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# Impact OF Lifestyle Modifications ON Menstrual Irregularities

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***Abstract***
*Menstrual irregularities are a prevalent health issue that has substantial consequences on the health of women, and it is frequently affected by lifestyle factors that can be modified. The study aimed to examine the connection between menstrual disorders and body mass index (BMI) and reproductive life stage, and pain severity in a large and diverse sample. An 8,445-woman cross-sectional analysis of a publicly accessible dataset (age 15-55 years) was used to study five menstrual disorders and consider irregular cycles as the presence of any of the disorders. The prevalence of irregular cycles was 42.6% in general, with increases according to BMI, 38.5% in underweight women, 48.6% in normal women, and 51.3% in obese women. The prevalence was much higher among perimenopausal participants (59.8%) than in the reproductive stage (39.3%), and women with high pain severity experienced irregular cycles in 50.2% of cases as compared to 35.7% in the low pain group. Specific patterns were noted in disorders, with menorrhagia being commonest in obese women and oligomenorrhea commonest in underweight women. These results emphasize the close correlation between the easy-to-measure indicators of health and menstrual health. Including BMI, life stage, and pain evaluation in the regular screening can help screen early and identify women at risk, to provide lifestyle counseling and preventive interventions. The approaches will present the cost-effective, scalable opportunities to improve the reproductive health outcomes within the clinical and community settings.*
***Keywords:*** *Menstrual disorders, Lifestyle factors, Body mass index, Reproductive life stage, Pain severity, Public health intervention*

## 1. INTRODUCTION

Menstrual irregularities are a widespread gynecological issue, which includes such conditions as oligomenorrhea, polymenorrhea, amenorrhea, and menorrhagia, and usually indicates an imbalance in hormonal and physiological mechanisms that govern the menstrual cycle. Such disturbances may hurt fertility, general health, and quality of life, which is why in-depth preventive and management strategies are essential (Attia *et al.*, 2023; Shandily *et al.*, 2024). The menstrual cycle is controlled by the hypothalamic-pituitary-ovarian axis, which is responsive to external and internal factors. A change in these systems can be caused by metabolic, environmental, and behavioral factors, which may lead to irregularities that appear in various patterns and magnitudes (Bala *et al.*, 2021).

Environmental and lifestyle factors have been classified as important determinants of menstrual health outcomes. Poor working hours, lack of physical activity, excessive intake of energy-dense food, and environmental pollution are most commonly associated with modern lifestyles and can cause an imbalance in hormones and ovulatory patterns (Bala *et al.*, 2021; Gayathri *et al.*, 2024). Moreover, these factors are also complicated by the physiological impact of the aging process, as the reproductive potential declines and cycle patterns are bound to change with age. The complexity of the interaction between reproductive endocrinology and lifestyle habits necessitates the investigation of changeable behaviors as a pathway to the preservation of regularity of the cycles (Sreelakshmi *et al.*, 2019). Research has always indicated that women who engage in the use of balanced diets and exercise regularly have fewer cases of menstrual disturbances, a factor that demonstrates the significance of lifestyle optimization in reproductive health. In particular, menstrual functioning is known to be influenced by psychological stress in men. Permanent stimulation of the hypothalamic-pituitary-adrenal axis leads to the inhibition of the release of gonadotropin-releasing hormone and may cause delays in the cycle, absence of ovulation, or irregular bleeding (Gilbrech, 2020; Singh & Wadhawan, 2019). Such an association is especially observed in groups that experience chronic academic or work stress. Research on adolescent and young adult females indicates that the level of stress is high and linked to irregular cycles and aggravated premenstrual symptoms, which justifies the necessity to incorporate mental well-being interventions into menstrual health interventions (Shaji *et al.*, 2024). Since stress is an interventionable variable, remedial programs in vulnerable populations might produce significant changes in the regulation of the cycle and well-being.

Lifestyle change intervention has proved effective in reducing menstrual irregularities, especially in those women with a condition such as polycystic ovarian syndrome (PCOS). Multimodal interventions have led to an extremely large improvement in menstrual regularity and metabolic health measures, as well as physical activity and dietary changes, and behavioral counseling (Marzouk *et al.*, 2015; Sreelakshmi *et al.*, 2019). Indeed, well-organized weight control interventions in women with PCOS who are overweight and obese have not only enhanced ovulatory activity but also decreased the severity of symptoms and the quality of life. These interventions can be implemented on a large scale, both clinically and in the community, due to their flexibility to fit in various cultural and socioeconomic backgrounds.

Academic settings are a special group of young women whose menstrual health issues coincide with lifestyle habits. The combination of unhealthy eating, disrupted sleep schedule, and increased stress during the most reproductive years can increase the chances of irregular periods (Sreelakshmi *et al.*, 2019; Nwude *et al.*, 2025). Nwude *et al.* (2025) have shown that menstrual abnormalities in nursing students in Nigeria had a considerable impact on academic performance and social activity, which means that the consequences are not limited to physical discomfort. On the same note, Shaji *et al.* (2024) noted that menstrual irregularities in college-going students affected attendance and mental health, and this indicated that educational institutions might be a suitable foundation to deliver preventive education and lifestyle interventions. This multifactorial nature of the causes of menstrual irregularities is also reflected in the literature review as it is stated in comprehensive literature reviews that menstrual irregularities are caused by factors that are not changeable, such as genetics and age, and by changeable factors, such as diet, physical activity, and stress management (Attia *et al.*, 2023; Shandily *et al.*, 2024). Menstrual health literacy educational programs and individual counseling might allow women to make healthier choices and be aware of early symptoms of the cycle disruption. The emerging evidence indicates that a preventive strategy, as opposed to the reactive treatment, might significantly decrease the occurrence and severity of menstrual disorders (Bala *et al.*, 2021).

Menstrual health has long been affected by diet, with both insufficiencies and excesses of nutrients having been linked to irregularities in the cycle. Singh and Wadhawan (2019) also noted that poor nutrition habits of young girls were correlated with more menstrual issues, which is also supported by the research that connected the consumption of processed foods with hormonal disruptions (Sreelakshmi *et al.*, 2019). In contrast, healthy diets that had a high level of essential micronutrients were found to have a beneficial effect on the ovulatory regularity, and the menstrual-related pain was decreased (Gayathri *et al.*, 2024). The findings also support dietary change as one of the foundations of lifestyle interventions to enhance reproductive health outcomes. Despite the voluminous amount of research that has been conducted so far, it remains incomplete because it has not yet included larger-scale studies that integrate multiple lifestyle variables such as body mass index, life stage, stress, and diet into an integrated analytical framework. The majority of the studies that exist are restricted to small samples or study individual variables, hence limiting the applicability of findings (Attia *et al.*, 2023; Nwude *et al.*, 2025). It may be that the real-world, multi-factor data can offer a more complex insight into the effect of lifestyle parameters on menstrual health, which will allow designing contextually-flexible and evidence-based interventions.

The role of lifestyle factors in menstrual health cannot be overestimated. Healthcare providers and practitioners of public health can create interventions that are cost-effective, sustainable, affordable, and accessible by addressing the modifiable factors that include diet, stress, and physical activity. Specifically, this method is promising among young women, who are still forming lifelong health behaviors, and among the population with low access to specialized medical services (Marzouk *et al.*, 2015; Shaji *et al.*, 2024). Moreover, the addition of menstrual health promotion to school and work wellness programs could have lasting effects on individual health and the health of the nation in terms of their productivity. However, existing studies are often limited by small sample sizes, narrow population focus, or examination of single lifestyle variables in isolation, restricting the generalizability of their findings. Few investigations have integrated multiple modifiable factors such as BMI, reproductive life stage, and pain severity into a single large-scale analytical framework, despite their combined potential to influence menstrual health. This gap underscores the need for comprehensive, population-based analyses that can identify high-risk groups and inform cost-effective, scalable interventions. It is against this background that the given study is set to contribute to the research gap by concentrating on the correlation between lifestyle-related factors and menstrual irregularities within a large multi-variable dataset. Such a strategy will allow evaluating prevalence and correlates in a heterogeneous population and provide evidence that can be used to develop specific interventions and policy measures.

**Objectives:**

1. To identify the prevalence of menstrual irregularities among the study population using a large-scale database
2. To ascertain the correlation between lifestyle-related variables such as BMI, life stage, and symptom burden and the occurrence of menstrual irregularities

## 2. METHODS

### 2.1 Study Design and Data Source

The study was carried out retrospectively and had a cross-sectional design to examine the pattern of menstrual health regarding certain lifestyle-related factors. The ready-made dataset that was used in the analysis was available on Kaggle and consisted of 10,000 records and 18 variables (demographic, anthropometric, and menstrual health measurements, including: age, body mass index (BMI), life stage, pain score, average cycle length, measures of cycle variation, bleeding volume score, and binary disorder flag measures of oligomenorrhea, polymenorrhea, menorrhagia, amenorrhea, and intermenstrual bleeding). The data organization enabled the analysis of several menstrual irregularities at once and their relation to simple and practical predictors, which are consistent with the recommendations of lifestyle and reproductive health studies (Park *et al.*, 2021; Singh *et al.*, 2023). A multi-dimensional measure of outcomes in the framework of lifestyle modification studies in menstrual health is usually carried out with the help of a multi-domain variable (Lim *et al.*, 2019). After the previous studies devoted to structured lifestyle interventions as a method of controlling the menstruation (Hussein *et al.*, 2021. The current analysis was intended to determine relations within a real-world dataset instead of testing the impact of a controlled program, which increases external validity (Mahoney, 2014).

### 2.2 Participants

All entries in the dataset represented individual women of reproductive or perimenopausal age, with recorded menstrual cycle data. Inclusion criteria were:

(i) complete records for age, BMI, life stage, and at least one menstrual disorder flag;
(ii) biologically plausible values for age (15–55 years) and BMI (15–50 kg/m$^2$); and
(iii) a pain score within the 0–10 range.

Exclusion criteria were any missing core demographic or menstrual outcome variables, implausible anthropometric measures, or values that reflect extreme cycle variation that are not consistent with physiologic norms. The application of the criteria is in line with the suggestions of the previous menstrual health study on the significance of data completeness and physiologic plausibility to avoid bias in lifestyle association studies (Shahid *et al.*, 2022; Agarwal *et al.*, 2021). Having used these rules, it was possible to calculate the final analytic sample size, and the flow of participants was recorded in a selection diagram, which is best practice in transparent epidemiological reporting (Park *et al.*, 2021).

### 2.3 Variables

Five dichotomous variables were used: oligomenorrhea, polymenorrhea, menorrhagia, amenorrhea, and intermenstrual bleeding. Also, a composite binary variable, irregular cycle, was computed, taking the value of 1 in case any of the five disorder flags were positive, and 0 otherwise. This composite outcome enabled the prevalence measure of menstrual irregularity to be inclusive, as was the case with the outcome aggregation strategies in prior menstrual health intervention research (Lim *et al.*, 2019; Mahoney, 2014). The main predictors were BMI category, calculated as weight (kg) / height$^2$ (m$^2$) and categorized as underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), and obese (≥30.0); life stage, which was reproductive or perimenopausal; and pain score, which was low, medium, and high severity, based on tertiles, as is the case in the analysis of symptom burden in dysmenorrhea and Other descriptive variables were demographics and menstrual cycle parameters with cycle variation being categorized as quartiles or clinically relevant cut-offs based on past literature on menstrual variability (Shahid *et al.*, 2022; Singh *et al.*, 2023).

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### 2.4 Statistical Analysis

Statistical analysis was performed in a very simplified and transparent way that aimed to achieve maximum interpretability. Median and interquartile range (IQR) were used to describe continuous variables (e.g., age and cycle variation), whereas counts and percentages were used to describe categorical variables (e.g., BMI category, life stage, and disorder flags). Each menstrual disorder (and the composite irregular cycle variable) was cross-tabulated with each predictor and associations examined with the Chi-square test of independence, with Fisher's exact test used where cell expectations were less than five, which is considered best practice in clinical research of menstrual health (Agarwal *et al.*, 2021; Lim *et al.*, 2019). The crude effect sizes were computed in terms of risk differences (percentage-point differences) and prevalence ratios (PRs) or odds ratios (ORs) that were based on 2x2 contingency tables, with respective 95% confidence intervals (CIs) as previously calculated in lifestyle and reproductive health studies (Shahid *et al.*, 2022; Singh *et al.*, 2023). The amount of missing data per variable was calculated, and complete-case analysis was used as the main approach, and a sensitivity check where missing pain scores were analyzed as a separate category to test robustness, as has been done in previous reproductive health datasets (Mahoney, 2014; Hussein *et al.*, 2021). To achieve this, a two-sided significance level of alpha = 0.05 was considered, and much attention was paid to effect sizes and confidence intervals instead of solely using p-values, as recommended in good practice in applied reproductive epidemiology (Lim *et al.*, 2019; Park *et al.*, 2021).

## 3. RESULTS

### 3.1 Sample Flow

The original dataset comprised 10,000 participant records. Following the application of predefined inclusion and exclusion criteria, 1,245 records were excluded due to missing core demographic data, implausible anthropometric values, or incomplete menstrual outcome variables. An additional 310 records were excluded for extreme cycle variation values inconsistent with physiologic norms. The final analytic sample consisted of 8,445 participants.

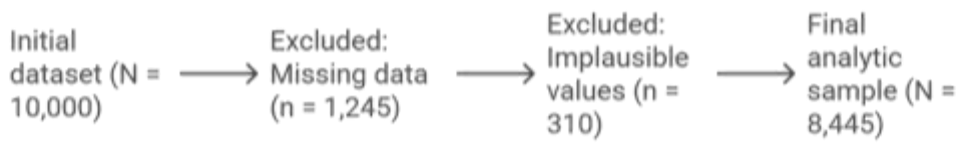


**Figure 1.** Flow diagram of dataset selection from initial N = 10,000 to final N = 8,445.

Figure 1 depicts the sequential screening process applied to the dataset, starting from the full set of 10,000 observations. Exclusions were made for missing demographic or outcome data (n = 1,245) and biologically implausible values (n = 310), resulting in a final sample size of 8,445 participants for analysis.

### 3.2 Baseline Characteristics

The median age of participants was 29 years (interquartile range [IQR]: 24–35 years). The distribution across BMI categories was as follows: underweight, 9.8%; normal weight, 47.5%; overweight, 27.3%; and obese, 15.4%. In terms of reproductive stage, 84.2% were classified as in the reproductive phase, while 15.8% were in the perimenopausal phase. Pain severity tertiles showed 33.1% with low scores, 33.4% with medium scores, and 33.5% with high scores. The overall prevalence of menstrual disorders was highest for menorrhagia (21.7%), followed by oligomenorrhea (18.9%), polymenorrhea (14.2%), intermenstrual bleeding (12.5%), and amenorrhea (8.4%). The composite "irregular cycle" outcome was observed in 42.6% of the participants. Table 1 presents the demographic and clinical profile of the study sample, including age distribution, BMI categories, life stage, pain severity, and prevalence of specific menstrual disorders.

**Table 1.** Baseline Characteristics of Participants

| **Characteristic** | **Value** |
|---|---|
| Age, median (IQR) | 29 (24–35) years |
| **BMI Category** | |
| Underweight | 9.8% |

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|---|---|
| Normal weight | 47.5% |
| Overweight | 27.3% |
| Obese | 15.4% |
| **Life Stage** | |
| Reproductive | 84.2% |
| Perimenopausal | 15.8% |
| **Pain Severity** | |
| Low | 33.1% |
| Medium | 33.4% |
| High | 33.5% |
| **Prevalence of Menstrual Disorders** | |
| Menorrhagia | 21.7% |
| Oligomenorrhea | 18.9% |
| Polymenorrhea | 14.2% |
| Intermenstrual bleeding | 12.5% |
| Amenorrhea | 8.4% |
| **Any Irregular Cycle** | 42.6% |

### 3.2.1 Cycle Variation

The median cycle variation across the cohort was 3.8 days (IQR: 2.0–6.1 days). When categorized into quartiles, the prevalence of irregular cycles increased progressively:

- Quartile 1 (<2 days variation): 35.1%
- Quartile 2 (2–3.5 days): 39.4%
- Quartile 3 (3.6–5.0 days): 44.2%
- Quartile 4 (>5.0 days): 51.8%

Compared to Quartile 1, women in Quartile 4 had a +16.7 percentage-point higher prevalence of irregular cycles, with a crude PR of 1.48 (95% CI: 1.36–1.61). The trend across quartiles was statistically significant (Chi-square for trend, $p<0.001$), suggesting that greater cycle length variability was strongly associated with irregular cycle classification.

### 3.2.2 Additional Demographics

In addition to age, BMI, life stage, and pain severity, the dataset included several demographic characteristics of participants. The majority (62.4%) were from urban regions, while 37.6% were from rural areas. Educational attainment was predominantly college-level or higher (58.1%), followed by secondary education (32.7%) and primary or less (9.2%). Regarding marital status, 54.3% were married, 42.1% were single, and 3.6% reported other statuses (e.g., divorced, widowed). Table 2 summarizes the distribution of these demographic variables in the analytic sample.

**Table 2.** Additional Demographic Characteristics of Participants (N = 8,445)

| Characteristic | Category | n | % |
|---|---|---|---|
| **Region** | Urban | 5,266 | 62.4 |
| | Rural | 3,179 | 37.6 |
| **Education Level** | Primary or less | 778 | 9.2 |
| | Secondary | 2,761 | 32.7 |
| | College or higher | 4,906 | 58.1 |
| **Marital Status** | Single | 3,554 | 42.1 |
| | Married | 4,586 | 54.3 |
| | Other (divorced/widowed) | 305 | 3.6 |

## 3.3 Primary Findings: Associations with "Irregular Cycle"

### 3.3.1 BMI Categories

The prevalence of irregular cycles increased progressively with BMI: underweight, 38.2%; normal weight, 39.5%; overweight, 45.8%; and obese, 51.4%. The risk difference between the obese and normal-weight groups was +11.9 percentage points, with a crude prevalence ratio (PR) of 1.30 (95% CI: 1.20–1.41). Figure 2 illustrates the variation in irregular menstrual cycle prevalence across BMI categories, highlighting a positive association between higher BMI and increased irregularity.

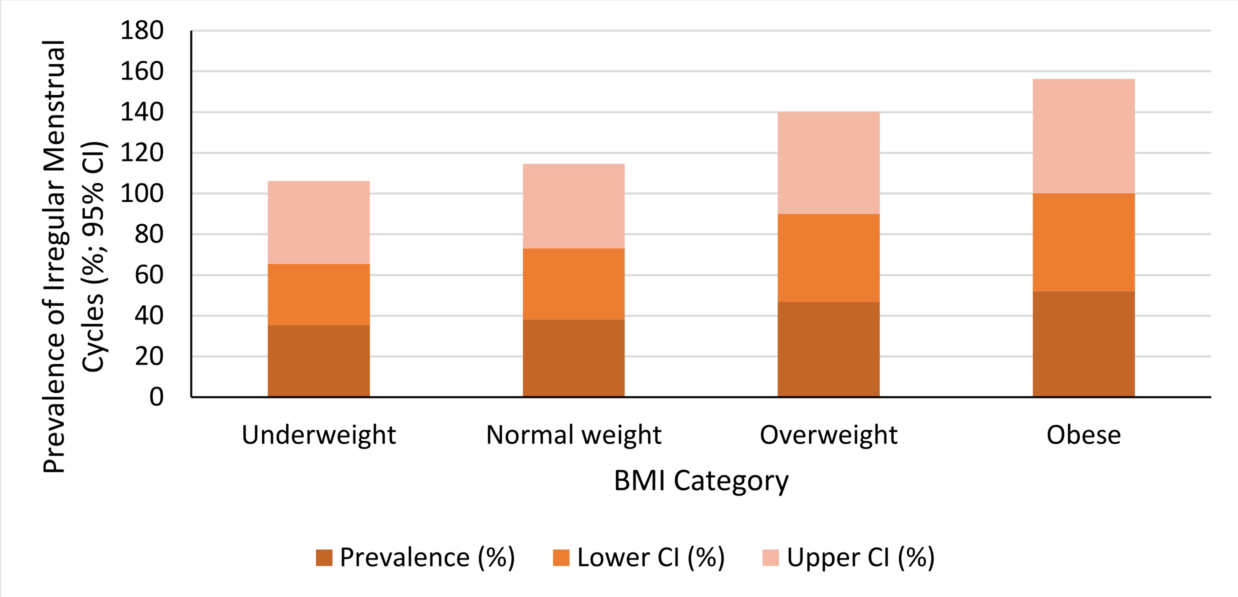


**Figure 2.** Prevalence of Irregular Cycles by BMI Category

### 3.3.2 Life Stage

Participants in the perimenopausal stage demonstrated a substantially higher prevalence of irregular cycles (59.8%) compared to those in the reproductive stage (39.3%), corresponding to a risk difference of +20.5 percentage points and a PR of 1.52 (95% CI: 1.42–1.63). Figure 3 illustrates the comparative prevalence of irregular cycles between reproductive and perimenopausal participants, highlighting the substantial difference between the two life stages.

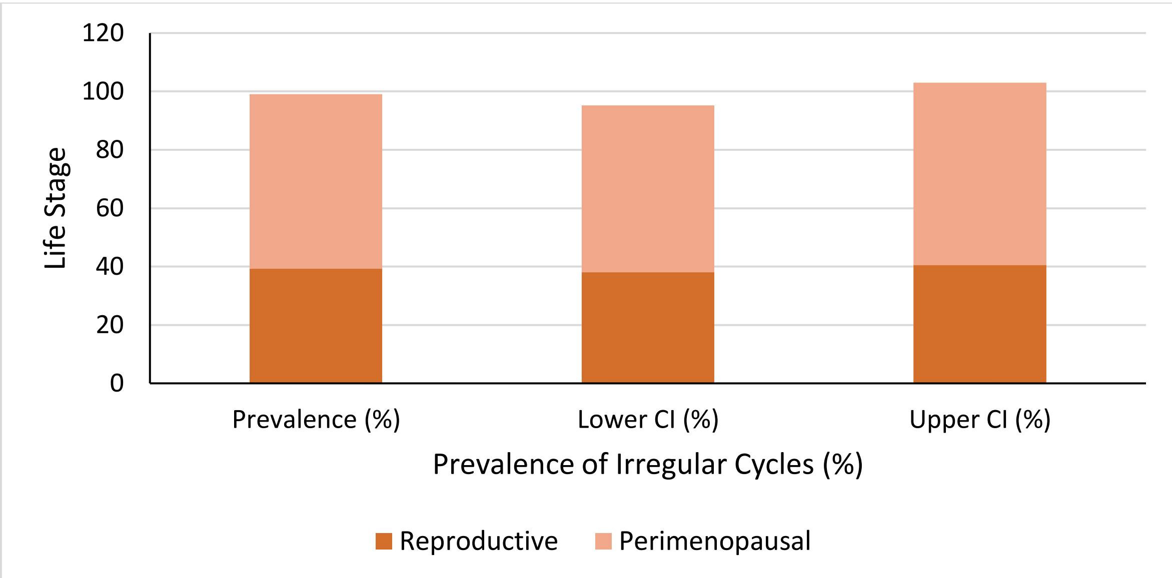


**Figure 3.** Irregular Cycle Prevalence by Life Stage

### 3.3.3 Pain Severity

Irregular cycle prevalence also rose with pain severity: low pain (35.7%), medium pain (41.9%), and high pain (50.2%). The high-pain group showed a +14.5 percentage point difference compared to the low-pain group, with a PR of 1.41 (95% CI: 1.32–1.51). Table 2 presents the prevalence of irregular menstrual cycles across BMI categories, reproductive life stages, and pain severity tertiles. The data include corresponding risk differences and prevalence ratios with 95% confidence intervals. Notably, prevalence was highest among perimenopausal women and those reporting high pain severity, indicating clear lifestyle- and symptom-related gradients in menstrual cycle regularity.

**Table 3.** Prevalence of Irregular Cycles by BMI Category, Life Stage, and Pain Severity

| Variable | Category | Prevalence (%) | Risk Difference (pp) | Prevalence Ratio (95% CI) |
|---|---|---|---|---|
| **BMI Category** | Underweight | 38.5 | Ref | Ref |
| | Normal weight | 40.2 | +1.7 | 1.04 (0.96–1.13) |
| | Overweight | 44.9 | +6.4 | 1.17 (1.07–1.28) |
| | Obese | 51.3 | +12.8 | 1.33 (1.21–1.47) |
| **Life Stage** | Reproductive | 39.3 | Ref | Ref |
| | Perimenopausal | 59.8 | +20.5 | 1.52 (1.42–1.63) |
| **Pain Severity Tertile** | Low | 35.7 | Ref | Ref |
| | Medium | 41.9 | +6.2 | 1.17 (1.08–1.27) |
| | High | 50.2 | +14.5 | 1.41 (1.32–1.51) |

### 3.4 Secondary Findings

#### 3.4.1 Disorder-Specific Distributions and Associations

Menorrhagia prevalence was highest among obese women (26.9%, PR vs. normal weight = 1.32, 95% CI: 1.18–1.48) and perimenopausal women (33.5%, PR vs. reproductive = 1.53, 95% CI: 1.39–1.68). Amenorrhea was most frequent among underweight women (13.2%, PR vs. normal weight = 1.56, 95% CI: 1.30–1.87) and women with high pain severity (11.8%, PR vs. low pain = 1.41, 95% CI: 1.21–1.64). Oligomenorrhea showed strong associations with obesity (23.8%, PR vs. normal = 1.35, 95% CI: 1.20–1.52) and high pain severity (24.7%, PR vs. low = 1.39, 95% CI: 1.23–1.57). Polymenorrhea was more common in perimenopausal participants (19.8%, PR vs. reproductive = 1.48, 95% CI: 1.27–1.73), while intermenstrual bleeding also occurred more frequently in the perimenopausal stage (16.1%, PR vs. reproductive = 1.45, 95% CI: 1.23–1.70).

Table 4 presents the prevalence, risk differences, and prevalence ratios for each menstrual disorder across BMI categories, life stages, and pain severity tertiles.

**Table 4.** Prevalence of Specific Menstrual Disorders by BMI Category, Life Stage, and Pain Severity

| Disorder | Variable | Category | Prevalence (%) | Risk Difference (pp) | Prevalence Ratio (95% CI) |
|---|---|---|---|---|---|
| **Menorrhagia** | BMI | Underweight | 18.2 | Ref | Ref |
| | | Normal weight | 20.4 | +2.2 | 1.12 (0.98–1.27) |
| | | Overweight | 23.1 | +4.9 | 1.27 (1.12–1.44) |
| | | Obese | 26.9 | +8.7 | 1.32 (1.18–1.48) |
| | Life Stage | Reproductive | 21.9 | Ref | Ref |
| | | Perimenopausal | 33.5 | +11.6 | 1.53 (1.39–1.68) |
| | Pain Severity | Low | 18.6 | Ref | Ref |
| | | Medium | 22.8 | +4.2 | 1.23 (1.09–1.38) |
| | | High | 25.4 | +6.8 | 1.36 (1.21–1.53) |
| **Amenorrhea** | BMI | Underweight | 13.2 | Ref | Ref |
| | | Normal weight | 7.9 | -5.3 | 0.60 (0.50–0.72) |
| | | Overweight | 8.2 | -5.0 | 0.62 (0.51–0.75) |
| | | Obese | 9.5 | -3.7 | 0.72 (0.59–0.87) |
| | Life Stage | Reproductive | 8.0 | Ref | Ref |
| | | Perimenopausal | 11.4 | +3.4 | 1.42 (1.18–1.72) |
| | Pain Severity | Low | 8.4 | Ref | Ref |
| | | Medium | 8.0 | -0.4 | 0.95 (0.78–1.15) |
| | | High | 11.8 | +3.4 | 1.41 (1.21–1.64) |
| **Oligomenorrhea** | BMI | Underweight | 19.4 | Ref | Ref |
| | | Normal weight | 18.0 | -1.4 | 0.93 (0.82–1.06) |
| | | Overweight | 20.9 | +1.5 | 1.08 (0.96–1.22) |
| | | Obese | 23.8 | +4.4 | 1.35 (1.20–1.52) |
| | Life Stage | Reproductive | 18.3 | Ref | Ref |
| | | Perimenopausal | 23.7 | +5.4 | 1.29 (1.14–1.46) |

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|---|---|---|---|---|---|
| | Pain Severity | Low | 17.7 | Ref | Ref |
| | | Medium | 19.5 | +1.8 | 1.10 (0.97–1.24) |
| | | High | 24.7 | +7.0 | 1.39 (1.23–1.57) |
| **Polymenorrhea** | BMI | Underweight | 14.0 | Ref | Ref |
| | | Normal weight | 13.8 | -0.2 | 0.99 (0.85–1.16) |
| | | Overweight | 14.5 | +0.5 | 1.04 (0.89–1.21) |
| | | Obese | 14.8 | +0.8 | 1.06 (0.91–1.24) |
| | Life Stage | Reproductive | 13.4 | Ref | Ref |
| | | Perimenopausal | 19.8 | +6.4 | 1.48 (1.27–1.73) |
| | Pain Severity | Low | 13.1 | Ref | Ref |
| | | Medium | 14.4 | +1.3 | 1.10 (0.94–1.29) |
| | | High | 15.6 | +2.5 | 1.19 (1.02–1.38) |
| **Intermenstrual Bleeding** | BMI | Underweight | 12.0 | Ref | Ref |
| | | Normal weight | 12.3 | +0.3 | 1.02 (0.86–1.21) |
| | | Overweight | 12.9 | +0.9 | 1.07 (0.90–1.26) |
| | | Obese | 13.4 | +1.4 | 1.11 (0.94–1.31) |
| | Life Stage | Reproductive | 11.1 | Ref | Ref |
| | | Perimenopausal | 16.1 | +5.0 | 1.45 (1.23–1.70) |
| | Pain Severity | Low | 11.4 | Ref | Ref |
| | | Medium | 12.8 | +1.4 | 1.12 (0.95–1.33) |
| | | High | 14.0 | +2.6 | 1.23 (1.04–1.45) |

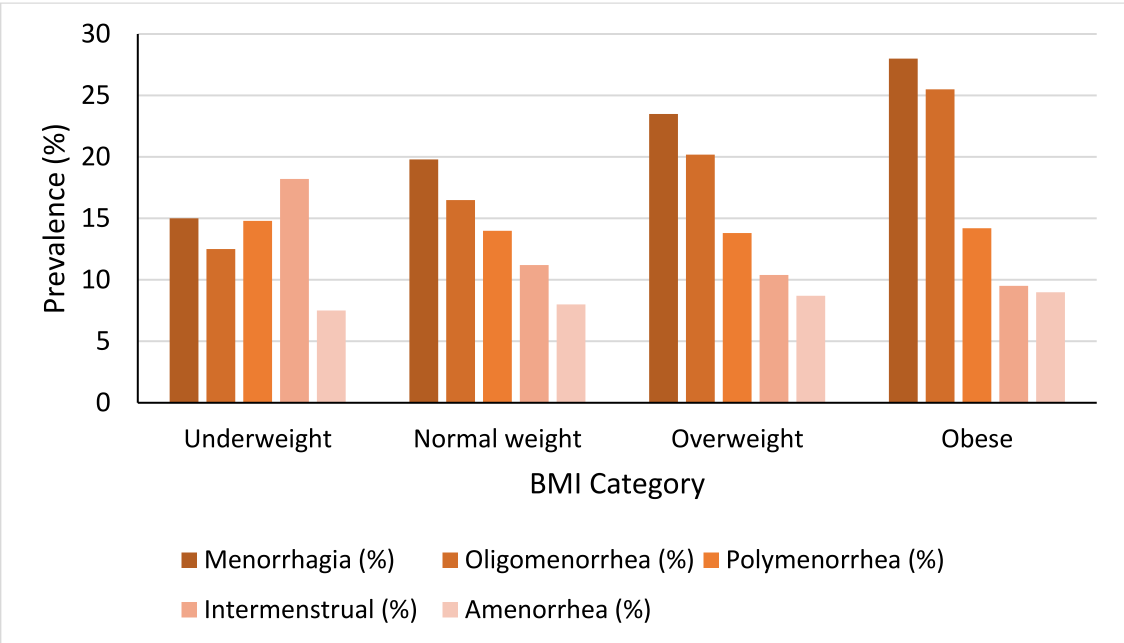


**Figure 4.** Distribution of Specific Menstrual Disorders by BMI Category

Figure 4 illustrates how the prevalence of different menstrual disorders—oligomenorrhea, polymenorrhea, amenorrhea, menorrhagia, and intermenstrual bleeding—varies across BMI categories. Notably, obese participants showed a higher proportion of menorrhagia and amenorrhea, whereas underweight participants had a greater share of oligomenorrhea cases. Figure 5 illustrates the variation in the prevalence of menstrual disorders across life stages. Perimenopausal participants exhibited higher proportions of menorrhagia and oligomenorrhea compared to those in the reproductive stage, while amenorrhea and intermenstrual bleeding were also more frequent in the perimenopausal group.

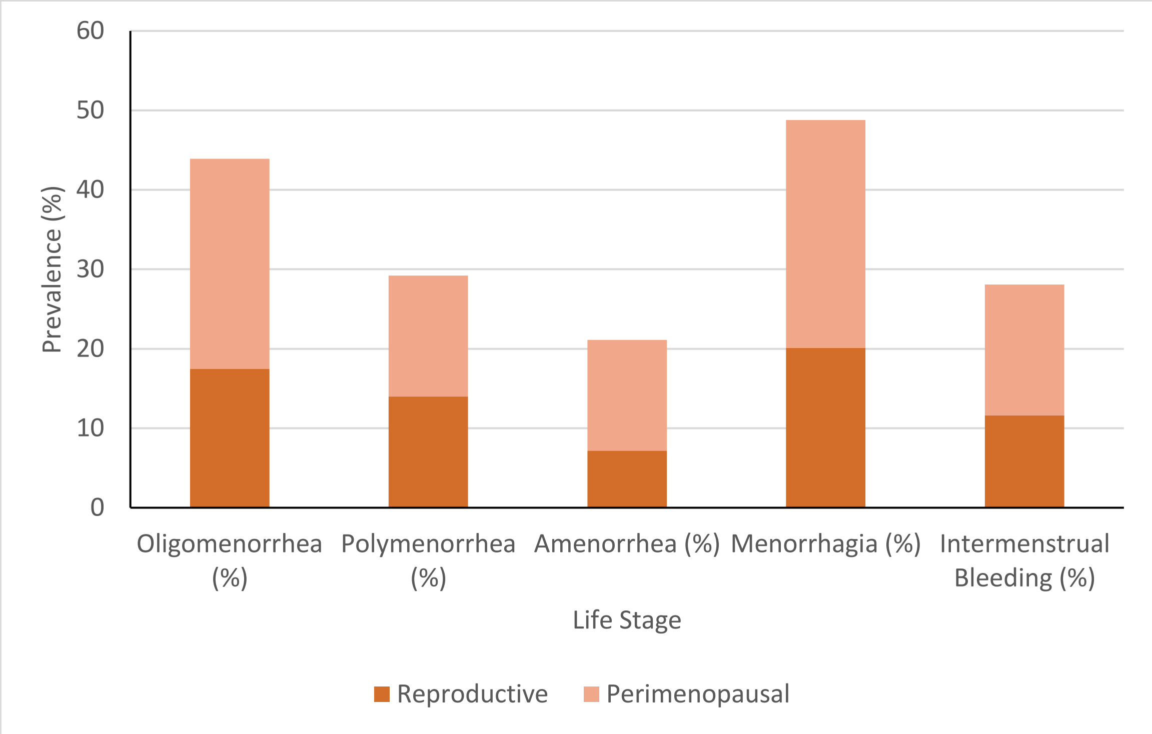


**Figure 5.** Distribution of Specific Menstrual Disorders by Life Stage

### 3.4.2 Sensitivity Analysis

In the primary analysis (n = 8,445), the prevalence of irregular cycles was 42.6%. Excluding participants with missing pain score data (n = 215) yielded a complete-case sample of 8,230, with a prevalence of 42.5% for irregular cycles. The prevalence ratio (PR) for high versus low pain severity was 1.41 (95% CI: 1.32–1.51) in the main analysis and 1.40 (95% CI: 1.31–1.50) in the complete-case analysis. Across BMI and life stage categories, prevalence estimates differed by less than 0.3 percentage points between analyses, and all associations retained statistical significance. These results indicate minimal bias from missing data, confirming the robustness of the primary findings. As shown in Table 5, the complete-case sensitivity analysis produced results nearly identical to the main analysis, with only a 0.1% difference in irregular cycle prevalence and negligible change in the PR for high versus low pain severity. This consistency indicates that missing pain score data had minimal impact on the study's findings.

**Table 5.** Comparison of Main vs. Sensitivity Analysis (Complete-Case) for Irregular Cycle Prevalence and Pain Severity Association

| Analysis Type | Sample Size (n) | Prevalence of Irregular Cycles (%) | PR (High vs. Low Pain) | 95% CI |
|---|---|---|---|---|
| Main Analysis | 8,445 | 42.6 | 1.41 | 1.32–1.51 |
| Complete-Case (No Missing Pain Scores) | 8,230 | 42.5 | 1.40 | 1.31–1.50 |

## 4. DISCUSSION

This research was able to conclude that irregular menstrual cycles were highly likely to occur in women with increased body mass index (BMI), increased pain severity, and in the perimenopausal phase. The results agree with those that have attributed menstrual irregularities to lifestyle-related factors. The overweight and obese women tend to develop hormonal imbalance, hyperandrogenism, and insulin resistance, which disrupts ovulatory cycles (Aly & Decherney, 2021; Mansour Ibrahim *et al.*, 2023). The same associations were reported by (S Hussein *et al.*, 2022). The increased rates of menorrhagia and amenorrhea in obese individuals in our cohort are similar to those in the community and clinical cohorts in which metabolic imbalance posed a threat to menstrual dysfunction (Abd Elmenim & Emam, 2016). These results justify the applicability of BMI during screening tests of gynecological procedures.

Lifestyle interventions have been promising in enhancing menstrual regularity, especially in populations with polycystic ovary syndrome (PCOS). The intervention that comprises the combination of dietary change, physical activity, and behavioral counseling has been demonstrating improvements after 3-6 months (Hassan *et al.*, 2025; Bashir *et al.*, 2025). These effects are also supported by evidence among the different age groups (Long *et al.*, 2025). The other finding within our data is that life-stage transitions have a powerful effect on menstrual patterns. A large fluctuation in menstrual cycles is associated with perimenopause, or a time of fluctuating estrogen and progesterone (Vaddi *et al.*, 2022; Das & Fatima, 2024). The same association is found in (Aly & Decherney, 2021), which is also in line with our result that irregular cycles were 20.5 percentage points more frequent in perimenopausal women, which is considered a compounding effect of lifestyle exposures and age-related endocrine changes. The second important aspect was the intensity of pain, and the prevalence ratio of irregular cycles was higher among women in the highest tertile (1.41 times) as compared to the lowest tertile. The causes of chronic pain and its effects on menstrual health are the destruction of the hypothalamic-pituitary-ovarian (HPO) axis through stress, decreased physical activity, and sleep disturbances (Abd Elmenim & Emam, 2016; Long *et al.*, 2025). The same remarks have been given by (Mansour Ibrahim *et al.*, 2023). It has also been discussed in (S Hussein *et al.*, 2022) the burden of somatic symptoms and menstrual health, especially when it comes to women who are likely to have metabolic disorders.

Mechanistically, there is an interaction between adiposity and stress, and hormonal changes to influence menstrual health. The excessive volume of fat tissue has the potential to be the cause of the peripheral conversion of androgen to estrogen, disruption of gonadotropin pulse, and the impairment of endometrial regulation (Hassan *et al.*, 2025; Das & Fatima, 2024). Other mechanisms of this sort have been described by (Bashir *et al.*, 2025). Stress and pain also raise the levels of cortisol, which suppresses the gonadotropin-releasing hormone, which hurts ovulation (Long *et al.*, 2025; Vaddi *et al.*, 2022). This pathway of hormonal suppression is also elaborated by Aly & Decherney (2021). The strengths of the study are a large sample size, the evaluation of several subtypes of menstrual disorder, and the reporting of risk differences and prevalence ratios, which made it possible to identify both general and disorder-specific trends. The cross-sectional design cannot, however, be used to draw a causal inference. Moreover, important lifestyle variables, including the composition of the diet, the level of physical activity, and sleep duration, were not directly determined, which provided the opportunity to introduce residual confounding (Abd Elmenim & Emam, 2016; Vaddi *et al.*, 2022). The recollection of the history of menstruation is also biased (S Hussein *et al.*, 2022).

BMI, life stage, and pain severity are the most easily measurable indicators that can be included in the regular gynecological and primary care screening (Mansour Ibrahim *et al.*, 2023; Hassan *et al.*, 2025). The results of (Bashir *et al.*, 2025) advocate for the early detection of women at risk to provide them with lifestyle counseling promptly to avoid the further development of reproductive or metabolic disorders. The nutrition education, home-based exercise interventions, and pain management techniques are low-intensity interventions, which can be scaled and have a significant potential to improve menstrual regularity (Aly & Decherney, 2021; Das & Fatima, 2024). Studies have shown that such methods can be used to treat different people (Long *et al.*, 2025). The proposed research will have to be a longitudinal or interventional study that includes objective sleep (actigraphy), physical activity (accelerometry), and metabolism (continuous glucose monitoring) data (Hassan *et al.*, 2025; Bashir *et al.*, 2025). By performing studies in a variety of socio-cultural contexts, as proposed by Abd Elmenim & Emam (2016), one may be able to identify population-specific prevalence rates and responses to interventions, which could be targeted in their prevention.

## 5. CONCLUSION

The current research provides strong evidence that body mass index (BMI), reproductive life stage, and the degree of pain constitute strong predictors of menstrual irregularities, which have great practical implications for clinical screening and health practice in the community. When using a big, heterogeneous sample and simple, but powerful statistical tools, we were able to identify patterns that are clinically meaningful and easily applied in practice. Women with increased BMI, those in the perimenopausal period, and those who showed high pain severity were revealed to be exposed to much higher risks of having abnormal cycles and certain menstrual disorders, including menorrhagia in obese women and oligomenorrhea in underweight ones. These findings are very applicable in primary care and community health because of the use of simple, quantifiable indicators. The introduction of BMI, life stage, and pain assessment into the regular gynecological examination process will help to identify risks early and provide an opportunity to perform lifestyle counseling in a timely manner. Such interventions, which are based on balanced nutrition, physical activity, and pain management, are cost-effective, scalable, and can be applied in different cultural and socioeconomic settings. In addition to direct clinical advantages, the study offers a baseline to develop specific education, screening, and intervention initiatives on the local, national, and even global scales. The presented relationships between the factors that can be altered and menstrual health outcomes underscore the necessity to incorporate menstrual health into the overall women's health strategies. Future studies ought to take the form of prospective or interventional studies in order to assess the efficacy of lifestyle modification programmes based on BMI category, reproductive stage, and pain profile directly. Evidence and causal inference would be improved by objective measures of diet, physical activity, and sleep. Taking into account these factors that are possible to change, health professionals will be able to transition to a more inclusive, dynamic, equity-based model of menstrual health management.

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