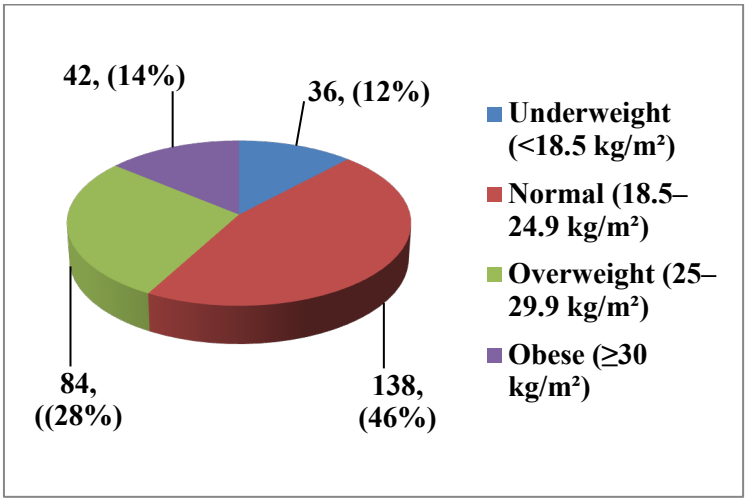

Figure 1: Pie Chart Showing Distribution of BMI Categories

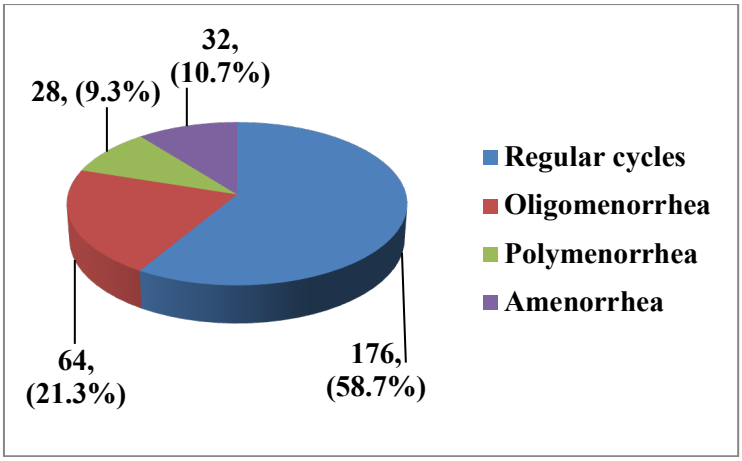

Figure 2: Pie Chart Showing Distribution of Menstrual Patterns

Table 2: Association of BMI with Menstrual Irregularities

BMI Category	Regular Cycles	Irregular Cycles	Total	p-value
Underweight	12 (33.3%)	24 (66.7%)	36	
Normal	102 (73.9%)	36 (26.1%)	138	
Overweight	42 (50.0%)	42 (50.0%)	84	
Obese	20 (47.6%)	22 (52.4%)	42	
Total	**176**	**124**	**300**	**<0.001***

***significant p value**

Both underweight and obese women showed significantly higher menstrual irregularities and infertility compared to normal BMI women.

Table 3: Distribution of Infertility among Participants

Infertility Status	Frequency	Percentage (%)
Fertile	214	71.3
Infertile	86	28.7
• Primary infertility	52	17.3
• Secondary infertility	34	11.4

Infertility was present in 28.7% of women.

Table 4: Association of BMI with Infertility

BMI Category	Infertile	Fertile	Total	p-value
Underweight	14 (38.9%)	22 (61.1%)	36	
Normal	26 (18.8%)	112 (81.2%)	138	
Overweight	28 (33.3%)	56 (66.7%)	84	
Obese	18 (42.9%)	24 (57.1%)	42	
Total	**86**	**214**	**300**	**<0.001***

***significant p value**

A statistically significant association was observed between BMI and both menstrual irregularities and infertility ($p < 0.001$).

Table 5: Multivariate Logistic Regression Analysis for Predictors of Menstrual Irregularities

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Underweight (BMI <18.5 kg/m²)	2.8	1.4–5.6	0.003
Overweight (BMI 25–29.9 kg/m²)	1.9	1.1–3.2	0.021
Obesity (BMI ≥30 kg/m²)	2.3	1.2–4.4	0.009
Age ≥30 years	1.6	1.0–2.6	0.047

Reference category: Normal BMI (18.5–24.9 kg/m²) Model adjusted for: Age and marital status

- Underweight women had 2.8 times higher odds of menstrual irregularities compared to women with normal BMI.
- Obese women had 2.3 times higher odds of menstrual irregularities.
- Increasing age was also an independent predictor.

Table 6: Multivariate Logistic Regression Analysis for Predictors of Infertility

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Underweight (BMI <18.5 kg/m²)	2.1	1.1–4.2	0.026
Overweight (BMI 25–29.9 kg/m²)	1.8	1.0–3.1	0.041
Obesity (BMI ≥30 kg/m²)	3.0	1.5–5.9	0.002
Menstrual irregularity	3.9	2.2–6.8	<0.001
Age ≥30 years	1.7	1.0–2.8	0.038

Reference category: Normal BMI (18.5–24.9 kg/m²) Model adjusted for: age and menstrual regularity

- Obese women had three times higher odds of infertility compared to normal BMI women.
- Menstrual irregularity emerged as the strongest independent predictor of infertility.
- Both underweight and overweight status remained significantly associated with infertility after adjustment.

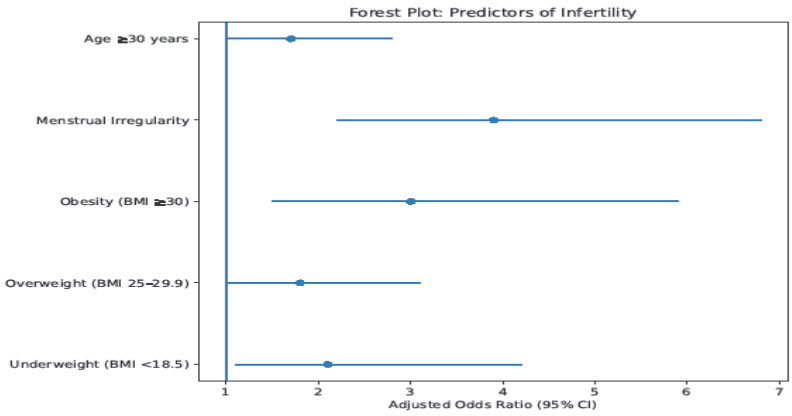

Figure 3: Forest Plot Showing Adjusted Odds Ratios for Predictors of Infertility

- BMI showed a U-shaped association with both menstrual irregularities and infertility.
- Normal BMI was protective, while both extremes of BMI independently increased risk.
- Multivariate analysis confirmed that the observed associations were independent of age and menstrual pattern.

Discussion

The present study demonstrated a significant U-shaped relationship, wherein both underweight and overweight/obese women exhibited higher risks compared to women with normal BMI. These findings highlight the crucial role of optimal body weight in maintaining normal reproductive physiology.

In the current study, 41.3% of participants had menstrual irregularities, with a markedly higher prevalence among underweight (66.7%) and obese (52.4%) women. Multivariate logistic regression analysis confirmed that underweight (AOR 2.8), overweight (AOR 1.9), and obese women (AOR 2.3) were independently associated with menstrual irregularities after adjusting for age. These findings are consistent with recent prospective cohort studies demonstrating that deviations from normal BMI disrupt hypothalamic–pituitary–ovarian (HPO) axis functioning, leading to abnormal gonadotropin secretion and ovulatory dysfunction. Itoi et al. (2025) [1] reported a similar non-linear association between BMI and menstrual cycle irregularity, emphasizing that both low and high BMI adversely affect menstrual regularity.

Infertility was seen in 28.7% of participants, with a higher burden among obese (42.9%) and underweight women (38.9%). Multivariate analysis revealed that obesity was the strongest BMI-related predictor of infertility (AOR 3.0), followed by underweight status (AOR 2.1). Importantly, menstrual irregularity emerged as the most powerful independent predictor of infertility (AOR 3.9), underscoring its role as a clinical surrogate marker for ovulatory dysfunction.

Similar findings were reported by Best et al. (2022) 10 which demonstrated that obese women have significantly prolonged time to conception and reduced fecundability, even in the absence of polycystic ovary syndrome. Similarly, Zhu et al. (2022) [11] reported a dose-dependent increase in infertility risk with rising BMI, which persisted after adjusting for metabolic comorbidities. Notably, adolescent and early adulthood BMI has also been linked to future infertility risk, suggesting long-term reproductive consequences of early-life nutritional status.

Age ≥30 years was found to be an independent predictor of both menstrual irregularities and infertility in the present study. This aligns with established evidence that advancing age is associated with declining ovarian reserve, reduced oocyte quality, and increased anovulatory cycles. [12] However, the persistence of BMI as an independent risk factor after age adjustment emphasizes that weight-related reproductive dysfunction is not solely age-dependent and remains clinically modifiable.

Recommendations

1. Routine assessment of Body Mass Index should be incorporated into gynecological and infertility clinics for early identification of women at risk of reproductive dysfunction.
2. Women with abnormal BMI should receive targeted lifestyle counseling focusing on balanced nutrition, regular physical activity, and weight optimization.
3. Menstrual irregularities should be promptly evaluated as they may serve as early indicators of underlying infertility, especially in women with abnormal BMI.

Limitations

1. The cross-sectional study design limits the ability to establish a causal relationship between BMI, menstrual irregularities, and infertility.
2. Hormonal profiles and ovulatory function assessments were not included, which may have provided deeper insight into the underlying mechanisms.
3. Potential confounding factors such as dietary intake, stress levels, and physical activity were not assessed in detail.

Conclusion

This study demonstrates a significant U-shaped association between body mass index and reproductive health outcomes among women of reproductive age. Both underweight and overweight/obese women exhibited higher prevalence of menstrual irregularities and infertility compared to women with normal BMI. Menstrual irregularity emerged as a strong independent predictor of infertility.

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