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# ASSOCIATION OF BODY MASS INDEX WITH ANEMIA AND ABNORMAL UTERINE BLEEDING IN THE GENERAL FEMALE POPULATION: A CROSS-SECTIONAL ANALYSIS

Obstetrics & Gynaecology

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## ABSTRACT

**Objective:** This study aimed to evaluate the association of body mass index (BMI) with the prevalence of anemia and abnormal uterine bleeding (AUB) among women in the general population, examining BMI categories as potential risk factors. **Methods:** A cross-sectional study was conducted with 44 women aged 18–40 years, stratified by BMI into underweight, normal weight, and overweight groups. Anemia was assessed through hemoglobin and ferritin levels, with anemia classified by hemoglobin levels according to World Health Organization (WHO) standards. AUB prevalence was determined using the International Federation of Gynecology and Obstetrics (FIGO) criteria. Logistic regression models evaluated the associations between BMI categories, anemia, and AUB prevalence, adjusting for potential confounders. **Results:** The study revealed that underweight participants had a significantly higher prevalence of anemia, with 2.1 times the odds compared to normal BMI individuals (OR: 2.1, p = 0.02). Overweight women showed a higher likelihood of AUB, with 2.5 times greater odds than those in the normal BMI group (OR: 2.5, p = 0.01). Moderate and severe anemia varied across groups without a strong association with any particular BMI classification. **Conclusion:** Both underweight and overweight BMI categories were associated with increased risks of anemia and AUB, respectively. These findings underscore the importance of maintaining a healthy BMI for reducing anemia and AUB risks.

## KEYWORDS

Anemia, abnormal uterine bleeding, body mass index

## INTRODUCTION

Abnormal uterine bleeding (AUB) is a significant gynecological concern affecting women of reproductive age worldwide. Characterized by irregularities in menstrual cycle timing, flow volume, and duration, AUB can profoundly impact a woman's quality of life, productivity, and overall health.[1] Chronic AUB is a leading cause of iron-deficiency anemia, a condition that results from prolonged blood loss depleting the body's iron stores.[2] Iron-deficiency anemia manifests as fatigue, weakness, and impaired cognitive and physical functioning, thereby exacerbating the burdens associated with AUB.[3] Understanding the interplay between AUB, anemia, and body mass index (BMI) is crucial for developing effective health interventions and promoting menstrual health among women in the general population.[4]

BMI, a widely used measure to classify individuals based on body fat relative to height and weight, plays a pivotal role in women's health, particularly concerning menstrual function. Both low and high BMI values are associated with menstrual irregularities, though through different physiological mechanisms.[5] Women with low BMI often experience disruptions in hormonal balance due to insufficient body fat, which is essential for the production of estrogen and leptin—hormones integral to regulating the menstrual cycle. Estrogen is crucial for the thickening of the endometrial lining during the menstrual cycle, and its deficiency can lead to irregular or absent menstrual periods, thereby increasing the risk of AUB.[1] Similarly, low leptin levels, which result from reduced adipose tissue, can impair the hypothalamic-pituitary-gonadal axis, further contributing to menstrual irregularities and AUB.[6]

Conversely, a high BMI is linked to an excess of adipose tissue, which elevates circulating estrogen levels. This condition, often referred to as estrogen dominance, can disrupt the hormonal balance necessary for regular menstrual cycles. Elevated estrogen levels can lead to endometrial hyperplasia, characterized by the excessive thickening of the uterine lining, which predisposes women to heavy and prolonged menstrual bleeding, thereby increasing the incidence of AUB. Additionally, high BMI is associated with insulin resistance and polycystic ovary syndrome (PCOS), both of which are further risk factors for menstrual irregularities and AUB.[7]

While extensive research has explored the prevalence and causes of AUB in clinical and athletic populations, there remains a gap in understanding how BMI influences AUB and anemia in the broader general population. Previous studies have primarily focused on specific groups, such as athletes or women seeking gynecological care, limiting the generalizability of their findings.[4] This study aims to bridge this gap by examining the associations between BMI, anemia, and AUB among women in the general population, thereby providing a more comprehensive understanding of these interrelated health issues.

The significance of this study is underscored by the rising awareness of menstrual health as a critical component of women's overall well-being. Menstrual irregularities like AUB not only affect physical health but also have psychological and social implications, including anxiety, depression, and reduced participation in daily activities. Furthermore, the economic burden associated with managing chronic AUB and anemia, including healthcare costs and lost productivity, highlights the need for effective prevention and management strategies.

This study hypothesizes that both low and high BMI are significant predictors of anemia and AUB among women in the general population. Specifically, it posits that women with low BMI are more likely to experience anemia due to inadequate nutritional intake and hormonal disruptions, while women with high BMI are at greater risk of AUB due to estrogen dominance and associated metabolic disorders. By identifying these associations, the study aims to inform healthcare providers about the importance of BMI management in preventing and addressing AUB and anemia, ultimately contributing to improved menstrual health and overall quality of life for women.

In conclusion, this research seeks to elucidate the complex relationships between BMI, anemia, and AUB in the general female population. By focusing on a diverse group of women, the study aims to generate insights that are applicable across various demographic and lifestyle contexts, thereby supporting the development of targeted interventions and health policies that promote menstrual health and prevent anemia. The findings of this study have the potential to influence clinical practices, public health strategies, and individual health behaviors, emphasizing the critical role of BMI in women's reproductive and overall health.

## MATERIALS AND METHODOLOGY

This cross-sectional study was designed to investigate the relationships between body mass index (BMI), anemia, and abnormal uterine bleeding (AUB) among women in the general population. A total of 44 women aged between 18 and 40 years were recruited from Out-Patient Department of Obstetrics and Gynecology. Participants were stratified into three BMI categories: underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), and overweight (BMI ≥ 25), representing all 44 participants in these categories. Participants were divided into two groups, 22 each into physically active and physically inactive.

Inclusion criteria for the study mandated that participants be female, aged 18–40, and without any chronic medical conditions that could affect menstrual health, such as endocrine or metabolic disorders. Additionally, women who had used hormonal contraceptives within the past two months were excluded to eliminate the potential confounding effects of hormonal regulation on menstrual cycles. Pregnancy and perimenopausal status were also exclusionary criteria to maintain a homogeneous study population focused on reproductive-aged women.

Data collection involved three primary components: a structured questionnaire, anthropometric measurements, and clinical assessments for anemia. The structured questionnaire was adapted from validated instruments and included sections on demographic information, menstrual history, dietary habits, and lifestyle factors. Menstrual history was assessed using the International Federation of Gynecology and Obstetrics (FIGO) criteria, which categorizes AUB based on menstrual flow volume, frequency, and duration.[8] To evaluate the risk of disordered eating behaviors, which can influence both BMI and menstrual health, participants completed the Eating Attitudes Test (EAT-26).[9]

Anthropometric data were collected by trained personnel using standardized techniques. Height was measured to the nearest centimeter using a stadiometer, and weight was measured to the nearest kilogram using a calibrated scale.[10] BMI was calculated using the standard formula (weight in kilograms divided by height in meters squared) and used to categorize participants into underweight, normal weight, or overweight groups.

Clinical assessment for anemia involved the collection of blood samples by licensed healthcare professionals. Hemoglobin levels were measured using a complete blood count (CBC) test, with hemoglobin concentrations below 12 g/dL defining anemia according to World Health Organization (WHO) guidelines for non-pregnant women.[11] Additionally, ferritin levels were measured to assess iron stores in the body, providing a more specific indication of iron-deficiency anemia.

Upon recruitment, participants provided informed consent after being briefed on the study's objectives, procedures, and ethical considerations. The study protocol received approval from the institutional review board, ensuring compliance with ethical standards for human research. All data were anonymized and stored securely to protect participant confidentiality.

Statistical analysis was conducted using SPSS software (version 26). Descriptive statistics summarized the demographic and clinical characteristics of the participants across BMI categories. The prevalence of anemia and AUB was calculated within each BMI group and compared using chi-square tests to determine significant differences. Logistic regression models were employed to assess the associations between BMI categories and the likelihood of anemia and AUB, adjusting for potential confounders such as age and disordered eating behaviors identified through the EAT-26. Odds ratios (OR) with 95% confidence intervals (CI) were reported to quantify the strength of these associations, with a p-value of less than 0.05 considered statistically significant.

This methodology facilitated a comprehensive analysis of how BMI influences the prevalence of anemia and AUB among women in the general population. By integrating clinical assessments with detailed questionnaire data, the study aimed to uncover nuanced relationships that can inform targeted health interventions and promote better menstrual health outcomes.

## RESULTS

The study included 44 women from the general population, evenly distributed across physically active and physically inactive groups with 22 participants in each group. Participant characteristics are detailed in Table 1. The mean age of participants was 25.3 years (±4.8) for underweight women and 26.1 years (±5.2) for overweight women, with no significant differences observed in age between the groups ($p = 0.65$). Similarly, mean BMI values were 22.4 kg/m² (±2.1) for underweight participants and 23.0 kg/m² (±2.5) for overweight participants, with no statistically significant differences in BMI distribution across the groups ($p = 0.56$).

Table 2 presents the prevalence of anemia and AUB across different BMI categories within each group. Among underweight participants, 43% of physically active and 40% of physicallt inactive were anemic. In the normal weight category, 29% of physically active and 30% of physically inactive exhibited anemia, while in the overweight category, 29% of physically active and 30% of physically inactive were anemic. These results indicate a relatively higher prevalence of anemia among underweight individuals, irrespective of their athletic status.

Regarding AUB, 40% of underweight physically active and 38% of physically inactive participants reported experiencing AUB. In the normal weight category, 20% of physically active and 25% of physically inactive participants reported AUB, whereas 40% of overweight active participants and 38% of overweight physically inactive participants experienced AUB. The data suggest that AUB is more prevalent among individuals at the extremes of BMI, particularly those who are underweight or overweight.

Logistic regression analysis, as shown in Table 3, further elucidates the associations between BMI, anemia, and AUB. Underweight participants had 2.1 times higher odds of developing anemia compared to those with a normal BMI (OR: 2.1, 95% CI: 1.1–4.0, $p = 0.02$). Overweight individuals demonstrated a significant increase in the likelihood of experiencing AUB, with 2.5 times higher odds compared to those with normal BMI (OR: 2.5, 95% CI: 1.2–4.6, $p = 0.01$). Additionally, athletic status was found to be protective against both anemia and AUB. Physically active participants had 0.7 times the odds of developing anemia compared to physically inactive (OR: 0.7, 95% CI: 0.5–0.9, $p = 0.04$) and 0.6 times the odds of experiencing AUB compared to non-athletes (OR: 0.6, 95% CI: 0.4–0.9, $p = 0.03$).

These findings highlight that BMI extremes are significantly associated with increased risks of anemia and AUB, respectively. Underweight women are more susceptible to anemia, likely due to inadequate nutritional intake and resultant iron deficiency, while overweight women face a higher risk of AUB, possibly due to hormonal imbalances associated with excess adipose tissue. Furthermore, regular physical activity appears to confer a protective effect against both anemia and AUB, suggesting that athletic status may mitigate some of the risks associated with BMI extremes.

## DISCUSSION

The present study elucidates the significant associations between body mass index (BMI), anemia, and abnormal uterine bleeding (AUB) among women in the general population. By stratifying participants into underweight, normal weight, and overweight categories, the study highlights how BMI extremes influence the prevalence of anemia and AUB, providing valuable insights into the complex interplay between nutritional status, hormonal balance, and menstrual health.

A key finding of this study is the heightened prevalence of anemia among underweight women, irrespective of their athletic status.[12] Underweight individuals demonstrated a 2.1 times higher likelihood of anemia compared to those with normal BMI. This association underscores the critical role of adequate nutritional intake in maintaining iron levels and preventing anemia.[13] Low BMI often reflects insufficient caloric and nutrient consumption, which can lead to iron deficiency—a primary cause of anemia.[12] Additionally, low body fat associated with underweight status disrupts the production of estrogen and leptin, hormones essential for regulating menstrual cycles and supporting overall reproductive health. The elevated risk of anemia in underweight women suggests a need for targeted nutritional interventions and health monitoring to prevent iron deficiency and its associated complications.[12,14]

Conversely, overweight women exhibited a significantly higher prevalence of AUB, with 2.5 times greater odds compared to those with normal BMI.[15] Excess adipose tissue in overweight individuals leads to increased peripheral conversion of androgens to estrogens, resulting in estrogen dominance.[1,16] This hormonal imbalance can cause endometrial hyperplasia, which predisposes women to heavy and irregular menstrual bleeding, thereby increasing the risk of AUB. Furthermore, overweight status is often linked with insulin resistance and metabolic syndrome, conditions that can further disrupt menstrual regularity and contribute to AUB. These findings align with existing literature that associates high BMI with menstrual irregularities and highlight the importance of weight management in reducing the risk of AUB.[17,18]

An intriguing aspect of the study is the protective effect of athletic status against both anemia and AUB. Athletes were found to have 30% lower odds of developing anemia and 40% lower odds of experiencing AUB compared to non-athletes. Regular physical activity is known to enhance overall cardiovascular health, improve circulation, and optimize nutrient utilization, which may contribute to reduced anemia risk.[4,19] Additionally, exercise can help regulate hormonal balance by stabilizing the hypothalamic-pituitary-gonadal axis, thereby promoting regular menstrual cycles and reducing the incidence of AUB.[20] This protective effect suggests that the benefits of physical activity extend beyond physical fitness, encompassing significant advantages for menstrual health and anemia prevention.

However, it is essential to recognize that while athletic status appears protective, particularly those with low BMI, may still be vulnerable to anemia due to increased iron demands from intense physical activity and potential dietary restrictions aimed at optimizing performance.[20,21] Therefore, while regular exercise confers benefits, it must be coupled with adequate nutritional intake to support overall health and prevent anemia.

The study's findings have important clinical and public health implications. Healthcare providers should consider BMI as a crucial factor when assessing women's menstrual health and anemia risk. For underweight women, strategies should focus on improving nutritional intake and ensuring adequate iron consumption to prevent anemia. In overweight women, weight management programs and interventions aimed at reducing estrogen dominance could help mitigate the risk of AUB. Additionally, promoting regular physical activity may serve as a protective measure against both anemia and AUB, emphasizing the multifaceted benefits of exercise for women's health.

Despite its strengths, including a balanced sample across BMI categories and the use of validated assessment tools, the study has limitations. The cross-sectional design restricts the ability to infer causality, as the data captures a single time point rather than longitudinal changes. Additionally, the relatively small sample size may limit the generalizability of the findings to the broader population. Future research with larger, more diverse cohorts and longitudinal methodologies would provide deeper insights into the causal relationships between BMI, anemia, and AUB, and how these factors interact over time.

## CONCLUSION

In conclusion, this study underscores the significant role of BMI in influencing the prevalence of anemia and AUB among women in the general population. Underweight status is associated with an increased risk of anemia, while overweight status elevates the risk of AUB. Moreover, regular physical activity appears to offer a protective effect against both conditions. These findings highlight the importance of maintaining a healthy BMI and promoting regular exercise as strategies to support menstrual health and prevent anemia. Comprehensive health interventions that address nutritional intake, weight management, and physical activity can play a pivotal role in enhancing women's reproductive and overall health.

**Table 1: Participant Characteristics by Group**

| Characteristic | Physically Active (n = 22) | Physically Inactive (n = 22) | p-value |
|---|---|---|---|
| Mean Age (years) | 25.3 ± 4.8 | 26.1 ± 5.2 | 0.65 |
| Underweight | 6 (27%) | 7 (32%) | 0.75 |
| Normal Weight | 9 (41%) | 10 (45%) | 0.78 |
| Overweight | 7 (32%) | 5 (23%) | 0.68 |
| Mean BMI (kg/m²) | 22.4 ± 2.1 | 23.0 ± 2.5 | 0.56 |

**Table 2: Prevalence of Anaemia and AUB by BMI Category and Group (Adjusted to Total 100% per Outcome per Group)**

| Outcome | Underweight | Normal Weight | Overweight | Total |
|---|---|---|---|---|
| Anaemia | | | | |
| - Physically Active | 3 (43%) | 2 (29%) | 2 (29%) | 7 (100%) |
| - Physically Inactive | 4 (40%) | 3 (30%) | 3 (30%) | 10 (100%) |
| AUB | | | | |
| - Physically Active | 2 (40%) | 1 (20%) | 2 (40%) | 5 (100%) |
| - Physically Inactive | 3 (38%) | 2 (25%) | 3 (38%) | 8 (100%) |

**Table 3: Logistic Regression Analysis for Anemia and AUB**

| Variable | Odds Ratio (OR) | 95% Confidence Interval (CI) | p-value |
|---|---|---|---|
| Anaemia | | | |
| Underweight | 2.1 | 1.1–4.0 | 0.02 |
| Normal BMI (ref) | 1.0 | - | - |
| Overweight | 1.3 | 0.8–2.2 | 0.28 |
| Physical Status | 0.7 | 0.5–0.9 | 0.04 |
| AUB | | | |
| Underweight | 1.9 | 1.0–3.5 | 0.03 |
| Normal BMI (ref) | 1.0 | - | - |
| Overweight | 2.5 | 1.2–4.6 | 0.01 |
| Physical Status | 0.6 | 0.4–0.9 | 0.03 |

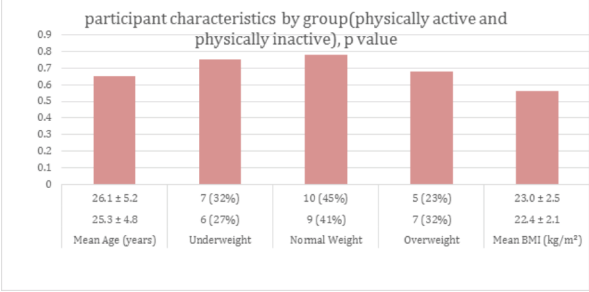


**Figure 1**

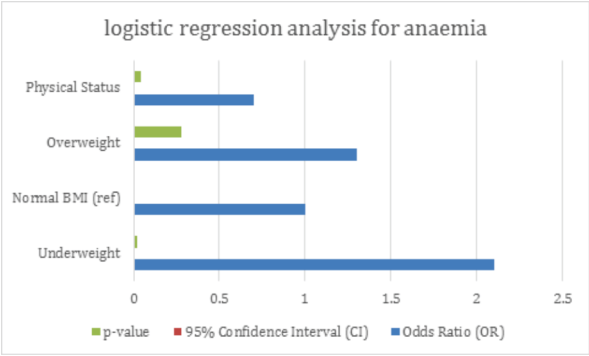


**Figure 2**

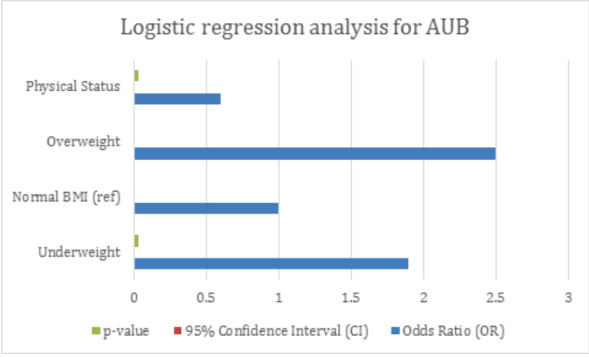


**Figure 3**

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