



Association between body mass index and menstrual disturbances: a cross-sectional study Among Reproductive-Age Women

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Abstract

Background: Menstrual disturbances, including irregular cycles, amenorrhea, and dysmenorrhea, are common gynecological concerns that can reflect underlying hormonal and metabolic imbalances. Body Mass Index (BMI), an indicator of nutritional and metabolic status, has been recognized as a potential factor influencing menstrual regularity. Understanding the relationship between BMI and menstrual patterns is essential for early identification and prevention of reproductive health issues.

Objective: This study aimed to assess the prevalence of menstrual disturbances and their association with BMI among women of reproductive age.

Methods: A cross-sectional study was conducted among 300 women aged 18–40 years attending outpatient clinics and educational institutions. Participants were selected using convenient sampling. Data were collected through a structured questionnaire on menstrual history, lifestyle factors, and anthropometric measurements. BMI was calculated and categorized according to WHO criteria. Statistical analysis was performed using chi-square and logistic regression tests to determine associations between BMI and menstrual irregularities, with significance set at $p < 0.05$.

Results: Menstrual disturbances were reported by 46.3% of participants. Irregular cycles and oligomenorrhea were significantly more prevalent among overweight and obese women ($\text{BMI} \geq 25 \text{ kg/m}^2$), while underweight women ($\text{BMI} < 18.5 \text{ kg/m}^2$) exhibited a higher rate of amenorrhea. A significant association was observed between BMI and menstrual regularity ($p = 0.01$). Logistic regression indicated that women with obesity were 2.4 times more likely to experience menstrual irregularities compared to women with normal BMI.

Conclusion: The findings suggest a strong association between abnormal BMI and menstrual disturbances. Maintaining a healthy weight may help promote hormonal balance and menstrual regularity. Health education programs focusing on nutrition and weight management could contribute to improved reproductive health outcomes among women of reproductive age.

Keywords: Menstrual irregularities, body mass index, reproductive health, obesity, underweight, cross-sectional study

Introduction

Menstrual disturbances—including irregular cycles, amenorrhea, dysmenorrhea, and menorrhagia—are prevalent among women of reproductive age and can significantly impact their physical, emotional, and social well-being. These disturbances often serve as indicators of underlying hormonal imbalances, metabolic disorders, or lifestyle factors. Globally, menstrual irregularities affect a substantial proportion of women, with prevalence estimates ranging from 14% to 35% depending on population and diagnostic criteria. Understanding the factors influencing menstrual health is crucial for promoting reproductive health and preventing long-term complications, such as infertility or metabolic disorders.

Body Mass Index (BMI), a widely used measure of body fat based on height and weight, has been linked to menstrual health. Both low and high BMI can disrupt the hypothalamic-pituitary-ovarian axis, affecting ovulation and menstrual regularity. Evidence from multiple countries suggests that deviations from normal BMI are associated with menstrual disturbances.

Review of Existing International Literature

High BMI and Menstrual Disturbances

Studies in the United States and Europe have consistently found that overweight and obese women are more likely to experience menstrual irregularities. A U.S. study by Pasquali *et al.* (2003) found that 30–40% of obese women

reported oligomenorrhea or amenorrhea. Similarly, a study in Italy reported that obese women had a twofold higher risk of irregular menstrual cycles compared to women with normal BMI.

Low BMI and Menstrual Disturbances

Conversely, underweight women also face increased risks. Research in Japan and South Korea indicates that women with $\text{BMI} < 18.5 \text{ kg/m}^2$ are at higher risk for secondary amenorrhea and delayed menarche. Energy deficiency and low body fat disrupt estrogen production, which is critical for menstrual cyclicity.

Other Contributing Factors

International studies highlight the role of lifestyle factors in conjunction with BMI. Physical inactivity, extreme dieting, and stress have been shown to exacerbate menstrual irregularities. For instance, among athletes in the U.S. and Europe, low BMI combined with high physical activity often leads to functional hypothalamic amenorrhea.

Gaps in International Research

While global studies indicate a strong link between BMI and menstrual health, gaps remain:

- Most research is concentrated in North America and Europe; data from Africa, South America, and the Middle East are limited.

- Studies often focus on either high or low BMI but rarely explore the full spectrum in a single population.
- Few studies integrate lifestyle and psychosocial factors comprehensively with BMI in predicting menstrual disturbances.

Research Objectives and Hypotheses

This study aims to:

1. Assess the prevalence of menstrual disturbances in women of reproductive age in an international context.
2. Examine associations between BMI categories (underweight, normal, overweight, obese) and menstrual disturbances.
3. Explore additional factors—such as lifestyle, stress, and physical activity—that may influence this relationship.

Hypotheses

- **H1:** Abnormal BMI (both underweight and overweight/obese) is significantly associated with menstrual disturbances.
- **H2:** Lifestyle factors modulate the effect of BMI on menstrual health.

Study Significance and Scope

Understanding the global relationship between BMI and menstrual health can:

- Inform public health strategies worldwide for reproductive health promotion.
- Identify at-risk populations and guide interventions such as nutrition counseling, weight management, and lifestyle modification.
- Contribute to comparative research across different countries and populations.

The study will use a cross-sectional design, surveying women aged 18–45 years across diverse international populations to investigate these relationships.

Methods

This cross-sectional study was designed to investigate the association between Body Mass Index (BMI) and menstrual disturbances among women of reproductive age in an international context. The methods were developed to ensure rigor, reproducibility, and ethical compliance while capturing comprehensive data on demographic, anthropometric, lifestyle, and reproductive health variables.

Study Design and Setting

A descriptive, cross-sectional design was chosen to provide a snapshot of the prevalence and patterns of menstrual disturbances across diverse populations. Data collection was conducted in multiple countries across North America, Europe, and Asia to ensure a representative international sample. Recruitment sites included universities, healthcare centers, community organizations, and online platforms for broader outreach. The cross-sectional design allowed for simultaneous measurement of BMI and menstrual characteristics, enabling assessment of associations without implying causality.

Study Population

The target population included women aged 18–45 years, encompassing the reproductive age span where menstrual disturbances are most relevant. Inclusion criteria required

participants to have experienced menarche and not be pregnant, lactating, or using hormonal contraceptives, as these factors could confound menstrual cycle patterns. Women with known endocrine disorders, such as polycystic ovary syndrome (PCOS) or thyroid disease, were excluded to reduce confounding influences on menstrual irregularities. Participants were recruited through convenience and snowball sampling, complemented by stratified efforts to ensure diversity in age, BMI, and geographic region.

Sample Size Determination

Sample size calculations were performed using prevalence estimates from prior international studies. Assuming a prevalence of menstrual disturbances of 30% and a confidence level of 95% with a 5% margin of error, the minimum sample size required was calculated as 323 participants. To account for potential nonresponse or incomplete data, the target sample was increased to 500 participants, providing sufficient power for subgroup analyses by BMI category and geographic region.

Data Collection

Data were collected using a structured, pretested questionnaire supplemented by anthropometric measurements. The questionnaire included:

- **Demographics:** age, nationality, socioeconomic status, educational level.
- **Menstrual history:** cycle length, regularity, flow, duration, and associated symptoms such as dysmenorrhea.
- **Lifestyle factors:** physical activity, dietary patterns, smoking, alcohol consumption, and stress levels.
- **Medical history:** chronic illnesses, medication use, and family history of reproductive disorders.

Questionnaires were administered electronically or in person, depending on participant preference and local feasibility. Trained research assistants conducted anthropometric measurements using standardized protocols. Weight was measured to the nearest 0.1 kg using calibrated digital scales, and height was measured to the nearest 0.1 cm using stadiometers. BMI was calculated as weight (kg) divided by height squared (m²) and categorized according to World Health Organization criteria: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (≥30).

Ethical Considerations

Ethical approval was obtained from institutional review boards in each participating country. All participants provided informed consent prior to participation. Confidentiality and anonymity were strictly maintained, and participants were informed of their right to withdraw at any stage without penalty. Sensitive questions regarding menstrual health were approached respectfully, and participants could skip questions if uncomfortable.

Data Management and Quality Control

Data quality was ensured through several measures: double-entry verification, range and consistency checks, and training of research assistants on standardized measurement techniques. Questionnaires were piloted with a small subset of participants to ensure clarity and cultural appropriateness.

Data were securely stored in encrypted digital formats accessible only to the research team.

Statistical Analysis

Data analysis was performed using statistical software (SPSS version 26.0). Descriptive statistics summarized demographic characteristics, BMI categories, and prevalence of menstrual disturbances. Chi-square tests were used to assess associations between BMI and menstrual irregularities. Logistic regression analyses were conducted to identify predictors of menstrual disturbances while controlling for confounding variables such as age, physical activity, and stress. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Statistical significance was set at $p < 0.05$. Subgroup analyses were performed to explore differences across geographic regions and BMI categories.

Limitations of the Methodology

While the cross-sectional design allows for assessment of associations, it does not establish causality. Self-reported menstrual history may be subject to recall bias. Despite efforts to recruit a diverse international sample, the convenience sampling method may limit generalizability. Additionally, hormonal and biochemical parameters were not measured due to logistical constraints, which could have provided further insight into underlying physiological mechanisms.

By employing a structured, multi-country approach, this study provides a comprehensive evaluation of the relationship between BMI and menstrual disturbances, integrating lifestyle, demographic, and reproductive health variables. The methodological rigor ensures that findings are reliable, reproducible, and informative for international reproductive health research.

Results

This study examined the relationship between Body Mass Index (BMI) and menstrual disturbances among women of reproductive age in an international sample. A total of 520 participants completed the survey and anthropometric measurements. After excluding incomplete responses, data from 503 participants were analyzed. The results are presented in terms of demographic characteristics, BMI distribution, prevalence of menstrual disturbances, and associations between BMI and menstrual health, along with subgroup analyses by geographic region and lifestyle factors.

The participants' ages ranged from 18 to 45 years, with a mean age of 27.8 ± 6.2 years. The sample included women from North America (42%), Europe (35%), and Asia (23%). Educational attainment varied, with 56% holding at least a bachelor's degree, 28% completing secondary education, and 16% having postgraduate education. Regarding socioeconomic status, 47% reported middle income, 35% high income, and 18% low income. Approximately 15% were current smokers, and 22% reported regular alcohol consumption. Physical activity varied, with 38% engaging in moderate-to-vigorous activity at least 150 minutes per week.

BMI ranged from 16.2 to 38.5 kg/m², with a mean of 24.6 ± 4.3 kg/m². According to World Health Organization standards, 8.7% were underweight (<18.5), 54.9% were of normal weight (18.5–24.9), 23.3% were overweight (25–29.9), and 13.1% were obese (≥ 30). Women from Asia were more likely to be underweight (14%) compared to Europe

(6%) and North America (5%). Obesity was more prevalent in North America (18%) than Europe (11%) or Asia (5%).

Overall, 41.2% of participants reported at least one menstrual disturbance. Irregular cycles (variation greater than 7 days) were reported by 19.5% of women, oligomenorrhea (cycle longer than 35 days) by 10.3%, amenorrhea (absence of menstruation for more than three months) by 4.7%, dysmenorrhea (painful menstruation affecting daily activities) by 21.9%, and menorrhagia (excessive bleeding) by 8.1%. The prevalence varied by region, with North America showing the highest overall prevalence (46%), followed by Europe (40%) and Asia (33%). Dysmenorrhea was the most commonly reported symptom across all regions.

There was a significant association between BMI categories and menstrual disturbances. Underweight and obese women reported higher rates of menstrual irregularities compared to women with normal BMI. Specifically, 59.1% of underweight women reported disturbances, compared to 36.2% of normal-weight women, 44.4% of overweight women, and 63.6% of obese women. Logistic regression analysis, adjusting for age, geographic region, physical activity, and stress levels, indicated that underweight women had an odds ratio (OR) of 2.45 (95% CI: 1.42–4.21) and obese women an OR of 2.71 (95% CI: 1.62–4.53) for menstrual disturbances compared to normal-weight women. Overweight women had an OR of 1.37 (95% CI: 0.85–2.20), which was not statistically significant.

Regional analyses revealed variations in the BMI–menstrual disturbance relationship. In North America, obese women had the highest prevalence of menstrual disturbances (68%), while underweight women had a prevalence of 45%. Overweight women had a moderate prevalence of 42%. In Europe, both underweight (56%) and obese women (61%) reported elevated menstrual disturbances, with normal-weight women at 34%. In Asia, underweight women had the highest prevalence (64%), while obese women, though fewer in number, reported disturbances at 50%. These results suggest that both extremes of BMI are consistently associated with menstrual irregularities across international populations, though regional differences in prevalence exist due to variations in diet, lifestyle, and genetic factors.

Lifestyle factors, including physical activity, dietary patterns, and stress, were also analyzed in relation to menstrual health. Women engaging in less than 60 minutes of moderate-to-vigorous activity per week had a higher prevalence of menstrual disturbances (48%) compared to those meeting activity guidelines (36%). Low physical activity amplified the effect of obesity and underweight status on menstrual irregularities. Participants reporting irregular meals, high sugar intake, or low fruit and vegetable consumption had a 1.5-fold increased risk of menstrual disturbances (OR = 1.53, 95% CI: 1.07–2.18). High self-reported stress, assessed via a validated stress scale, was independently associated with menstrual disturbances (OR = 1.68, 95% CI: 1.12–2.52) and interacted with BMI to further increase risk, particularly among underweight women.

Different types of menstrual disturbances showed varying associations with BMI. Dysmenorrhea was more common among underweight (29.5%) and obese women (28.8%) compared to normal-weight women (19.6%). Irregular cycles were significantly higher in obese women (27.3%) and underweight women (22.7%). Amenorrhea was observed predominantly in underweight women (11.4%),

with fewer cases among obese women (6.1%). Menorrhagia was predominantly reported by obese women (15.2%) and less so among underweight women (4.5%). These patterns indicate that both low and high BMI are associated with distinct menstrual disturbances, reflecting different underlying hormonal mechanisms.

Multivariate logistic regression models confirmed that BMI, physical activity, diet, and stress were independent predictors of menstrual disturbances. Interaction terms suggested that lifestyle factors modified the effect of BMI on menstrual health, with high stress and low activity exacerbating irregularities in both underweight and obese women. The model explained approximately 28% of the variance in menstrual disturbances (Nagelkerke $R^2 = 0.28$), indicating a moderate predictive capacity.

The key findings indicate that 41.2% of the international sample reported menstrual disturbances, and both underweight and obese women had significantly higher prevalence of menstrual irregularities compared to normal-weight women. Dysmenorrhea was the most common disturbance, followed by irregular cycles, oligomenorrhea, and menorrhagia. Lifestyle factors, including physical inactivity, poor diet, and high stress, were independently associated with menstrual disturbances and interacted with BMI to exacerbate risk. Regional differences were observed, with underweight status more impactful in Asia and obesity more prominent in North America and Europe. These findings demonstrate a consistent association between BMI extremes and menstrual disturbances across international populations, highlighting the importance of maintaining a healthy BMI and lifestyle for optimal reproductive health.

Discussion

This study provides a comprehensive analysis of the relationship between Body Mass Index (BMI) and menstrual disturbances among women of reproductive age in an international context. The findings indicate that both extremes of BMI—underweight and obese—are associated with a higher prevalence of menstrual irregularities. Additionally, lifestyle factors, including physical activity, diet, and stress, were found to influence menstrual health, often interacting with BMI to exacerbate disturbances. The discussion below interprets these results, situates them within existing literature, explores potential mechanisms, considers implications for public health, and addresses the strengths and limitations of the study.

The observed prevalence of menstrual disturbances in this international sample was 41.2%, which aligns with prior studies reporting global prevalence rates ranging from 30% to 45%. Dysmenorrhea was the most common disturbance, followed by irregular cycles, oligomenorrhea, and menorrhagia. These findings are consistent with research indicating that menstrual pain is a widespread concern among reproductive-age women, affecting quality of life and daily functioning. The slightly higher prevalence in North America compared to Europe and Asia may reflect differences in lifestyle, diet, stress levels, and healthcare access, highlighting the importance of considering regional variation in menstrual health research.

The study confirms that underweight and obese women are at a higher risk for menstrual disturbances. Underweight women exhibited increased prevalence of amenorrhea, irregular cycles, and dysmenorrhea, consistent with previous studies linking low BMI to hypothalamic-pituitary-ovarian

axis dysfunction. In underweight individuals, reduced adipose tissue can lead to lower estrogen production, disrupting the normal hormonal feedback necessary for ovulation and regular menstruation. This mechanism may explain the higher incidence of amenorrhea observed in underweight participants, particularly among Asian women where undernutrition is more prevalent.

Obese women also showed elevated rates of menstrual disturbances, including dysmenorrhea, irregular cycles, and menorrhagia. Obesity is associated with hyperinsulinemia, insulin resistance, and increased androgen levels, which can contribute to menstrual irregularities and anovulation. The higher prevalence of obesity-related menstrual disturbances in North American participants is consistent with regional obesity rates and aligns with international research linking excess adiposity to reproductive dysfunction. Interestingly, overweight women had moderately increased odds of menstrual disturbances, but this was not statistically significant, suggesting that mild-to-moderate increases in BMI may have less impact on menstrual regulation than extremes of body weight.

Lifestyle factors played a significant role in modulating menstrual health. Low physical activity was associated with higher rates of disturbances, particularly among underweight and obese women. Regular exercise has been shown to influence hormonal balance, improve insulin sensitivity, and regulate ovulatory function, providing a potential protective effect against menstrual irregularities. Conversely, physical inactivity may exacerbate the hormonal imbalances associated with extreme BMI, leading to irregular cycles or dysmenorrhea. Dietary patterns were similarly influential, with irregular meals, high sugar intake, and low fruit and vegetable consumption linked to increased menstrual disturbances. These findings support prior research demonstrating that nutrition affects hormonal regulation, inflammatory pathways, and prostaglandin synthesis, all of which are relevant to menstrual cycle health.

Stress emerged as an independent predictor of menstrual disturbances, with high-stress participants reporting higher prevalence of irregular cycles, dysmenorrhea, and amenorrhea. Stress activates the hypothalamic-pituitary-adrenal axis, resulting in increased cortisol secretion, which can interfere with gonadotropin-releasing hormone pulses and ovulatory function. Interaction analyses indicated that stress amplified the effect of BMI extremes on menstrual irregularities, particularly in underweight women. This emphasizes the multifactorial nature of menstrual disturbances, highlighting the interplay between physiological and psychosocial factors.

Regional differences in the association between BMI and menstrual disturbances suggest that sociocultural, dietary, and genetic factors may modulate risk. In Asia, underweight status had a more pronounced impact on menstrual irregularities, while in North America and Europe, obesity was more strongly associated with disturbances. These differences may reflect variations in baseline BMI distribution, cultural dietary habits, and lifestyle factors such as exercise patterns and stress management. Furthermore, healthcare access and awareness of menstrual health may influence reporting and prevalence estimates across regions. The mechanisms linking BMI extremes to menstrual disturbances are primarily hormonal. In underweight women, low estrogen levels due to insufficient adipose

tissue reduce endometrial proliferation and may result in amenorrhea or oligomenorrhea. In obese women, excess adiposity leads to increased aromatization of androgens to estrogen, insulin resistance, and elevated androgen levels, which disrupt follicular development and ovulation. Both scenarios demonstrate that deviation from normal BMI can compromise reproductive endocrine function, ultimately affecting menstrual regularity.

These findings have important clinical and public health implications. Healthcare providers should consider BMI assessment as part of routine reproductive health evaluations. Early identification of underweight or obese individuals with menstrual disturbances can facilitate interventions such as nutritional counseling, weight management programs, stress reduction strategies, and tailored physical activity plans. Public health campaigns should emphasize the importance of maintaining a healthy weight and lifestyle to support reproductive health, particularly in populations at risk for extreme BMI. Furthermore, international differences in prevalence suggest that interventions should be culturally sensitive and context-specific.

The study has several strengths. It employed a large, international sample, allowing for cross-regional comparisons and generalization to diverse populations. The use of standardized BMI measurements and structured questionnaires enhanced data reliability. Statistical analyses accounted for potential confounders such as age, lifestyle factors, and geographic region, providing robust estimates of the association between BMI and menstrual disturbances. Nevertheless, there are limitations. The cross-sectional design precludes causal inference, meaning that while associations between BMI and menstrual disturbances were observed, the directionality cannot be confirmed. Menstrual history was self-reported, introducing potential recall bias. Hormonal and biochemical measurements were not collected, limiting the ability to explore physiological mechanisms in detail. The convenience sampling method, despite efforts to achieve international representation, may limit generalizability to the broader population. Additionally, cultural differences in reporting menstrual symptoms could influence prevalence estimates, particularly in regions where discussion of reproductive health is stigmatized.

Future research should employ longitudinal designs to assess causality and temporal relationships between BMI and menstrual disturbances. Inclusion of hormonal and metabolic biomarkers, such as estradiol, progesterone, insulin, and androgens, would provide mechanistic insight into the observed associations. Interventional studies examining the impact of weight management, dietary modification, stress reduction, and physical activity on menstrual health could further inform evidence-based guidelines. Investigating the role of genetic and epigenetic factors may also help explain regional differences in BMI-related menstrual disturbances.

In conclusion, this study demonstrates a clear association between BMI extremes and menstrual disturbances among women of reproductive age across international populations. Both underweight and obese women are at increased risk for menstrual irregularities, with lifestyle factors such as physical activity, diet, and stress modulating this relationship. Regional variations highlight the influence of sociocultural, dietary, and genetic factors on menstrual

health. These findings underscore the importance of maintaining a healthy BMI and lifestyle to support reproductive function and provide evidence for targeted clinical and public health interventions. The results contribute valuable knowledge to the field of international reproductive health, emphasizing the need for culturally sensitive, evidence-based strategies to reduce menstrual disturbances and improve overall well-being for women globally.

Conclusion

The study demonstrates a significant association between Body Mass Index (BMI) and menstrual disturbances among women of reproductive age across international populations. Both underweight and obese women were found to have a higher prevalence of menstrual irregularities, including dysmenorrhea, irregular cycles, oligomenorrhea, amenorrhea, and menorrhagia, compared to women with normal BMI. Lifestyle factors such as physical inactivity, poor dietary habits, and high stress levels were also independently associated with menstrual disturbances and appeared to exacerbate the effects of BMI extremes. Regional differences were observed, with underweight status more impactful in Asian populations and obesity more prevalent in North American and European participants, suggesting the influence of sociocultural, dietary, and genetic factors.

These findings underscore the importance of maintaining a healthy BMI and adopting supportive lifestyle behaviors to promote optimal reproductive health. Clinicians should incorporate BMI assessment, nutritional counseling, physical activity guidance, and stress management into routine reproductive health evaluations. Public health strategies should focus on culturally sensitive interventions that address both undernutrition and obesity to reduce menstrual disturbances globally.

Future research should employ longitudinal designs, include hormonal and metabolic biomarkers, and explore interventional strategies to better understand causal relationships and optimize menstrual health outcomes. Overall, this study contributes valuable international evidence linking BMI and menstrual health, providing a foundation for clinical practice and public health policies aimed at improving women's reproductive well-being.

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