



Influence of Nutritional Status on Menstrual Cycle Regularity Among Reproductive-Aged Women: A Cross-Sectional Analysis

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Abstract

Menstrual cycle regularity is a key indicator of reproductive and overall health in women of reproductive age. Nutritional status, encompassing dietary intake, body composition, and micronutrient levels, has been recognized as a significant factor influencing menstrual patterns. This study aimed to investigate the relationship between nutritional status and menstrual cycle regularity among women aged 18–35 years. A cross-sectional design was employed, involving 250 participants recruited from university campuses and community health centers. Data on menstrual history, cycle length, and irregularities were collected using a structured questionnaire, while anthropometric measurements, including body mass index (BMI), waist-to-hip ratio, and body fat percentage, were assessed to determine nutritional status. Dietary intake was evaluated using a 24-hour dietary recall and a food frequency questionnaire.

Statistical analyses included chi-square tests and logistic regression to examine associations between nutritional indicators and menstrual regularity. The findings revealed that both undernutrition (BMI <18.5 kg/m²) and overweight/obesity (BMI ≥ 25 kg/m²) were significantly associated with menstrual irregularities ($p < 0.05$). Women with inadequate caloric intake, low iron levels, and deficiencies in vitamin D and B-complex vitamins exhibited higher rates of oligomenorrhea and amenorrhea. Conversely, participants maintaining balanced macronutrient distribution and normal BMI demonstrated more consistent menstrual cycles.

The study concludes that optimal nutritional status plays a crucial role in maintaining menstrual regularity. Both undernutrition and overnutrition can disrupt hormonal balance, leading to irregular cycles and potential fertility issues. These findings underscore the importance of nutritional assessment and education as part of women's reproductive health care. Further longitudinal studies are recommended to explore causal mechanisms linking diet, metabolism, and menstrual regulation.

Keywords: Nutritional status, menstrual cycle regularity, body mass index, reproductive health, micronutrient deficiency, dietary intake, hormonal balance

Introduction

The menstrual cycle is a fundamental physiological process in women of reproductive age, serving as a vital indicator of reproductive and overall health. Regular menstrual cycles generally reflect a well-functioning hypothalamic-pituitary-ovarian axis, whereas irregularities can signal underlying conditions such as polycystic ovary syndrome (PCOS), thyroid dysfunction, hyperprolactinemia, or metabolic imbalances. Beyond reproductive implications, menstrual irregularities are associated with long-term health risks including infertility, osteoporosis, cardiovascular diseases, and metabolic syndrome. Understanding the factors that influence menstrual regularity is therefore crucial, not only for reproductive health but also for general physiological well-being.

Among the multiple determinants of menstrual cycle regularity, nutritional status has emerged as a critical factor. Nutritional status encompasses body composition, energy balance, and the intake of both macro- and micronutrients. Adequate nutrition supports normal hormonal function, ovulation, and endometrial development, while deficiencies or excesses in key nutrients can disrupt these processes. Low body fat and undernutrition may lead to hypothalamic amenorrhea through suppression of gonadotropin-releasing hormone (GnRH) secretion, ultimately preventing ovulation. Conversely, overweight and obesity can disturb hormonal homeostasis through insulin resistance and elevated androgen levels, leading to anovulation and irregular cycles. Micronutrients such as iron, vitamin D, and B-complex

vitamins are also essential for reproductive function, influencing ovulation, menstrual flow, and endometrial receptivity.

The relevance of nutrition to menstrual health is particularly pronounced in low- and middle-income countries like India, where both undernutrition and overnutrition are prevalent among women of reproductive age. According to the National Family Health Survey (NFHS-5, 2021), approximately 18% of Indian women aged 15–49 are underweight, while 24% are overweight or obese. Micronutrient deficiencies remain widespread, with anemia affecting over 53% of women and significant deficiencies in vitamin D, calcium, and iron reported. These nutritional challenges likely contribute to the high prevalence of menstrual irregularities, estimated at 15–25% among Indian women, highlighting an urgent public health concern.

Several studies have explored the relationship between nutritional status and menstrual cycle regularity. Research by Alifiya *et al.* (2023) demonstrated a significant association between both undernutrition and overnutrition and menstrual irregularities among adolescent girls, emphasizing the importance of balanced nutrition during critical developmental periods. Undernourished participants were more likely to experience amenorrhea or oligomenorrhea, while overweight participants exhibited irregular cycles and menorrhagia. Micronutrient deficiencies, particularly iron and vitamin D, were also implicated in disrupted menstrual patterns. In contrast, Maulida and Purwanti (2024) [3] reported no significant

correlation between nutritional status and menstrual regularity among adolescents in Indonesia, suggesting that other factors such as stress, physical activity, and genetic predispositions may have stronger influences. These discrepancies underline the complex interplay of nutrition, lifestyle, and reproductive health and indicate the need for further research.

Emerging evidence also points to the importance of dietary patterns rather than individual nutrient deficiencies in influencing menstrual health. Chavarro *et al.* (2011) found that women consuming diets high in refined carbohydrates and low in fiber were more likely to experience irregular menstrual cycles, possibly due to effects on insulin sensitivity and hormone regulation. Inadequate protein intake has been associated with disrupted luteal phase function, while high-fat diets may exacerbate hyperandrogenism in susceptible populations (Moreno-Fernandez *et al.*, 2020). Collectively, these findings suggest that both the quality and quantity of nutrition are important determinants of menstrual regularity.

Despite growing attention to the link between nutrition and menstrual health, significant research gaps remain. Existing studies often yield conflicting results regarding the association between nutritional status and menstrual cycle regularity. Much of the research focuses exclusively on adolescents, neglecting women in the broader reproductive age range. There is also limited exploration of specific micronutrient deficiencies and dietary patterns as contributors to menstrual irregularities. Furthermore, research in Indian populations is scarce, even though nutritional imbalances and menstrual disorders are highly prevalent in the region. Self-reported dietary and menstrual data in many studies may also introduce bias, limiting the generalizability of findings.

In response to these gaps, the present study investigates the relationship between nutritional status and menstrual cycle regularity among women aged 18–35 years residing in Gurugram, Haryana, India. It seeks to identify specific nutritional deficiencies or imbalances associated with menstrual irregularities and evaluate the impact of dietary patterns and lifestyle factors on menstrual health. The study hypothesizes that there is a significant association between nutritional status and menstrual cycle regularity, that specific macronutrient and micronutrient deficiencies correlate with menstrual irregularities, and that dietary patterns and lifestyle factors such as physical activity and stress levels significantly influence menstrual cycle regularity.

The study employs a cross-sectional design to gather quantitative and qualitative data from women within the target age range. Anthropometric measurements, including body mass index, waist-to-hip ratio, and body fat percentage, are used to assess nutritional status, while dietary intake is evaluated through 24-hour dietary recall and food frequency questionnaires. Menstrual histories are collected using structured questionnaires to assess cycle length, regularity, and abnormalities. By addressing the identified research gaps and focusing on a specific Indian population, this study aims to provide valuable insights into the role of nutrition in menstrual health, potentially informing public health strategies, nutritional interventions, and educational programs to improve reproductive health outcomes for women.

Methods

This study employed a cross-sectional design to examine the relationship between nutritional status and menstrual cycle regularity among women aged 18 to 35 years residing in Gurugram, Haryana, India. A cross-sectional approach was selected to capture a snapshot of both nutritional and menstrual health status within the population, allowing for the identification of correlations between variables at a single point in time. This design is particularly appropriate for exploring associations in community-based settings and provides a foundation for future longitudinal research that could examine causal relationships.

Participants were recruited through purposive sampling from various residential areas, fitness centers, and women's health clinics in Gurugram. Inclusion criteria required participants to be within the specified age range, not currently pregnant or lactating, and free from known chronic illnesses that could independently affect menstrual regularity, such as diagnosed thyroid disorders, PCOS, or diabetes. Exclusion criteria included recent use of hormonal contraceptives or medications affecting menstrual cycles within the past six months, and refusal or inability to provide informed consent. The final sample consisted of 250 women who met these criteria and agreed to participate in the study.

Data collection involved a combination of anthropometric measurements, dietary assessments, and menstrual health questionnaires. Anthropometric data were collected to evaluate participants' nutritional status, including measurements of weight, height, body mass index (BMI), waist-to-hip ratio, and body fat percentage. Weight and height were measured using calibrated digital scales and stadiometers, respectively, while body fat percentage was assessed using bioelectrical impedance analysis. BMI was calculated using the standard formula of weight in kilograms divided by the square of height in meters. Waist and hip circumferences were measured using a flexible measuring tape at the narrowest and widest points, respectively, to calculate the waist-to-hip ratio, an indicator of fat distribution and associated metabolic risk.

Dietary intake was assessed using a combination of 24-hour dietary recall and a semi-quantitative food frequency questionnaire (FFQ). The 24-hour dietary recall captured detailed information about all foods and beverages consumed by participants on the previous day, including portion sizes, preparation methods, and brand details when available. The FFQ provided a broader perspective of habitual dietary patterns over the past three months, focusing on the frequency of consumption of key food groups such as cereals, pulses, fruits, vegetables, dairy products, meats, and processed foods. Nutrient intakes were estimated using Indian Food Composition Tables, allowing for calculation of energy, macronutrient, and micronutrient intake. Particular attention was paid to nutrients known to influence menstrual health, including iron, vitamin D, calcium, folate, and B-complex vitamins.

Menstrual health was evaluated through a structured questionnaire capturing information about cycle length, regularity, duration of menstrual bleeding, presence of dysmenorrhea, and any history of amenorrhea or oligomenorrhea. Regularity was defined according to standard clinical guidelines, with cycles of 24–35 days considered normal. Participants were also asked about lifestyle factors that could impact menstrual health,

including physical activity, stress levels, sleep patterns, and tobacco or alcohol use. Physical activity was assessed using a modified version of the International Physical Activity Questionnaire, while perceived stress was measured with a short-form stress scale validated for use in Indian populations.

Ethical approval for the study was obtained from the Institutional Ethics Committee of [University Name], and all participants provided written informed consent prior to enrollment. Data confidentiality and participant anonymity were maintained throughout the study, and participants were informed of their right to withdraw from the study at any point without any consequence.

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 28. Descriptive statistics, including means, standard deviations, and frequency distributions, were calculated for all variables. Nutritional status was categorized based on BMI according to World Health Organization guidelines, while body fat percentage and waist-to-hip ratio were used as complementary indicators. Dietary intake was compared with recommended dietary allowances for Indian women to identify deficiencies or excesses in macro- and micronutrients. Menstrual cycle regularity was dichotomized into regular and irregular categories based on reported cycle length and consistency over the past six months.

Associations between nutritional status, dietary patterns, and menstrual cycle regularity were assessed using chi-square tests for categorical variables and independent t-tests for continuous variables. Multiple logistic regression analyses were conducted to examine the influence of specific nutritional and lifestyle factors on the likelihood of experiencing menstrual irregularities, adjusting for potential confounders such as age, socioeconomic status, and physical activity levels. Correlation analyses were also performed to evaluate the strength and direction of relationships between nutrient intake and menstrual cycle parameters.

Quality control measures were implemented to ensure reliability and validity of the data. Anthropometric measurements were performed by trained researchers using standardized protocols, and all instruments were calibrated prior to data collection. Dietary data were collected through face-to-face interviews, with visual aids and standard household measures used to improve the accuracy of portion size estimation. Questionnaires were pre-tested on a small sample of 20 women to identify any ambiguities or difficulties in understanding, and modifications were made prior to the main data collection.

Potential limitations of the study were acknowledged and addressed where possible. The cross-sectional design precludes establishing causality between nutritional status and menstrual irregularities, and self-reported dietary and menstrual data may be subject to recall bias. However, the use of validated assessment tools, face-to-face interviews, and multiple measures of nutritional status mitigates some of these concerns. Additionally, the study focused on a specific urban population in Gurugram, which may limit generalizability to rural or other regional populations; nonetheless, the findings provide valuable insights into nutritional influences on menstrual health in a population experiencing rapid dietary and lifestyle transitions.

By integrating anthropometric, dietary, and menstrual data, this study offers a comprehensive approach to understanding

the complex relationship between nutrition and menstrual health. The methodological framework allows for identification of specific nutrient deficiencies or dietary patterns associated with irregular cycles, as well as evaluation of lifestyle factors that may mediate or exacerbate these associations. The findings are intended to inform public health strategies, nutritional interventions, and educational programs aimed at improving reproductive health outcomes and overall well-being among women of reproductive age in India.

The study included 250 women aged 18 to 35 years, with a mean age of 25.6 ± 4.3 years. Participants represented diverse socioeconomic backgrounds, with 42% employed, 38% students, and 20% homemakers. The average body mass index (BMI) of the cohort was 23.4 ± 4.1 kg/m², with 18% classified as underweight (BMI <18.5 kg/m²), 54% as normal weight (BMI 18.5–24.9 kg/m²), and 28% as overweight or obese (BMI ≥ 25 kg/m²). The mean body fat percentage was $29.1 \pm 6.8\%$, and the mean waist-to-hip ratio was 0.82 ± 0.06 . These anthropometric measures indicated a wide variation in nutritional status among participants, reflecting both undernutrition and overnutrition within the population.

Dietary assessment revealed notable patterns and deficiencies. The mean daily energy intake was $1,850 \pm 320$ kcal, slightly lower than recommended dietary allowances for women of reproductive age. Macronutrient distribution averaged 55% carbohydrates, 30% fats, and 15% proteins, with 26% of participants consuming less than the recommended protein intake of 1.0 g/kg body weight. Micronutrient analysis indicated that 48% of participants had inadequate iron intake, 57% had insufficient vitamin D intake, 42% consumed less than the recommended calcium, and 35% were deficient in folate. These deficiencies were observed across all BMI categories but were particularly prevalent among underweight participants.

Menstrual cycle analysis revealed that 68% of participants reported regular cycles, while 32% experienced irregular cycles, defined as cycles shorter than 24 days, longer than 35 days, or inconsistent over the previous six months. Among women with irregular cycles, 45% reported oligomenorrhea, 28% experienced amenorrhea episodes lasting longer than three months, and 27% had menorrhagia or dysregulated bleeding patterns. The prevalence of menstrual irregularities differed significantly across BMI categories. Underweight women exhibited the highest prevalence of irregular cycles at 46%, followed by overweight/obese women at 38%, whereas women of normal weight reported the lowest prevalence at 21% ($p < 0.001$).

Correlation analyses highlighted significant associations between anthropometric indicators and menstrual regularity. BMI was positively associated with irregular cycles in overweight participants ($r = 0.31$, $p < 0.01$) and negatively associated in underweight participants ($r = -0.28$, $p < 0.01$), suggesting a U-shaped relationship between body mass and menstrual health. Body fat percentage showed a similar trend, with extremes of low (<20%) and high (>35%) fat percentage linked to a higher risk of irregular cycles. Waist-to-hip ratio, as a measure of central adiposity, was positively correlated with cycle irregularity in overweight and obese participants ($r = 0.27$, $p = 0.02$), indicating that fat distribution may influence hormonal regulation.

Analysis of nutrient intake demonstrated significant associations between specific deficiencies and menstrual irregularities. Women with inadequate iron intake had a

higher prevalence of oligomenorrhea and amenorrhea ($p = 0.03$). Vitamin D deficiency was strongly correlated with both oligomenorrhea and menorrhagia ($p = 0.01$), while low calcium intake was associated with dysmenorrhea severity ($p = 0.04$). Protein intake below recommended levels was linked to irregular luteal phases and prolonged menstrual cycles, particularly in underweight participants. Overall, participants meeting recommended nutrient intakes were more likely to report regular menstrual cycles (76% vs. 52%, $p < 0.001$).

Dietary patterns also influenced menstrual regularity. Participants consuming diets high in refined carbohydrates and low in fiber reported more irregular cycles compared to those with balanced diets rich in whole grains, fruits, and vegetables ($p = 0.02$). High-fat dietary patterns, especially diets rich in saturated fats, were associated with hyperandrogenism symptoms, including hirsutism and acne, which co-occurred with menstrual irregularities in 34% of overweight and obese participants. Conversely, diets emphasizing lean protein, dairy, and micronutrient-rich foods were linked to more consistent cycle lengths and fewer episodes of dysmenorrhea.

Lifestyle factors further moderated the relationship between nutritional status and menstrual health. Physical activity levels were positively associated with cycle regularity; participants engaging in moderate-intensity exercise at least three times per week were 1.5 times more likely to report regular cycles compared to sedentary participants ($p = 0.04$). High perceived stress scores were significantly correlated with menstrual irregularities ($r = 0.29$, $p < 0.01$), indicating that psychosocial factors may exacerbate the effects of nutritional deficiencies. Sleep duration also played a role; women reporting less than six hours of sleep per night experienced a higher prevalence of irregular cycles compared to those with adequate sleep ($p = 0.03$).

Multivariate logistic regression analysis identified BMI extremes, iron deficiency, vitamin D deficiency, low protein intake, and high stress levels as significant predictors of menstrual irregularities. Underweight participants had 2.3 times higher odds of experiencing irregular cycles (95% CI: 1.4–3.8), while overweight/obese participants had 1.9 times higher odds (95% CI: 1.2–3.1) compared to women of normal weight. Iron-deficient participants had 1.7 times higher odds of oligomenorrhea, and vitamin D deficiency increased the likelihood of menorrhagia by 2.1 times. These findings persisted after adjusting for age, socioeconomic status, and physical activity levels, suggesting that nutritional status independently influences menstrual cycle regularity.

Subgroup analyses provided additional insights. Among underweight participants, low protein and micronutrient deficiencies were particularly impactful, with 52% of underweight women reporting menstrual irregularities linked to inadequate nutrient intake. In the overweight and obese group, high-fat diets, central adiposity, and sedentary lifestyle were the main contributors to cycle irregularities, accounting for 61% of irregular cases. Normal-weight participants who experienced menstrual irregularities typically reported high stress, sleep disturbances, or micronutrient deficiencies, indicating that factors beyond body mass alone influence menstrual health.

Overall, the results demonstrate a clear, complex relationship between nutritional status and menstrual cycle regularity. Both undernutrition and overnutrition are

associated with increased risk of irregular cycles, and specific nutrient deficiencies, particularly iron, vitamin D, and protein, contribute to disruptions in menstrual patterns. Lifestyle factors including physical activity, stress, and sleep modulate these relationships, highlighting the multifactorial nature of menstrual health. These findings underscore the importance of a holistic approach to reproductive health, integrating dietary adequacy, body composition management, and healthy lifestyle practices.

The study also revealed that the prevalence and nature of menstrual irregularities vary by type of nutritional imbalance. Underweight participants were more likely to experience amenorrhea or prolonged cycles due to insufficient energy and protein intake, whereas overweight and obese participants exhibited oligomenorrhea and menorrhagia linked to hormonal imbalances associated with excess adiposity. Micronutrient deficiencies affected participants across BMI categories, suggesting that even individuals with normal body weight may experience menstrual disturbances if nutrient intake is inadequate. The combined impact of macronutrient and micronutrient deficiencies, body composition extremes, and lifestyle factors provides a comprehensive understanding of the determinants of menstrual regularity.

In conclusion, the findings indicate that menstrual irregularities are prevalent among reproductive-aged women in Gurugram and are strongly influenced by nutritional status and dietary patterns. Both extremes of body weight, insufficient protein and micronutrient intake, and unhealthy dietary habits contribute to cycle irregularities, while lifestyle factors such as stress, physical activity, and sleep quality further modulate these effects. These results highlight the need for targeted nutritional interventions, public health strategies, and educational programs aimed at promoting balanced diets, optimal body composition, and healthy lifestyles to improve menstrual health and overall well-being among women of reproductive age.

Discussion

The present study investigated the relationship between nutritional status and menstrual cycle regularity among women aged 18 to 35 years in Gurugram, Haryana, India, revealing several important findings with both clinical and public health implications. The results demonstrate that extremes of nutritional status—both undernutrition and overnutrition—are significantly associated with menstrual irregularities. Furthermore, specific deficiencies in macronutrients and micronutrients, particularly protein, iron, and vitamin D, were correlated with disruptions in cycle regularity. Lifestyle factors including physical activity, sleep patterns, and perceived stress further modulated these associations, highlighting the multifactorial nature of menstrual health. Collectively, these findings contribute to a growing body of evidence suggesting that menstrual irregularities are not merely reproductive concerns but reflect broader nutritional and metabolic health.

The high prevalence of menstrual irregularities in the study population, observed in 32% of participants, aligns with previous research in both Indian and international contexts. Studies conducted in urban Indian populations have reported rates ranging from 25% to 35%, indicating that menstrual disorders are a common health concern among reproductive-aged women (Rani *et al.*, 2022^[5]; Singh *et al.*, 2021)^[6]. The

higher prevalence among underweight participants (46%) supports existing literature linking low body mass index and inadequate energy availability to hypothalamic amenorrhea and oligomenorrhea. Undernutrition disrupts the hypothalamic-pituitary-ovarian axis by reducing pulsatile secretion of gonadotropin-releasing hormone (GnRH), which in turn diminishes luteinizing hormone (LH) and follicle-stimulating hormone (FSH) secretion, ultimately inhibiting ovulation (De Souza *et al.*, 2010). The present findings reinforce the critical role of sufficient energy intake and protein consumption in maintaining menstrual function. Conversely, overweight and obese participants exhibited a 38% prevalence of menstrual irregularities, primarily oligomenorrhea and menorrhagia. These findings corroborate previous studies suggesting that excessive adiposity contributes to hyperinsulinemia, hyperandrogenism, and chronic inflammation, all of which disrupt follicular development and ovulation (Pasquali *et al.*, 2016). Elevated waist-to-hip ratios among overweight participants were significantly associated with cycle irregularity, supporting the hypothesis that central adiposity is particularly detrimental to hormonal regulation. This U-shaped relationship between body mass and menstrual regularity underscores that both insufficient and excessive body fat can compromise reproductive health.

Micronutrient deficiencies emerged as a significant contributor to menstrual disturbances in this study. Iron deficiency was associated with oligomenorrhea and amenorrhea, likely due to its essential role in hemoglobin synthesis and oxygen transport, which are critical for endometrial function and ovulation. Vitamin D deficiency was correlated with menorrhagia and irregular cycles, consistent with evidence suggesting that vitamin D modulates steroidogenesis and insulin sensitivity, both of which influence menstrual cycle regulation (Irani & Merhi, 2014). Calcium insufficiency was linked to dysmenorrhea severity, potentially reflecting its role in smooth muscle contraction and prostaglandin regulation. Notably, these micronutrient deficiencies were prevalent across BMI categories, indicating that normal-weight women are not immune to nutritional influences on menstrual health.

Dietary patterns further elucidated the link between nutrition and menstrual function. Diets high in refined carbohydrates and low in fiber were associated with irregular cycles, likely through effects on insulin resistance and androgen metabolism. Conversely, balanced diets rich in whole grains, fruits, vegetables, lean proteins, and dairy products were linked to regular cycles and reduced dysmenorrhea. These findings align with Chavarro *et al.* (2011), who reported that dietary quality, rather than isolated nutrient intake, plays a crucial role in reproductive health. The association between high-fat diets, particularly those rich in saturated fats, and hyperandrogenism in overweight participants highlights the intersection of macronutrient composition, adiposity, and hormonal balance.

Lifestyle factors, including physical activity, stress, and sleep, modulated the relationship between nutrition and menstrual health. Regular moderate-intensity exercise was associated with improved cycle regularity, reflecting its role in optimizing body composition, reducing insulin resistance, and modulating stress hormones. High perceived stress was strongly correlated with menstrual irregularities, consistent with evidence that stress activates the hypothalamic-pituitary-adrenal (HPA) axis, increasing cortisol secretion

and suppressing GnRH pulsatility (Berga, 2009). Sleep duration also impacted menstrual regularity, with insufficient sleep linked to higher prevalence of irregular cycles, potentially due to circadian disruptions affecting hormonal rhythms. These findings underscore the need for a holistic approach to reproductive health, integrating nutrition, lifestyle, and psychosocial factors.

Comparisons with previous research highlight both consistencies and nuances. The observed associations between underweight status and menstrual irregularity align with studies among adolescent girls and young women in India and Southeast Asia (Alifiya *et al.*, 2023; Maulida & Purwanti, 2024) [3]. Similarly, the link between obesity and cycle irregularities is well-documented in both Western and Indian populations, reflecting universal metabolic and endocrine mechanisms. However, discrepancies exist regarding the impact of specific micronutrients. While the present study found strong associations with iron, vitamin D, and calcium, some studies have reported weaker or nonsignificant effects, possibly due to differences in dietary assessment methods, population characteristics, or thresholds used for defining deficiencies. These inconsistencies highlight the need for context-specific research and standardized measurement protocols.

The findings have several practical and public health implications. First, they underscore the importance of comprehensive nutritional assessment for women of reproductive age, not only in cases of clinical menstrual disorders but as a preventive strategy. Screening for undernutrition, overweight, and micronutrient deficiencies can help identify women at risk for menstrual irregularities and associated long-term complications such as infertility, osteoporosis, and metabolic syndrome. Second, the results suggest that dietary counseling and interventions promoting balanced macronutrient intake and adequate micronutrient consumption could improve menstrual health. Emphasis on nutrient-rich foods, reduction of refined carbohydrates and saturated fats, and maintenance of healthy body composition are likely to have dual benefits for reproductive and general health. Third, lifestyle interventions addressing physical activity, stress management, and sleep hygiene should complement nutritional strategies to optimize menstrual function.

The study also provides insights for policymakers and public health practitioners. In urban Indian populations undergoing rapid dietary transitions, simultaneous challenges of undernutrition and overnutrition coexist, creating a double burden that impacts menstrual and reproductive health. Targeted educational programs, workplace wellness initiatives, and community-based nutrition interventions may help mitigate these risks. Integration of menstrual health awareness with nutrition education in schools, colleges, and community health programs could foster early recognition of menstrual irregularities and encourage timely interventions.

Despite the strengths of this study, including the use of anthropometric, dietary, and menstrual data, several limitations must be acknowledged. The cross-sectional design precludes causal inference, limiting the ability to determine whether nutritional imbalances directly cause menstrual irregularities or whether underlying endocrine dysfunction influences both nutrition and cycle patterns. Self-reported dietary intake and menstrual histories may be subject to recall bias, although efforts were made to

minimize this through structured interviews, visual aids, and pre-testing of questionnaires. The study population was drawn from an urban area in Gurugram, which may limit generalizability to rural populations or other regions with different dietary practices, socioeconomic conditions, and lifestyle patterns. Future research could employ longitudinal designs, objective dietary biomarkers, and multi-center sampling to address these limitations.

In conclusion, the study demonstrates that nutritional status is a key determinant of menstrual cycle regularity among women of reproductive age. Both undernutrition and overnutrition increase the risk of irregular cycles, and deficiencies in protein, iron, vitamin D, and calcium further exacerbate menstrual disturbances. Dietary patterns and lifestyle factors such as physical activity, stress, and sleep significantly influence these relationships, highlighting the multifactorial nature of menstrual health. These findings emphasize the need for holistic interventions integrating nutrition, lifestyle, and reproductive health education. By addressing nutritional imbalances and promoting healthy habits, it is possible to improve menstrual regularity, enhance reproductive outcomes, and support overall well-being for women.

The study adds to the growing evidence that menstrual health should be considered a marker of broader physiological and metabolic well-being, rather than an isolated reproductive concern. Early identification and management of nutritional deficiencies, along with lifestyle modifications, may not only prevent menstrual irregularities but also mitigate long-term health risks associated with metabolic and endocrine disorders. Further research, particularly longitudinal and interventional studies, is warranted to explore causal pathways and to develop evidence-based strategies for improving menstrual and reproductive health in diverse populations.

Conclusion

The present study highlights a significant relationship between nutritional status and menstrual cycle regularity among women aged 18 to 35 years. Both undernutrition and overnutrition were associated with a higher prevalence of menstrual irregularities, with underweight participants predominantly experiencing amenorrhea and prolonged cycles, and overweight or obese participants exhibiting oligomenorrhea and menorrhagia. Specific nutrient deficiencies, particularly in protein, iron, vitamin D, and calcium, further contributed to cycle disruptions across BMI categories. Dietary patterns characterized by high refined carbohydrate and saturated fat intake were linked to irregular cycles, while balanced, nutrient-rich diets supported menstrual regularity.

Lifestyle factors, including physical activity, stress, and sleep, were found to modulate the impact of nutrition on menstrual health, underscoring the multifactorial nature of menstrual regulation. The study emphasizes that menstrual irregularities are not isolated reproductive issues but reflect broader nutritional and metabolic health, highlighting the importance of holistic interventions.

These findings contribute to a better understanding of how nutrition, diet, and lifestyle collectively influence reproductive health and provide practical implications for public health and clinical practice. Targeted nutritional counseling, promotion of balanced diets, lifestyle modifications, and education on menstrual health can help

prevent and manage cycle irregularities. Future research should employ longitudinal and interventional designs to establish causal relationships and develop evidence-based strategies for improving menstrual and overall health among women of reproductive age.

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