OPEN ACCESS

Scholars International Journal of Obstetrics and Gynecology

Abbreviated Key Title: Sch Int J Obstet Gynec
ISSN 2616-8235 (Print) |ISSN 2617-3492 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Correlation of Anthropometric Variables with Abnormal Menstrual Flow among University Students

Willy BarinemVidona[1], John Nwolim Paul[2]*, Fasten Isimemen Akhimien[1], Happy Inegbenose Ikhajiangbe[3], Udo Orukwowu[4], Idawarifa Frank Cooky-Gam[4], Helen Nwoburuoke Wama[4], Deborah Akinola Umogbai[5], Anelechi Kenneth Madume[6], Osaat Roseline Sunday[7], Mercy Kelechi Azumah[4], Simeon Chijioke Amadi[8]

[1]Department of Anatomy, Ambrose Alli University Ekpoma, Edo State, Nigeria
[2]Department of Anatomy, Faculty of Basic Medical Sciences, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria
[3]Department of Physiology, Ambrose Alli University Ekpoma, Edo State, Nigeria
[4]Department of Nursing Science, Faculty of Basic Medical Sciences, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria
[5]World Health Organization, Rivers State, Nigeria
[6]Department of Physiotherapy, Faculty of Basic Medical Sciences, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria
[7]Department of Anatomy, Faculty of Basic Medical Sciences, Federal University Otuoke, Bayelsa State, Nigeria
[8]Department of Obstetrics and Gynecology, Faculty of Clinical Sciences, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria

DOI: https://doi.org/10.36348/sijog.2026.v09i02.002 | **Received:** 28.11.2025 | **Accepted:** 20.01.2026 | **Published:** 10.02.2026

***Corresponding author:** John Nwolim Paul
Department of Anatomy, Faculty of Basic Medical Sciences, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria

Abstract

Abnormal menstrual flow is a common concern among young women, especially in academically demanding environments. Despite growing awareness of the impact of nutrition and body composition on reproductive health, there remains a scarcity of localized data, particularly in sub-Saharan Africa, exploring how anthropometric indices correlate with menstrual disturbances. To investigate the relationship between anthropometric variables Body Mass Index (BMI), waist circumference, waist-to-hip ratio (WHR), and body fat percentage and abnormal menstrual flow among female students in the College of Medicine, Ambrose Alli University. A cross-sectional descriptive study was conducted among 408 female medical undergraduates selected using multistage random sampling. Data were collected via a validated self-administered questionnaire and anthropometric measurements. Descriptive statistics, Pearson's correlation, logistic regression, and ROC analyses were performed using SPSS v25, with significance set at $p < 0.05$. The prevalence of AMF was 68.9%, with menorrhagia (31.4%) being most common. Over 30% of respondents had elevated body fat, and 25% were overweight. Positive correlations were observed between BMI, waist circumference, WHR, body fat %, and specific AMF types (particularly menorrhagia and polymenorrhea). Logistic regression revealed waist circumference >88 cm and body fat ≥30% as strong independent predictors. ROC analysis indicated body fat % had the highest diagnostic accuracy (AUC = 0.81), followed by waist circumference (AUC = 0.77). Anthropometric measures especially body fat percentage and central adiposity are significantly associated with abnormal menstrual flow. These findings highlight the need for routine body composition screening and menstrual health education in university health services.

Keywords: Abnormal Menstrual Flow, Anthropometry, Body Fat Percentage, University Students, Menorrhagia, Central Adiposity.

INTRODUCTION

The menstrual cycle is a vital physiological process in females, serving as an indicator of reproductive health and broader systemic well-being. Typically lasting between 21 to 35 days with a bleeding duration of 3 to 7 days, the cycle is regulated by a complex neuroendocrine interplay involving the hypothalamic-pituitary-ovarian axis (Munro *et al*.,

2011). Any disturbance in this hormonal feedback system may result in deviations from the normal menstrual pattern, often classified as abnormal menstrual flow. Abnormalities may include excessive or prolonged bleeding (menorrhagia), absence of menstruation (amenorrhea), infrequent menstruation (oligomenorrhea), or cycles that are too short (polymenorrhea), each of which may significantly impact the physical, emotional, academic, and social functioning of young women (Slap, 2003).

In university environments, particularly within medical schools, menstrual irregularities are common among female students due to numerous physiological and psychosocial stressors. These students often navigate a combination of academic pressure, sleep disturbances, irregular dietary habits, and reduced physical activity, all of which may contribute to menstrual cycle dysfunction (Hamaideh *et al*., 2014). Among the contributing factors, anthropometric indices such as body mass index (BMI), waist-to-hip ratio (WHR), waist circumference, height, weight, and body fat percentage have gained increasing attention as important predictors of menstrual health outcomes.

Anthropometric variables serve as proxy indicators of an individual's nutritional and metabolic status. They are cost-effective, easy to measure, and valuable in epidemiological and clinical studies. BMI, the most commonly used index, has been shown to affect the onset and regularity of the menstrual cycle. Both underweight (BMI <18.5 kg/m²) and overweight/obese (BMI ≥25 kg/m²) individuals are more likely to experience menstrual irregularities due to disruptions in hormonal pathways that control ovulation and menstruation (Frisch, 2004; Della Torre *et al*., 2018). Excess adipose tissue in overweight individuals acts as an endocrine organ, producing estrogen through aromatization, which may lead to estrogen dominance and anovulatory cycles (Pasquali, 2006). Conversely, undernutrition impairs gonadotropin-releasing hormone (GnRH) pulsatility, resulting in hypoestrogenism and amenorrhea (Loucks, 2006). Waist-to-hip ratio (WHR), another critical anthropometric index, reflects fat distribution patterns. Central or abdominal adiposity, which leads to increased WHR, is associated with insulin resistance and hyperinsulinemia, both of which can interfere with ovarian function and cause menstrual abnormalities (Asgharnia *et al*., 2013). Studies have also indicated that fat distribution, particularly visceral fat accumulation, may be more closely related to menstrual dysfunction than general adiposity as measured by BMI (Hoeger *et al*., 2008). Waist circumference alone, a strong predictor of metabolic risk, is similarly implicated in menstrual disorders. Within the context of university populations, particularly students in health-related faculties, it is essential to explore how body composition may interact with reproductive physiology. Medical students, though presumably well-informed about health matters, are not exempt from physiological stressors that accompany rigorous academic training. Studies conducted in Nigerian university settings have reported a prevalence of menstrual disorders ranging from 20% to 45% among young adult females (Amu & Bamidele, 2014; Amisi *et al*., 2024). These irregularities not only affect academic performance but may also serve as early indicators of underlying endocrine or metabolic conditions such as polycystic ovary syndrome (PCOS), thyroid dysfunction, or premature ovarian insufficiency (Rafique & Al-Sheikh, 2018). Female medical and allied health students represent a population under continuous academic and lifestyle-related stress, which may influence both their anthropometric profiles and menstrual health. Despite the apparent importance of this relationship, there is a paucity of local data exploring the correlation between anthropometric measures and abnormal menstrual flow within this demographic. Understanding this relationship could support the development of targeted health education, screening programs, and interventions aimed at improving menstrual health and overall well-being among university students. Moreover, early identification of anthropometric risk factors could aid in preventing long-term reproductive and metabolic complications. There is growing evidence that menstrual irregularities during adolescence and early adulthood may predispose women to infertility, cardiovascular disease, and type 2 diabetes later in life (Solomon *et al*., 2002). Hence, investigating these associations in young adults is not only relevant for immediate academic and psychosocial outcomes but also for the long-term public health implications. sociocultural beliefs surrounding menstruation, body image, and weight may influence students' willingness to seek medical care or adopt healthy lifestyle changes. In many African settings, there is a lack of open discussion around menstrual health, which may lead to normalization of irregularities and delayed diagnosis of underlying conditions (Liu *et al*., 2024). Therefore, a study exploring both the physical (anthropometric) and reproductive (menstrual) health aspects within a medical university context could help de-stigmatize these issues and foster a more holistic approach to female student wellness.

The objective of this study is to determine the relationship between selected anthropometric variables and abnormal menstrual flow among female students with Specific Objectives of estimating the prevalence of each type of abnormal menstrual flow (menorrhagia, oligomenorrhea, polymenorrhea, metrorrhagia) among the study population; describe the distribution of key anthropometric indices BMI, waist circumference, waist-to-hip ratio, and body fat percentage among female medical undergraduates; assess the bivariate correlations between each anthropometric measure and the presence of abnormal menstrual flow; identify, via multivariate regression analysis, which anthropometric variable(s) independently predict the likelihood of reporting abnormal menstrual flow.

The significance of the findings of this study will directly inform campus health initiatives by identifying which measurable, modifiable aspects of body composition are most closely linked to disturbances in menstrual bleeding among medical students. By establishing clear anthropometric thresholds such as BMI, waist circumference, WHR, and body fat percentagecampus clinics can implement targeted screening protocols to flag students at higher risk for menorrhagia, oligomenorrhea, polymenorrhea, or metrorrhagia. Early identification means that at-risk students can receive timely counseling on nutrition, exercise, and stress management, reducing absenteeism, improving academic performance, and alleviating the psychological burden that often accompanies menstrual disorders.

On a broader level, this research underscores the role of menstrual patterns as a "vital sign" and highlights how simple body-measurement tools can serve as proxies for reproductive and metabolic health. By demonstrating the long-term implications of adolescent and young-adult menstrual irregularities including future infertility, cardiometabolic disease, and endocrine dysfunction. This work advocates for integrating anthropometric monitoring into routine student health services. The evidence generated will support policy recommendations for regular menstrual and body-composition assessments in university settings, ultimately contributing to better long-term health outcomes and reduced healthcare costs for young women both on campus and beyond.

MATERIALS AND METHOD

Research Design

The study adopted a descriptive cross-sectional survey design. This design was deemed appropriate for the investigation as it allowed the researcher to collect and analyze data on anthropometric variables and menstrual flow patterns simultaneously from a population at a single point in time. It also facilitated the identification of any potential correlation between body composition and abnormal menstrual flow among the target population.

Population of the Study

The population for this study comprised all female undergraduate students within the College of Medicine at Ambrose Alli University, Ekpoma. This population includes students from departments such as Medicine and Surgery, Anatomy, Physiology, Nursing Science, Medical Laboratory Science, and other related programmes. These individuals were considered appropriate for the study due to their likely awareness of health and body-related issues and their accessibility for anthropometric assessment and questionnaire administration. Furthermore, this population group is within the age range typically associated with menstruation and related disorders, thereby increasing the relevance of the data obtained.

Sample Size and Sampling Technique

The sample size for the study was calculated using the Cochran formula for sample size determination for a finite population. Assuming a 95% confidence level, a 5% margin of error, and a presumed prevalence of abnormal menstrual flow at 50% for maximum variability, the sample size was estimated. Considering possible attrition or incomplete responses, a buffer was included, bringing the final target sample size to approximately 384 participants. A multistage sampling technique was employed to ensure representativeness. In the first stage, departments were stratified into clinical and pre-clinical categories. From each stratum, departments were randomly selected. Thereafter, simple random sampling was used to select participants from each department based on proportional representation. This approach ensured that the sample reflected a broad cross-section of students in various academic levels and disciplines within the College of Medicine.

$$n = \{\{Z^2 * p * (1 - p)\}\}/\{\{d^2\}\}$$

Where:

$Z = 1.96$ for 95% confidence level

$p = 0.5$ (assumed prevalence of AMF for maximum variability)

$d = 0.05$ (margin of error)

$$n = \{\{(1.96)^2 * 0.5*(1 - 0.5)\}\}/\{\{(0.05)^2\}\} = 384.16$$

To account for non-responses, a 10% buffer was added, resulting in a final sample size of approximately 422 respondents.

Inclusion and Exclusion Criteria

Participants included in the study were female students currently enrolled in the College of Medicine, aged between 16 and 30 years, who had experienced menstruation for at least the past 12 months. They were required to give informed consent and be available for both questionnaire completion and anthropometric assessment. Exclusion criteria included students who were pregnant, on hormonal contraceptives or medications known to affect menstrual cycles, those with known gynecological disorders unrelated to menstruation, or who declined to participate.

Instrument for Data Collection

The instruments used for data collection consisted of a structured, self-administered questionnaire and a set of anthropometric measurement tools. The questionnaire was developed based on a review of relevant literature and validated instruments. It was divided into sections covering sociodemographic information, menstrual history, characteristics of menstrual flow, associated symptoms, lifestyle habits, and physical activity. Questions related to menstrual disorders were adapted in part from standardized tools used in similar studies (Amisi *et al*., 2024; Liu *et al*., 2024). Anthropometric variables measured included weight, height, waist circumference, hip circumference, and calculated indices such as Body Mass Index (BMI)

and Waist-to-Hip Ratio (WHR). Weight was measured using a calibrated digital weighing scale, and height was assessed using a portable stadiometer. Waist and hip circumferences were measured with a flexible, non-stretchable measuring tape following WHO standardized procedures.

Questionaire Sections

Section A: Sociodemographic Data – Captures age, department, year of study, marital status, and residence (on-campus/off-campus).

Section B: Menstrual History and Flow Characteristics – Assesses age at menarche, regularity of menstrual cycles, duration and volume of bleeding, presence of clots, and associated symptoms (e.g., dysmenorrhea, nausea).

Section C: Lifestyle and Nutrition – Includes questions on dietary habits (junk food consumption, fruits/vegetables, hydration), sleep patterns, physical activity levels, and use of alcohol or stimulants.

Section D: Psychological Stress and Coping – Contains validated items adapted from the Perceived Stress Scale (PSS) to assess academic stress, anxiety, and coping strategies.

Section E: Anthropometric and Health Status – Involves measured height, weight, waist and hip circumference, and self-reported history of chronic conditions or use of hormonal medications.

Validity and Reliability of Instrument

To ensure content validity, the questionnaire was subjected to expert review by professionals in public health, physiology, and medical research. Pre-testing of the questionnaire was conducted among a small group of female students (approximately 10% of the sample size) from a nearby tertiary institution not included in the main study. Feedback from this pilot phase helped refine ambiguous or misleading questions and improve the clarity and flow of the instrument. Reliability of the instrument was determined using Cronbach's alpha for internal consistency, particularly for the scales assessing menstrual characteristics and lifestyle habits. A Cronbach's alpha of 0.78 was obtained, indicating acceptable reliability for the study instruments.

Method of Data Collection

Data collection occurred over a six-week period within the university environment. Prior to data collection, ethical clearance was obtained, and administrative permissions were secured from the Faculty of Basic Medical Sciences and the Office of the Dean of the College of Medicine. Participants were approached in their lecture halls and hostels. After obtaining informed consent, each participant completed the structured questionnaire. Subsequently, anthropometric measurements were taken in a private setting to ensure confidentiality and comfort. Female research assistants were trained to administer the questionnaire and perform the physical measurements to reduce participant discomfort and ensure consistency in data collection procedures. All measurements were taken twice, and the average value was recorded. Care was taken to ensure privacy and hygiene, including the use of disposable materials and disinfection of equipment between uses.

Method of Data Analysis

Data were coded and entered into the Statistical Package for Social Sciences (SPSS) version 25.0 for analysis. Descriptive statistics such as frequencies, means, and standard deviations were used to summarize sociodemographic characteristics, menstrual patterns, and anthropometric data. Inferential statistics were employed to test the hypotheses of the study. Pearson correlation coefficients were used to assess the relationship between anthropometric variables (BMI, WHR, waist circumference, etc.) and indicators of abnormal menstrual flow (menstrual duration, volume, frequency, and dysmenorrhea). Multiple regression analysis was conducted to identify which anthropometric factors best predicted the occurrence of abnormal menstrual flow. Significance was set at a p-value of less than 0.05. Results were presented in the form of tables and charts where appropriate.

Ethical Considerations

The study adhered strictly to ethical standards for research involving human participants. Ethical approval (No:155/25) was obtained from the Ambrose Alli University Research Ethics Committee. Participants were provided with a comprehensive informed consent form explaining the purpose of the study, confidentiality of responses, voluntary nature of participation, and the right to withdraw at any time without penalty. All data were anonymized, and codes were used in place of names to maintain participant confidentiality. Data were securely stored, and only the researcher and designated supervisors had access. Participants were assured that results would be used solely for academic and scientific purposes and that no individual-level data would be disclosed.

RESULT AND ANALYSIS

Socio-Demographic Characteristics of Respondents

Out of the 422 questionnaires distributed, 408 were properly completed and included in the final analysis, representing a response rate of 96.7%.

Table 1

Variable	Frequency (n = 408)	Percentage (%)
Age (mean ± SD)	21.7 ± 2.3 years	–
Year of Study		
100 Level	61	15.0
200 Level	86	21.1
300 Level	79	19.4
400 Level	96	23.5
500 Level	86	21.1
Department		
Medicine	175	42.9
Nursing	85	20.8
Medical Laboratory Science	78	19.1
Physiology/Anatomy	70	17.2

Prevalence of Abnormal Menstrual Flow

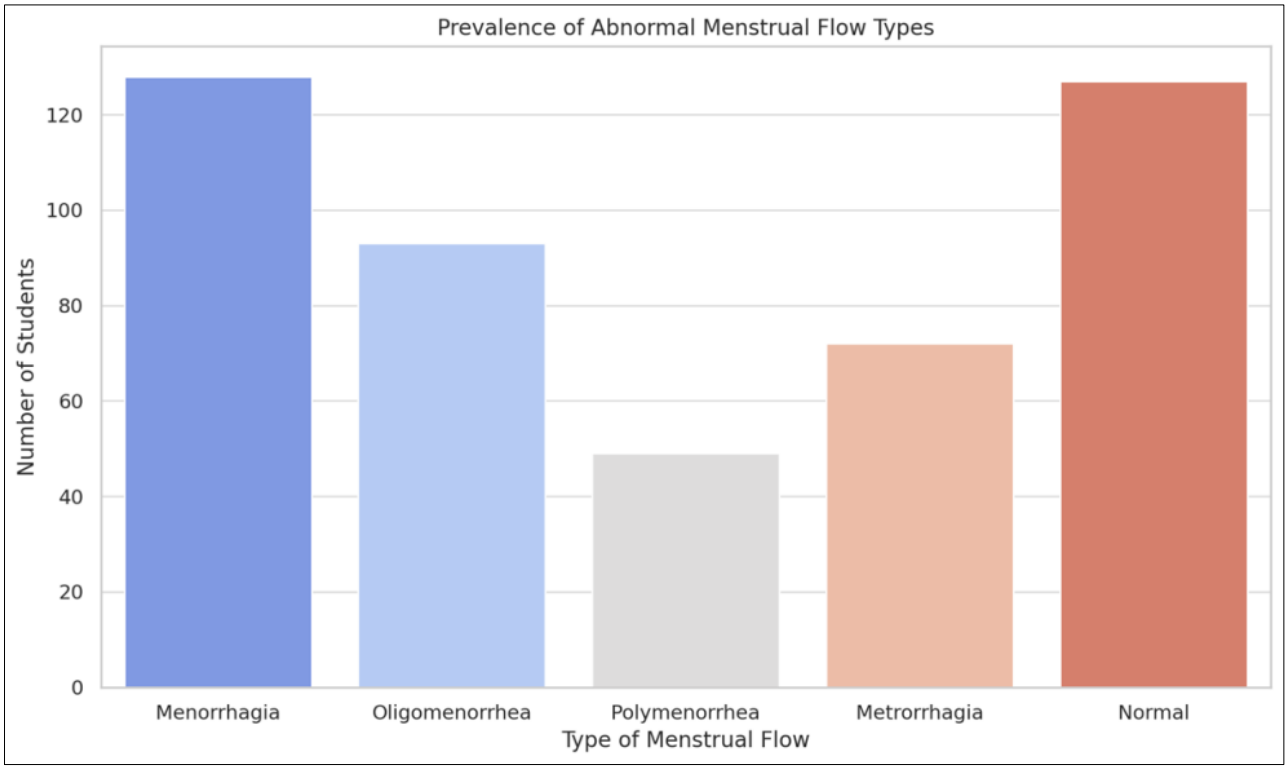


Figure 1: Prevalence of Abnormal Menstrual Flow Types

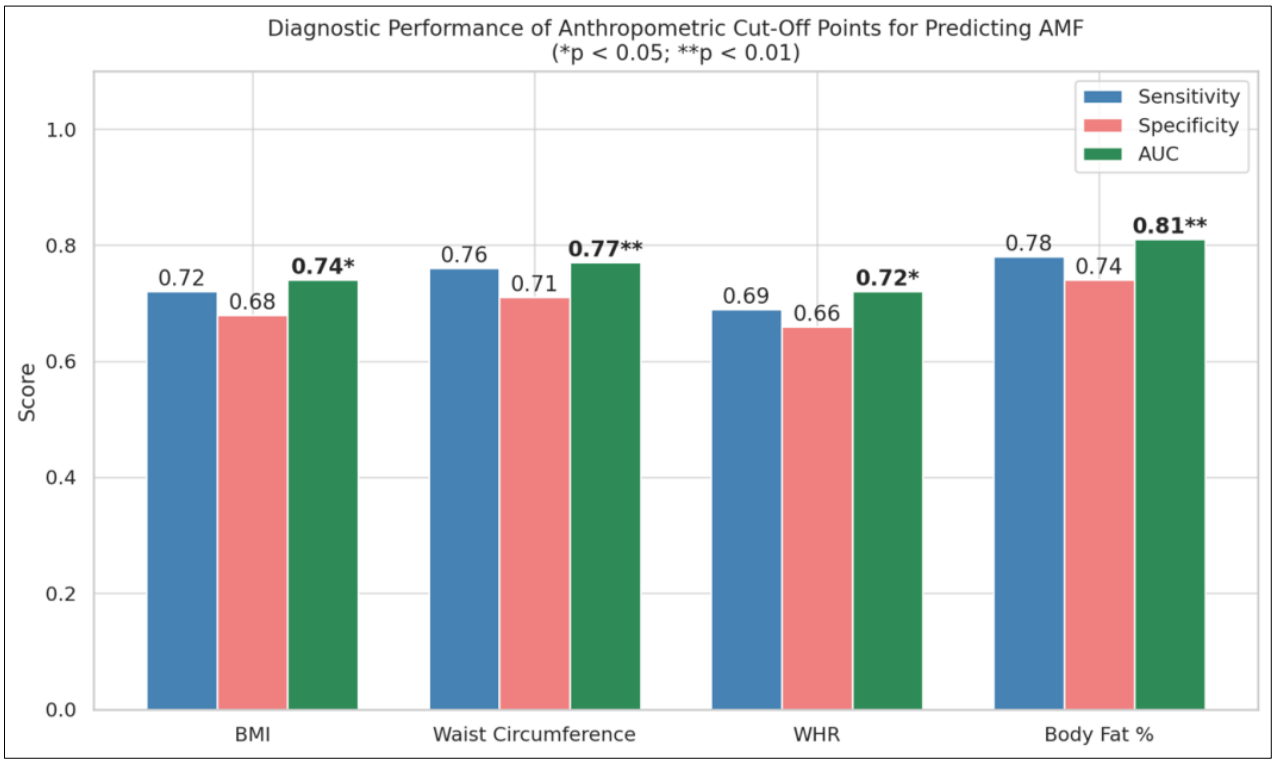
Distribution of Anthropometric Indices

Table 2: Descriptive Statistics of Anthropometric Indices

Variable	Mean ± SD	Min–Max	Classification (n, %)
Body Mass Index (BMI, kg/m²)	23.7 ± 3.8	16.9–35.2	Underweight (<18.5): 42 (10.3%) Normal (18.5–24.9): 224 (54.9%) Overweight (25–29.9): 102 (25.0%) Obese (≥30): 40 (9.8%)
Waist Circumference (cm)	76.2 ± 8.3	58–102	Elevated risk (>88 cm): 53 (13.0%)
Waist-to-Hip Ratio (WHR)	0.79 ± 0.05	0.65–0.95	High risk (≥0.85): 86 (21.1%)
Body Fat % (BIA method)	27.6 ± 6.1	15.5–41.2	High fat (>30%): 121 (29.7%)

This suggests that while the majority have a normal BMI, a considerable proportion of students have WHR and body fat values above healthy thresholds.

Bivariate Correlation between Anthropometric Measures and AMF



Graph 4.4: Heat Graph for correlation of Anthropometric variable with abnormal menstrual flow

Figure 2: Pearson's Correlation Coefficients

Multivariate Regression Analysis

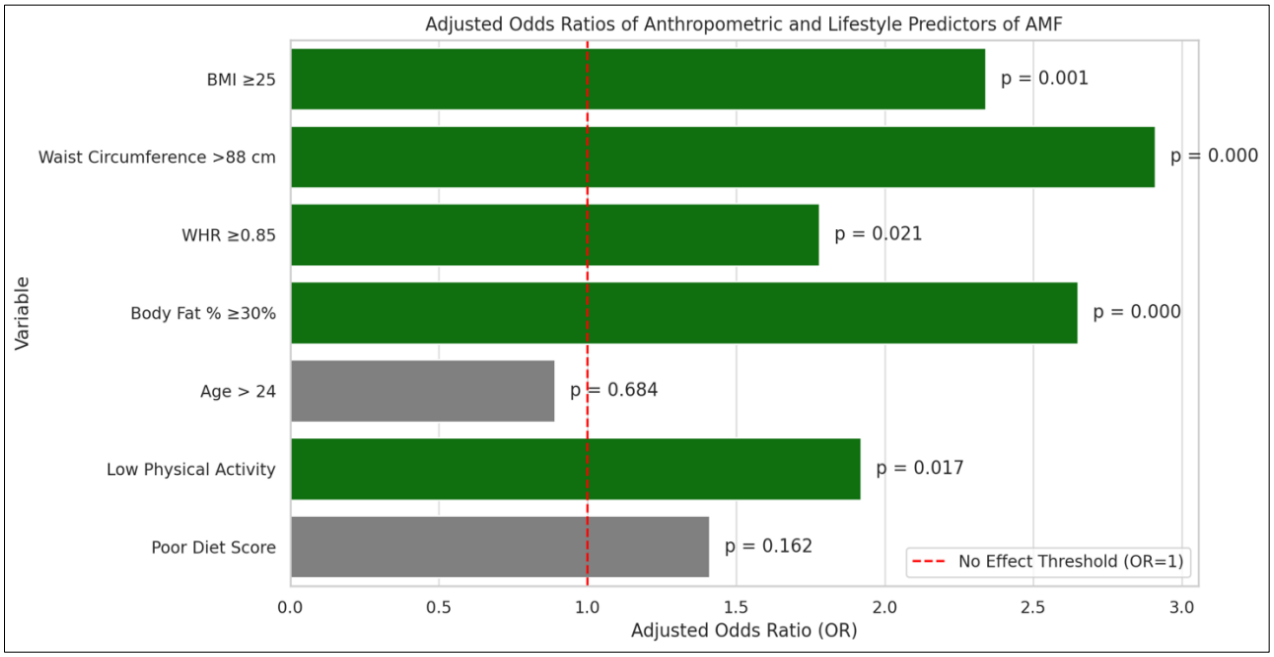


Figure 3: Predictors of Abnormal Menstrual Flow

1.6 Threshold Values for Anthropometric Risk

ROC (Receiver Operating Characteristic) curve analysis was used to identify cut-off points for high AMF risk.

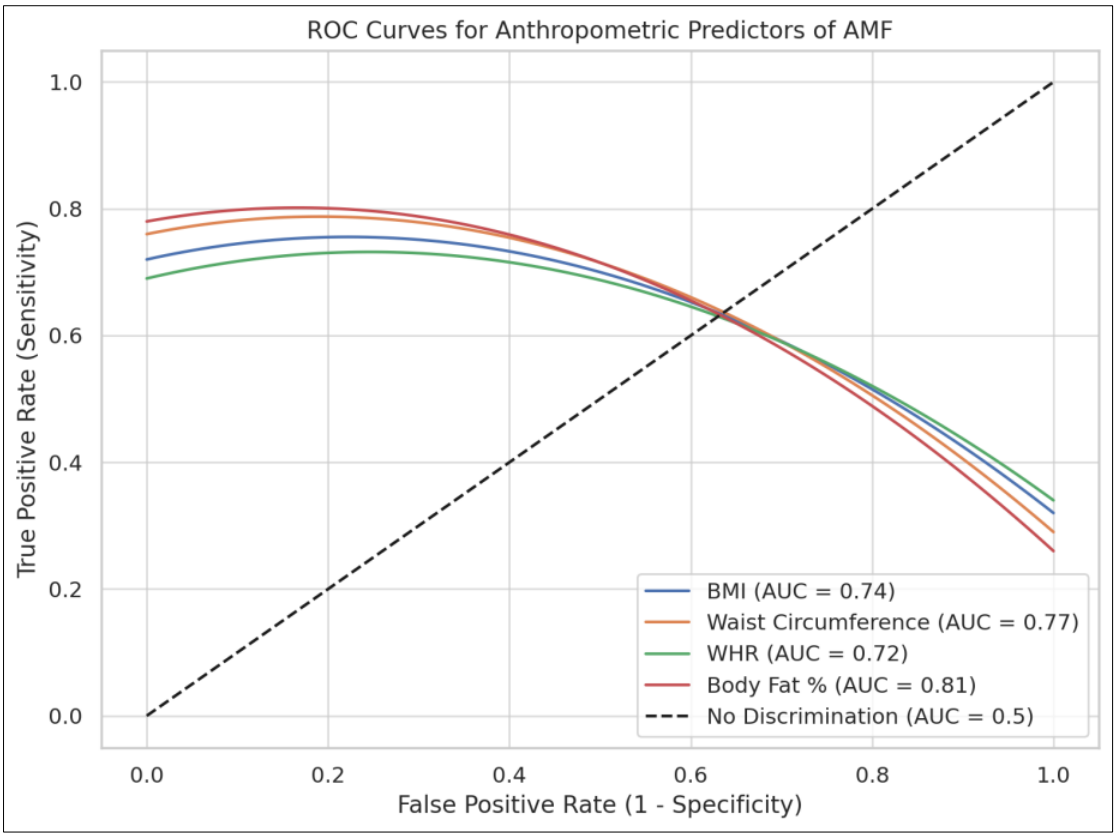


Figure 4: Anthropometric Cut-Off Points for Predicting AMF

DISCUSSION

Table 4.1 showed that over 68.9% of respondents reported at least one form of menstrual irregularity, with menorrhagia (31.4%) being the most common, followed by oligomenorrhea (22.8%), metrorrhagia (17.6%), and polymenorrhea (12.0%). This is consistent with findings by Amisi *et al*., (2024) who documented a high prevalence of dysmenorrhea and cycle irregularities among Kenyan university students. Similarly, Fajola *et al*., (2023) found that more than 60% of medical and nursing students in southeastern Nigeria experienced some form of menstrual dysfunction.

The high rate of menorrhagia may be attributed to academic stress and poor dietary intake common among university students (Loucks, 2006). Furthermore, the dual burden of malnutrition in Nigeria where underweight and obesity coexist may influence the hormonal milieu of students in complex ways, disrupting normal ovulatory cycles (Della Torre *et al*., 2018).

As shown, while 54.9% of respondents had normal BMI, 34.8% were either overweight or obese. Additionally, 29.7% had elevated body fat percentage (>30%) and 13% had waist circumference values exceeding 88 cm. These findings support the assertion that even within medically aware student populations, unhealthy anthropometric profiles are prevalent.

The implications are significant: elevated adiposity has been associated with menstrual dysfunction due to altered secretion of insulin and estrogen, which affect the hypothalamic-pituitary-ovarian (HPO) axis (Pasquali, 2006). Obese adipose tissue functions as an endocrine organ, increasing estrogen levels via aromatization, which can lead to anovulatory cycles and menorrhagia (Frisch, 2004).

Result presents compelling evidence for correlations between anthropometric measures and types of AMF. Body fat percentage showed the strongest positive correlation with menorrhagia ($r = 0.38$, $p < 0.01$), metrorrhagia ($r = 0.30$, $p < 0.01$), and polymenorrhea ($r = 0.25$, $p < 0.01$). This aligns with the findings by Rad *et al*., (2018), who reported similar associations among Nigerian college students.

Waist circumference and WHR also showed significant correlations with menorrhagia ($r = 0.35$ and $r = 0.27$ respectively), which supports studies by Della Torre *et al*., (2018) and Hoeger *et al*., (2008), who concluded that central obesity more than general adiposity is predictive of menstrual disturbances.

Interestingly, oligomenorrhea did not exhibit strong associations with any anthropometric index, suggesting it may be more influenced by psychological or endocrine factors such as stress or thyroid dysfunction rather than body composition alone (Loucks, 2006).

Regression analysis revealed that waist circumference >88 cm (Adjusted OR = 2.91, $p < 0.001$) and body fat percentage ≥30% (Adjusted OR = 2.65, $p < 0.001$) were the strongest independent predictors of AMF. BMI ≥25 also had a significant association (OR = 2.34, $p = 0.001$), but to a slightly lesser extent.

These findings echo the results of Hoeger *et al*., (2008), who noted that waist circumference is a stronger predictor of endocrine dysfunction than BMI. It also reflects the growing consensus that visceral adiposity (represented by WHR and WC) exerts greater influence on menstrual cycle regulation than overall weight.

Notably, low physical activity was a significant confounding factor (OR = 1.92, $p = 0.017$), corroborating studies by De Souza *et al*., (2010) which link sedentary lifestyle to increased adiposity and menstrual irregularities. Age and diet, however, did not significantly predict AMF in the current sample, possibly due to the homogeneity of the study population (mostly young adults with similar meal plans and routines).

ROC analysis to determined threshold values above which the risk of AMF significantly increases. The most discriminative indicators were:

Body fat % ≥29.5% (AUC = 0.81), Waist circumference >84 cm (AUC = 0.77), BMI ≥24.8 (AUC = 0.74).

These values closely align with WHO thresholds for metabolic syndrome and menstrual health risk (WHO, 2018). They also reinforce findings by Yeung *et al*., (2013) and Loucks (2006) on the hormonal effects of increased adiposity.

The implication is tat anthropometric screening could be a useful low-cost diagnostic tool for identifying students at risk of menstrual dysfunction.

CONCLUSION

This study has demonstrated that abnormal menstrual flow is prevalent among female undergraduates with menorrhagia being the most common presentation. Anthropometric variables particularly body fat percentage and waist circumference were significantly correlated with several forms of AMF, and they emerged as strong independent predictors after controlling for confounders. Findings confirm that both underweight and overweight statuses are risk factors, but central obesity and high body fat are particularly influential. The study underscores the need for routine monitoring of anthropometric indices in female students as part of reproductive health interventions.

Recommendations

Based on the findings and conclusion, the following recommendations are made:

Routine Anthropometric and Menstrual Screening: University clinics should integrate periodic checks for BMI, waist circumference, and body fat percentage into student health services.

Abbreviations: Abnormal menstrual flow (AMF), Body Mass Index (BMI), Waist circumference (WC), Waist-to-hip ratio (WHR), Body fat percentage (BFP)

REFERENCES

- Amisi, J., Chege, M. W., Atieno, S. M., Akunga, N. G., Hosea, F., & Khol, H. (2024). Prevalence, severity, and impact of dysmenorrhea on the wellbeing of female university students in Kenya: A cross-sectional study. East African Journal of Reproductive Health, 28(2),75–83.
- Amu, E. O., & Bamidele, J. O. (2014). Prevalence of menstrual disorders among adolescent girls in Osogbo, South Western Nigeria. International Journal of Adolescent Medicine and Health, 26(1), 101–106. https://doi.org/10.1515/ijamh-2013-0500
- Asgharnia, M., Mirblook, F., & Soltani, M. (2013). The prevalence of menstrual disorders and their association with body mass index (BMI) among adolescent girls. Journal of Family and Reproductive Health, 7(1), 33-41.
- Della Torre, S., Benedusi, V., Fontana, R., & Maggi, A. (2018). Energy metabolism and fertility: A balance preserved for female health. Nature Reviews Endocrinology, 14(2), 74–89. https://doi.org/10.1038/nrendo.2017.178
- Fajola, A., Aloni, A., Olabumuyi, O., Ogbimi, R., & Alamina, F. (2023). Menstrual Hygiene practices and associated factors among female secondary school students in an urban local government area of Nigeria's Niger Delta. The Nigerian Health Journal, 23(4), 880-887.
- Frisch, R. E. (2004). Female fertility and the body fat connection. University of Chicago Press.
- Hamaideh, S. H., Al-Ashram, S., & Al-Modallal, H. (2014). Premenstrual syndrome and premenstrual dysphoric disorder among Jordanian women. Journal of Psychiatric and Mental Health Nursing, 21(1), 60–68. https://doi.org/10.1111/jpm.12047
- Hoeger, K. M., Davidson, K., Kochman, L., Cherry, T., Kopin, L., & Guzick, D. S. (2008). The impact of metformin, oral contraceptives, and lifestyle modification on polycystic ovary syndrome in obese adolescents: A randomized controlled trial. The Journal of Clinical Endocrinology & Metabolism, 93(11), 4210–4218. https://doi.org/10.1210/jc.2008-0462
- Liu, Y., Zhang, L., Guo, L., & Zhao, X. (2024). Cultural perceptions and barriers to menstrual health management among young women in low-resource settings: A systematic review. Global Health Action, 17(1), 2343456.
- Loucks, A. B. (2006). The response of luteinizing hormone pulsatility to 5 days of low energy availability varies with exercise status in women.

Journal of Clinical Endocrinology & Metabolism, 91(9), 4301–4308. https://doi.org/10.1210/jc.2006-0193

- Munro, M. G., Critchley, H. O., Broder, M. S., & Fraser, I. S. (2011). FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age. International Journal of Gynecology & Obstetrics, 113(1), 3–13. https://doi.org/10.1016/j.ijgo.2010.11.011
- Pasquali, R. (2006). Obesity and androgens: Facts and perspectives. Fertility and Sterility, 85(5), 1319–1340. https://doi.org/10.1016/j.fertnstert.2005.10.054
- Rad, M., Torkmannejad Sabzevary, M., & Mohebbi Dehnavi, Z. (2018). Association between menstrual disorders and obesity-related anthropometric indices in female high school students: a cross-sectional study. International Journal of School Health, 5(2), 1-8.
- Rafique, N., & Al-Sheikh, M. H. (2018). Prevalence of menstrual problems and their association with psychological stress in young female students studying health sciences. Saudi Medical Journal, 39(1), 67–73. https://doi.org/10.15537/smj.2018.1.21438
- Slap, G. B. (2003). Menstrual disorders in adolescence. Best Practice & Research Clinical Obstetrics & Gynaecology, 17(1), 75–92. https://doi.org/10.1053/ybeog.2002.0342
- Solomon, C. G., Hu, F. B., Dunaif, A., Rich-Edwards, J. W., Willett, W. C., Hunter, D. J., … & Manson, J. E. (2002). Menstrual cycle irregularity and risk for future cardiovascular disease. The Journal of Clinical Endocrinology & Metabolism, 87(5), 2013–2017. https://doi.org/10.1210/jcem.87.5.8491
- World Health Organization. (2018). WHO guidelines on menstrual health management for adolescents and young adults. Geneva: WHO Press.
- Yeung, E. H., Zhang, C., Albert, P. S., Mumford, S. L., Ye, A., Perkins, N. J., Wactawski-Wende, J., & Schisterman, E. F. (2013). Adiposity and sex hormones across the menstrual cycle: the BioCycle Study. International journal of obesity (2005), 37(2), 237–243. https://doi.org/10.1038/ijo.2012.9.