

## RESEARCH STUDY

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# Factors Influencing the Menstrual Cycle of Female College Students in Depok, Indonesia

## Faktor yang Mempengaruhi Siklus Menstruasi pada Mahasiswi di Depok, Indonesia

Syania Fitri<sup>1</sup>, Nur Intania Sofianita<sup>1\*</sup>, Yessi Crosita Octaria<sup>1</sup><sup>1</sup>Bachelor of Nutrition Study Program, Faculty of Health Sciences, Pembangunan Nasional "Veteran" Jakarta University, Jakarta, Indonesia

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**\*Correspondent:**

Nur Intania Sofianita

[intania@upnvj.ac.id](mailto:intania@upnvj.ac.id)

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### ABSTRACT

**Background:** Adolescence is a critical period in life when reproductive organs mature and develop, especially in teenage girls. The menstrual cycle plays a crucial role in female reproductive health, often disrupted by various factors.**Objectives:** This research aims to identify factors affecting the menstrual cycle in female college students in Depok.**Methods:** This cross-sectional study involved 193 participants selected through stratified random sampling. Data collection included fast food consumption habits (measuring frequency and the amount of fat intake) using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), sleep quality assessment using the Pittsburgh Sleep Quality Index (PSQI), stress levels evaluation using the Perceived Stress Scale-10 (PSS-10), and menstrual cycles assessment using the menstrual cycle questionnaire. Statistical analysis employed chi-square tests and multiple logistic regression.**Results:** No significant correlation was observed between the frequency of fast food consumption and the menstrual cycle (p-value=0.780). Conversely, fat intake (p-value=0.027; OR=2.6), sleep quality (p-value=0.009; OR=10.8), and stress levels (p-value<0.001; OR=7.19) showed a significant correlation with the menstrual cycle. Multivariate analysis identified stress level as the predominant factor (p-value<0.001; OR=9.411).**Conclusions:** This research concluded that there is a significant correlation between fat intake, sleep quality, stress levels, and the menstrual cycles among college students in Depok. Stress level emerged as the primary factor affecting adolescent respondents' menstrual cycles.

### INTRODUCTION

Adolescence is a transitional period from childhood to adulthood, characterized by physical changes (such as the development of secondary sexual characteristics and rapid growth), achieving reproductive capacity, and gonadal maturation during gonadarche<sup>1</sup>. Sex differences in the onset and tempo of puberty are evident: girls typically experience earlier pubertal onset (8-12 years), marked by menarche, and exhibit a more linear increase in pubertal development with age compared to boys (9-14 years)<sup>2</sup>.

Adolescence is a critical period in life when reproductive organs mature and develop, especially in females. One of the key aspects of female adolescent reproductive health is the menstrual cycle. Menstruation is a natural physiological process that signifies the maturation of the reproductive organs and serves as an indicator of reproductive health. Approximately 5–7 years after menarche, menstrual cycles tend to lengthen and then gradually shorten until they become more

regular and normal, particularly during the reproductive phase between the ages of 20 and 40.

Adolescent girls are prone to menstrual cycle disorders. Menstrual cycle irregularities are a common issue, especially among late adolescents, with a prevalence of up to 75.0%<sup>3</sup>. According to National Basic Health Research (Riskesdas) data, 11.7% of adolescents in Indonesia experience irregular menstruation, with the prevalence in urban areas reaching 14.9%<sup>4</sup>. In West Java, 14.4% of adolescents experience irregular menstrual cycles<sup>5</sup>.

Irregular menstrual cycles in adolescent girls can have various health consequences. Menstrual irregularities have been linked to several diseases and medical conditions, including type 2 diabetes mellitus (DM), rheumatoid arthritis (RA), anemia, depression, anxiety, osteoporosis, and an increased risk of subfertility<sup>6</sup>. Several modern lifestyle and environmental factors can negatively impact the menstrual cycle of adolescent girls, such as fast food consumption, poor

sleep quality, and stress caused by academic or social pressures. These factors collectively contribute to menstrual cycle disorders.

The rise in fast food consumption among adolescents is associated with lifestyle changes and eating habits. Fast food refers to meals prepared and sold quickly at restaurants—commonly associated with Western restaurant chains, and ready to serve for takeout. According to the GSHS survey in 2015, 56.2% of women and 54.0% of men consumed fast food in the past seven days<sup>7</sup>. Fast food consumption has been linked to an increased risk of menstrual cycle disorders in adolescent girls. Fast food is generally high in saturated fat, sugar, and salt while being low in fiber, minerals, and essential vitamins that are important for health. Consuming nutrient-poor food can lead to menstrual cycle disturbances. This finding aligns with Ratnawati's research conducted among female students at SMAN 1 Sewon, which revealed that those who frequently consumed fast food experienced irregular menstrual cycles at a prevalence of 71.4%, compared to 33.3% among those who rarely consumed it<sup>8</sup>.

In addition to fast food consumption, sleep quality, and stress levels can also affect the menstrual cycle of adolescent girls. In Depok, the prevalence of sleep disturbances was found to be 44.8%, with most cases affecting adolescents<sup>9</sup>. Between 20% and 40% of college students reported getting less sleep than the recommended sleep duration for their age group<sup>10</sup>. College students frequently report that sleep is one of the first health behaviors they sacrifice during their studies<sup>11</sup>.

Lack of sleep in adolescent girls can lead to hormonal imbalances that disrupt the menstrual cycle. Sleep deprivation has been associated with menstrual irregularities, pain, and stress related to menstrual symptoms<sup>12</sup>. This finding is supported by research conducted by Siregar et al. on female medical students at the Faculty of Medicine, Islamic University of North Sumatra. The study found that 44 respondents (67.7%) had poor sleep quality, and 21 of them (32.3%) experienced abnormal menstrual cycles<sup>13</sup>.

In adolescents, stress can be triggered by various social dynamics, such as relationships with family and friends or academic challenges. Adolescents who experienced stress were 7.27 times more likely to have menstrual disorders compared to those who did not. According to the 2018 National Basic Health Research (Riskesmas), 7.8% of the population aged over 15 in West Java experience stress<sup>4</sup>.

Stress refers to the pressure or demands individuals face as they adapt or adjust to various circumstances. It significantly affects individual overall well-being by affecting the immune and endocrine systems, as well as the menstrual cycle. Stress stimulates the hypothalamic-pituitary-adrenal (HPA) axis, leading to increased cortisol production. This, in turn, causes hormonal imbalances, including disruptions in reproductive hormones, which can result in irregular menstrual cycles. Research conducted by Achmad et al. on female medical students at the Christian University of Indonesia in 2017 revealed that 29 out of 52 respondents experienced severe stress, primarily due to academic

pressures. Among them, 17 respondents reported irregular menstrual cycles<sup>14</sup>.

Based on the findings above, this study aims to identify the most influential factors affecting menstrual cycles among female university students in Depok. The results of this research are expected to advance scientific knowledge and serve as a valuable reference for health professionals, policymakers, and educational institutions in designing educational and counseling programs that support female students' reproductive health. Moreover, the study aims to provide direct benefits to female students by helping them understand the factors influencing their menstrual cycles. With this knowledge, students can take preventive measures to maintain and improve their reproductive health.

## METHODS

### Study Design, Time, and Settings

This cross-sectional study was conducted from February to May 2024 among female undergraduate students aged 18–21 years majoring in Nutrition Science at the University of Pembangunan Nasional 'Veteran' Jakarta. Ethical approval for the study was obtained from the Health Research Ethics Committee of Pembangunan Nasional 'Veteran' Jakarta University (Approval Number: 73/III/2024/KEP) on March 4<sup>th</sup>, 2024.

### Sample Size Calculation and Recruitment

Using a population of 336 female undergraduate Nutrition Science students at Pembangunan Nasional 'Veteran' Jakarta University, we calculated a sample size of 182 using an appropriate formula. Stratified random sampling was employed to select participants from UPNVJ Nutrition students across the classes of 2020, 2021, 2022, and 2023. Participants were recruited based on specific inclusion and exclusion criteria. To be included, participants had to be active students in the UPNVJ Nutrition program from the classes of 2020 to 2023, willing to participate, present during data collection, and have a history of menstruation. Exclusion criteria included unwillingness to participate, being inactive students, following a diet, smoking, taking certain medications (for thyroid conditions, epilepsy, depression, or undergoing chemotherapy), having a history of reproductive disorders (e.g., ovarian tumors, fibroids, or other reproductive conditions), or experiencing hormonal imbalances. These criteria ensured that the sample was appropriate for examining the relationship between fast food consumption, sleep quality, stress levels, and menstrual cycles among female students.

### Data Collection Procedure

Data were collected through questionnaires administered by trained enumerators to ensure data quality. The questionnaires assessed respondent characteristics, including age, nutritional status, and residence. A questionnaire on menstrual cycle history, consisting of closed-ended questions, was designed to obtain data on cycle length and classify it into the following categories: normal (21-35 days length) and abnormal cycle. The abnormal categories included polymenorrhea with a cycle length of less than 21 days,

oligomenorrhea with a cycle length greater than 35 days, and secondary amenorrhea characterized by the absence of menstruation for  $\geq 3$  consecutive months. Participants' fast food consumption (frequency and fat intake) was measured using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Sleep quality and stress levels were evaluated using the Pittsburgh Sleep Quality Index (PSQI) and Perceived Stress Scale-10 (PSS-10), respectively. Enumerators conducted interviews and measured participants' height and weight.

#### Data Analysis

Respondent characteristics were analyzed using univariate analysis. Menstrual cycles were categorized as normal or abnormal. Fast food consumption frequency was dichotomized as infrequent (below mean) or frequent (above mean). Fat intake from fast food was categorized as adequate or excessive relative to individual Recommended Dietary Allowances (RDAs). Sleep quality was classified as good ( $\leq 5$ ) or poor ( $> 5$ ) using the Pittsburgh Sleep Quality Index (PSQI). Stress levels were categorized as mild, moderate, or severe using the Perceived Stress Scale-10 (PSS-10).

The data analysis employed IBM SPSS Statistics version 23. Chi-square tests were used to examine relationships between fast food consumption, sleep quality, and stress levels as independent variables and menstrual cycle (dependent variable). The level of significance was determined at  $p\text{-value} < 0.05$ . Due to the absence of respondents with abnormal menstrual cycles in the mild stress category, therefore the stress levels were dichotomized into mild/moderate and severe. Multivariate logistic regression analysis was then performed to assess fat intake, sleep quality, and stress level as predictors of menstrual cycle status, incorporating variables with significant correlations.

#### RESULTS AND DISCUSSIONS

Table 1 displays the relationships between fast food consumption frequency, fat intake, sleep quality, stress levels, and menstrual cycles among female university students in Depok. The table provides an overview of the correlations between these variables. Results indicate significant associations between fat intake, sleep quality, stress levels, and menstrual cycle status ( $p\text{-value} < 0.05$ ).

**Table 1.** The relationship between fast food consumption frequency, fat intake, sleep quality, stress levels, and menstrual cycles among female university students in Depok, Indonesia.

Variable	Menstrual Cycle				Total		p-value	OR
	Normal		Abnormal		N	%		
	n	%	n	%				
<b>Fast Food Consumption Frequency</b>								
Infrequent	87	45.1	24	12.4	111	57.5	0.780	1.169
Frequent	62	32.1	20	10.4	82	42.5		
<b>Fat Intake</b>								
Adequate	126	65.3	30	15.5	156	80.8	0.027*	2.557
Excessive	23	11.9	14	7.3	37	19.2		
<b>Sleep Quality</b>								
Good	30	15.5	1	0.5	31	16.1	0.009*	10.840
Poor	119	61.7	43	22.3	162	83.9		
<b>Stress Level</b>								
Mild to Moderate	139	72.0	29	15.0	168	87.0	<0.001*	7.190
Severe	10	5.2	15	7.8	25	13.0		

\*)  $p\text{-value} < 0.05$

#### Relationship between Fast Food Consumption Frequency and Menstrual Cycle

Fast food is often referred to as Food Away from Home (FAFH). Generally, this type of food is quickly prepared in restaurants and can be taken home by customers. It is designed for instant availability and includes items such as hamburgers, pizza, fried chicken, and sandwiches. Traditional examples of fast food in Indonesia include *nasi padang*, meatball soup (*bakso*), chicken noodles (*mie ayam*), and Tegal food stalls (*warung tegal*)<sup>15</sup>. Fast food is designed for convenience, catering to individuals with limited time for meal preparation.

Fast food is frequently categorized as junk food (JF). According to the National Institute of Nutrition (NIN), junk food is characterized by high levels of salt, sugar, fat, and calories but is low in protein, vitamins, or minerals. Mursidah reported that fast food is nutritionally dense in calories, fat, salt, and sugar while being deficient in fiber, nutrients, ascorbic acid, calcium, and folate<sup>15</sup>. Although

not all fast food is classified as junk food, most fast food falls into this category due to its quick preparation and serving time.

The study findings indicated that among 111 female students who infrequently consumed fast food, 24 (12.4%) experienced irregular menstrual cycles. Conversely, of the 82 students who frequently consumed fast food, 20 (10.4%) had irregular menstrual cycles. Statistical analysis revealed no significant correlation between the frequency of fast food consumption and menstrual cycle regularity among Nutrition Science students at UPNVJ ( $p\text{-value} = 0.780$ ,  $p\text{-value} > 0.050$ ). Although the correlation was not statistically significant, a trend was observed in which students who frequently consumed fast food had a slightly higher likelihood of experiencing irregular menstrual cycles compared to those who consumed it less frequently (OR=1.2).

Fast food companies effectively target young people through sophisticated promotional strategies, appealing recipes, and engaging advertisements. Female

students are particularly drawn to fast food for several reasons. First, it is easily accessible, typically ready to eat, and requires minimal time to consume, making it convenient for a busy and active lifestyle. Second, fast food is flavorful and offers a wide variety of choices. Third, it is affordable and readily available, encouraging its inclusion in daily routines and contributing to an increase in fast food consumption among female students.

This study's findings diverge from previous research by Harefa and Rahma, who identified a significant correlation ( $p$ -value $<0.050$ ) between fast food consumption frequency and menstrual cycle regularity<sup>16,17</sup>. However, our study results align with Fadillah and Puspitasari's study, which found no significant correlation between fast food consumption and menstrual cycle irregularities. Their study revealed that 67.1% of the 85 respondents experienced irregular menstrual cycles despite infrequent fast food consumption ( $p$ -value=0.722)<sup>18</sup>. These findings suggest that infrequent but large portions of fast food may significantly impact menstrual cycles.

Similarly, this study aligns with the findings of the Manurung et al. study, which reported no significant correlation between junk food consumption and menstrual cycle irregularities ( $p$ -value $>0.05$ ). In their study, the majority of 20-year-old respondents (51.5%) had regular menstrual cycles despite infrequent or occasional junk food consumption (39.4%)<sup>19</sup>.

Although this study did not find a significant correlation between fast food consumption and menstrual cycles, it is crucial to emphasize the effect of overall dietary habits on reproductive health. Excessive consumption of fast food can lead to increased body fat accumulation, contributing to hormonal imbalances, including those that regulate menstrual cycles.

### Relationship between Fat Intake and Menstrual Cycle

Fat is an essential nutrient found in a wide variety of daily foods, playing a critical role in numerous physiological processes, including those related to reproductive health. As one of the three primary macronutrients, alongside carbohydrates and proteins, fat contributes significantly to energy storage, structural integrity, and overall bodily function. Chemically, fat consists of fatty acid molecules bound to glycerol, forming triglycerides. These triglycerides are derived from both animal and plant-based sources, making fat a versatile nutrient available in foods such as meat, dairy products, butter, olive oil, and nuts. The types of fats consumed vary widely, including saturated fats predominantly found in animal products, and unsaturated fats present in foods like olive oil and avocados.

The primary function of fat is to act as a dense energy source, providing 9 calories per gram—more than double the caloric content of carbohydrates and proteins. This energy-dense property makes fat indispensable for sustaining prolonged physical activity and supporting metabolic processes, particularly during periods of energy deficit. Fat also plays a vital role in maintaining the structural integrity of cell membranes, which are primarily composed of phospholipids. Furthermore, fat

serves as a medium for the absorption of fat-soluble vitamins (A, D, E, and K), which are essential for various physiological functions. Additionally, fat is instrumental in hormone regulation, particularly in the synthesis of steroid hormones such as estrogens, progesterone, and testosterone.

This study examines the relationship between fat intake and menstrual cycle regularity in female adolescents aged 18–21 years. Total fat intake was assessed and compared to the Recommended Dietary Allowance (RDA). According to the RDA, female adolescents aged 16–18 require approximately 71 grams of fat per day, while those aged 19–24 require about 65 grams per day. Assessing fat intake is essential to determine whether an individual's consumption is adequate or excessive.

The chi-square test revealed a statistically significant relationship between dietary fat intake and menstrual cycle regularity ( $p$ -value=0.027). Female students with excessive fat intake were 2.6 times more likely to experience menstrual irregularities compared to those with adequate fat intake (OR=2.6). Among the 126 female students (65.3%) with adequate fat intake, 65.3% had normal menstrual cycles, while 15.5% experienced irregular cycles. Conversely, in the group with excessive fat intake, only 11.9% had normal menstrual cycles and 7.3% experienced irregular cycles. Detailed information regarding the relationship between fat intake and menstrual cycle regularity is presented in Table 1.

This study identifies a distinct difference between the frequency of fast food consumption and total daily fat intake in their influence on menstrual cycles. Regarding the frequency of fast food consumption, no significant correlation was observed between how often fast food was consumed and menstrual cycle regularity. However, when total fat intake was compared to the Recommended Dietary Allowance (RDA), a significant correlation was found between excessive fat intake and menstrual irregularities. This suggests that while the frequency of fast food consumption does not always directly impact menstrual cycle regularity, the total amount of fat consumed daily plays a critical role.

The study findings underscore the importance of considering the fat content in fast food. It is not solely the frequency of fast food consumption that matters but also the nutritional quality and fat content of the meals. Fast foods high in saturated fat, when consumed in excessive quantities, can increase the risk of menstrual disorders, even if consumed infrequently. This indicates that the impact on menstrual cycles can occur even with infrequent fast food consumption if individual meals contain fat beyond recommended levels.

The consumption of fast food high in fat, particularly saturated fat, is a significant factor contributing to menstrual irregularities. Fast food typically has an unbalanced nutritional composition, characterized by high levels of sodium, sugar, and fat, while being deficient in essential macronutrients such as protein and micronutrients like vitamins and minerals. Excessive intake of such foods has been associated with various health concerns, including hormonal imbalances that adversely affect the menstrual cycle<sup>20</sup>. Saturated fats, in particular, can disrupt the body's hormonal

regulatory system, specifically the production of estrogen, a hormone integral to the menstrual cycle.

Adolescent girls with excessive saturated fat intake are at an elevated risk of menstrual disorders. High saturated fat consumption from fast food can increase the production of androgen hormones, which play a role in estrogen formation through the action of the enzyme aromatase. Aromatase facilitates the conversion of androgens into estrogen within granulosa cells and adipose tissue<sup>21</sup>. Excess fat disrupts this estrogen production process, leading to hormonal imbalances that affect the menstrual cycle. These disruptions are linked to decreased hypothalamic function, which impacts gonadotropin-releasing hormone (GnRH) production. GnRH is crucial for stimulating the pituitary gland to secrete luteinizing hormone (LH) and follicle-stimulating hormone (FSH), both of which are essential for menstrual cycle regulation<sup>22</sup>.

In addition, deficiencies in essential micronutrients further contribute to menstrual irregularities in adolescents. Micronutrients such as vitamins and minerals are essential for maintaining hormonal balance in the body. A deficiency in these nutrients can impair gonadotropin production, resulting in reduced estrogen levels. This hormonal disruption can lead to a shortened luteal phase—the second phase of the menstrual cycle following ovulation—due to impaired LH secretion, ultimately causing menstrual irregularities.

The findings of this study align with the research conducted by Fauziah et al., which demonstrated a significant relationship between fat intake and menstrual cycles ( $p$ -value $<0.050$ )<sup>23</sup>. These results are further supported by Tandy and Ismawati, who also reported a significant association between fat consumption and menstrual cycles ( $p$ -value $<0.05$ ). Among the 52 study participants, 36 individuals (40.9%) reported excessive fat intake. Of these, 14 participants (15.9%) experienced regular menstrual cycles, while 22 participants (25.0%) reported irregular menstrual cycles<sup>21</sup>.

These findings underscore the critical role of fat in maintaining hormonal balance. A diet that appropriately considers daily fat intake is vital for reproductive health. Even with limited fast food consumption, the high-fat content in such foods can disrupt hormonal balance and negatively impact menstrual cycle regularity.

### Relationship between Sleep Quality and Menstrual Cycle

Sleep is a recurring and reversible state characterized by relaxation and reduced responsiveness to external stimuli compared to wakefulness<sup>24</sup>. It forms part of a daily sleep pattern, where consistent sleep timing trains the body to expect sleep at the same time each day<sup>25</sup>. During sleep, consciousness shifts, resulting in diminished perception and responsiveness to the environment<sup>26</sup>. Sleep plays a critical role in supporting mental and physical health, as well as overall well-being<sup>27</sup>.

Sleep quality refers to an individual's overall satisfaction with their sleep, including factors such as the ability to fall asleep easily, the depth and duration of sleep, and feelings of refreshment upon waking. Poor

sleep quality can manifest as difficulty falling asleep, frequent nighttime awakenings, or insufficient restorative sleep. Furthermore, short sleep duration—or inadequate sleep—can significantly impact health. Sleep deprivation disrupts the circadian rhythm, the internal biological clock that regulates the sleep-wake cycle. The circadian rhythm is essential for numerous physiological processes, including hormone secretion, body temperature regulation, and metabolic function. Compromised sleep quality can misalign the circadian rhythm, adversely affecting overall health and the reproductive system<sup>28</sup>.

A chi-square analysis at a 95% confidence level revealed a significant association between sleep quality and menstrual cycle regularity ( $p$ -value=0.002). The odds ratio (OR) of 10.8 indicated that students with poor sleep quality were 10.8 times more likely to experience menstrual irregularities compared to those with good sleep quality. Among the 162 students with poor sleep quality, 44 (26.8%) reported irregular menstrual cycles, while only 1 out of 31 students with good sleep quality (0.5%) experienced irregularities.

Poor sleep quality adversely impacts both physical and mental health. Physically, it can reduce overall well-being and increase fatigue. Psychologically, it may contribute to stress, characterized by emotional fluctuations, lack of self-confidence, impulsivity, and carelessness.

Sleep quality significantly influences the menstrual cycle through its effect on hormonal regulation. Hormones such as melatonin, cortisol, and estrogen, which are integral to the menstrual cycle, are heavily influenced by sleep patterns and circadian rhythms<sup>29</sup>. Melatonin, a hormone secreted by the pineal gland primarily during nighttime, plays a critical role in regulating sleep cycles. Elevated melatonin levels at night circulate through the bloodstream to peripheral tissues, including the ovaries<sup>30</sup>. Melatonin not only induces drowsiness but also supports the production of steroidogenic enzymes involved in Cyclic Adenosine Monophosphate (cAMP) formation—a key factor in the synthesis of major steroids such as estrogen, which is crucial for menstrual cycle regulation. Disrupted melatonin production caused by poor sleep quality may lead to hormonal imbalances, such as elevated estrogen levels, which can adversely affect menstrual cycle regularity<sup>31</sup>.

Poor sleep quality has profound implications for mental health. Melatonin, a hormone regulating sleep, influences glucocorticoid production and inhibits cortisol release from the adrenal glands. Decreased melatonin levels elevate cortisol, the stress hormone.

Studies demonstrate a significant association between sleep quality and menstrual cycle regularity. Sholihah et al. found that 81.82% of Tanjungpura University medical students ( $N=52$ ) with poor sleep quality experienced irregular menstrual cycles ( $p$ -value $<0.001$ )<sup>32</sup>. Similarly, Kennedy et al. discovered that higher Pittsburgh Sleep Quality Index scores correlated with increased menstrual irregularity ( $p$ -value=0.022) among 579 menstruating women in the SHADES Study. Poor sleep quality increased the likelihood of menstrual irregularities by 1.05 times<sup>33</sup>.

### The Relationship between Stress Levels and Menstrual Cycles

Stress is defined as a state of mental tension or anxiety resulting from challenging situations<sup>34</sup>. Piperopoulos describes stress as a natural reaction of the body to sudden environmental demands, highlighting its role as a normal physiological response<sup>35</sup>. Additionally, stress can be characterized as a condition in which an individual experiences physical and emotional imbalance due to the circumstances they encounter, with causes rooted in biological and social factors<sup>36</sup>.

According to Hardjana (1994), stress occurs when an individual becomes overwhelmed by stressors, whether actual or perceived. These stressors can include academic pressures, family issues, work-related demands, or persistent negative thinking. Stress reflects a complex interaction between a person's internal state and their biological, psychological, and social resources<sup>36</sup>. The level of stress experienced depends significantly on an individual's capacity to manage these stressors, which can vary based on personal circumstances, environmental factors, and life experiences.

Stress is pervasive in modern life, affecting individuals across all age groups and arising from diverse environments. However, a person's ability to respond effectively to stressors plays a crucial role in determining the severity of stress experienced. From a gender perspective, women tend to be more vulnerable to stress than men due to hormonal fluctuations, particularly during the menstrual cycle. These cyclic changes influence serotonin and allopregnanolone activity—both of which are endogenous anxiolytics—leading to periods of heightened susceptibility to anxiety. Consequently, women are at a higher risk of experiencing stress and anxiety compared to men<sup>37</sup>.

Based on the data presented in Table 1, a statistically significant correlation was observed between stress levels and menstrual cycle regularity ( $p$ -value $<0.05$ ). Among the 168 students experiencing mild to moderate stress, only 29 (15%) reported irregular menstrual cycles. In contrast, 15 (60%) of the 25 students with severe stress experienced irregular menstrual cycles, suggesting a 7.19-fold higher risk of irregular cycles compared to those with mild to moderate stress levels.

Stress impacts an individual's psychological, emotional, and physiological states, as the body reacts to stimuli from stressors. Stress is inherently linked to the body's responses to these stimuli, resulting in changes that affect overall well-being.

Stress can be classified into three levels based on its symptoms. Mild stress is a common part of daily life, often serving as a motivating factor to remain alert and manage potentially harmful situations. At this level, no significant physical harm typically occurs. Moderate stress involves a heightened focus on critical matters, often at the expense of less important tasks, leading to a narrowing of perception. Symptoms of moderate stress may include digestive disturbances, muscle tension, anxiety, irrational fears, sleep disorders, irregular menstrual cycles, and a lack of motivation to complete daily activities due to boredom. Severe stress, the most intense level, is characterized by a hyper-focus on

ongoing issues and pronounced symptoms. These may include severe digestive issues, irregular menstrual cycles, rapid heartbeat, shortness of breath, tremors, profound fatigue, and heightened anxiety and fear. Individuals experiencing severe stress often feel overwhelmed, confused, panicked, and unable to complete daily tasks effectively<sup>38</sup>.

Humans possess a highly advanced nervous system, which is divided into two main components. The first is the Central Nervous System (CNS), which comprises the brain, housed within the skull, and the spinal cord, protected by the vertebrae. The second component is the Peripheral Nervous System (PNS), which includes all nerves and nerve cells outside the CNS. The PNS is responsible for transmitting information from the CNS to the body's organs and relaying sensory information from the organs back to the CNS<sup>35</sup>.

A major part of the PNS is the Autonomic Nervous System (ANS), which ensures the proper functioning of internal organs and glands. The ANS is divided into two subsystems: the Sympathetic Nervous System (SNS) and the Parasympathetic Nervous System (PNS). While both subsystems are associated with the same internal organs and glands, they perform opposing functions to maintain balance in the body.

The stress response system primarily involves the Hypothalamic-Pituitary-Adrenal (HPA) axis and the ANS. These systems interact with critical CNS regions, such as the amygdala and prefrontal cortex, to integrate sensory and emotional information. This interaction enables the body to mobilize adaptive responses, including increased heart rate, elevated blood pressure, and the release of stress hormones, to cope with threatening situations<sup>35</sup>.

When an individual experiences stress, the body activates two primary pathways: the SNS and the HPA axis. The SNS initiates the "fight-or-flight" response by signaling the adrenal medulla to release epinephrine and norepinephrine into the bloodstream. These hormones induce physiological changes, such as elevated blood glucose levels, increased blood pressure, accelerated respiratory rate, and temporary suppression of reproductive function<sup>39</sup>.

The effects of epinephrine and norepinephrine are extensive, significantly influencing various physiological systems, including the reproductive system. These hormones, released into the bloodstream during the stress response, can disrupt the hormonal balance necessary for normal reproductive function. One critical mechanism involves their impact on the release of gonadotropin-releasing hormone (GnRH) from the hypothalamus. GnRH is essential for initiating and regulating reproductive cycles, as it stimulates the pituitary gland to secrete luteinizing hormone (LH) and follicle-stimulating hormone (FSH), both of which are crucial for ovulation and menstrual regulation.

Elevated levels of epinephrine and norepinephrine due to acute or chronic stress can interfere with the release of GnRH, thereby affecting the subsequent secretion of LH and FSH from the pituitary gland. This hormonal imbalance can lead to irregularities in menstrual cycles, including alterations in cycle length and frequency, or even missed periods. Consequently, women experiencing high-stress levels may face

disruptions in their menstrual cycles, highlighting the profound impact of stress on reproductive health<sup>35,39</sup>.

In addition to the rapid response mediated by the sympathetic nervous system, stress activates the hypothalamic-pituitary-adrenal (HPA) axis. The hypothalamus releases corticotropin-releasing hormone (CRH) and vasopressin (VP), which stimulate the pituitary gland (hypophysis) to secrete adrenocorticotropic hormone (ACTH)<sup>39</sup>. ACTH, in turn, prompts the adrenal glands to release cortisol, the primary hormone involved in long-term stress responses. While cortisol plays a vital role in energy metabolism, it can also suppress reproductive system functions. Elevated cortisol levels, along with other stress hormones, disrupt the release of gonadotropin-releasing hormone (GnRH), leading to reduced secretion of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) by the pituitary gland. This hormonal imbalance can interfere with ovulation and result in menstrual cycle irregularities in women.

These findings are consistent with a study conducted by Fatimah and Ayu at the Faculty of Public Health, Universitas Ahmad Dahlan Yogyakarta, involving 94 students from the 2019, 2020, and 2021 cohorts. Of the 56 students (59.6%) reporting high-stress levels, 28 (29.8%) experienced irregular menstrual cycles, while the remaining 28 (29.8%) maintained normal cycles. A chi-

square test revealed a significant association between stress and menstrual cycle disturbances (p-value=0.019). Students with high-stress levels were 3.222 times more likely to experience irregular menstrual cycles than those with lower stress levels, a statistically significant finding<sup>40</sup>.

Similarly, a study by Lutviani et al. on first-year midwifery students at Helvetia Medan Academy demonstrated a significant association between stress and menstrual cycle disturbances (p-value<0.001). Both studies underscore that high-stress levels are a substantial risk factor for menstrual cycle irregularities, emphasizing the need for stress management in mitigating these risks<sup>41</sup>.

### Dominant Factors Affecting The Menstrual Cycle

Table 2 displays the results of the multivariate logistic regression analysis, which examined the relationships between predictor variables and menstrual cycle regularity. The analysis utilized SPSS version 23, employing the enter method for variable selection. Logistic regression was chosen due to the binary nature of the dependent variable (menstrual cycle regularity; 0=irregular, 1=regular). Nonsignificant variables were excluded from the final model.

**Table 2.** Multivariate analysis results on the individual effects of each variable on the menstrual cycle.

Variable	p-value	OR	95%CI	
			Lower	Upper
Fat Intake	0.096	2.084	0.878	4.945
Sleep Quality	0.010*	16.829	1.973	143.545
Stress Level	<0.001*	9.411	3.341	26.513

\*) p-value<0.05

The results of the study identified stress level as the most significant factor influencing menstrual cycle irregularity, with a p-value<0.001 and an odds ratio (OR) of 9.411 (95% CI=3.341–26.513). These findings indicate that women experiencing high-stress levels are significantly more likely to have irregular menstrual cycles compared to women with low stress levels. Sleep quality was also found to be a significant factor (p-value=0.010), with poorer sleep quality associated with a higher likelihood of menstrual irregularities (OR=16.829).

Both stress and poor sleep quality significantly affect menstrual cycle regularity, though stress appears to be the dominant factor. Sleep disturbances can indirectly influence cortisol levels by disrupting the circadian rhythm. When sleep is disrupted, the body's stress response system becomes more sensitive, leading to increased cortisol production. Consequently, poor sleep quality exacerbates the effects of stress on menstrual cycles.

Additionally, poor sleep quality intensifies the impact of stress on menstrual cycles by impairing the body's circadian rhythm, which plays a critical role in regulating cortisol levels. A disrupted circadian rhythm hampers the body's ability to stabilize hormonal levels, including those essential for reproductive health. Disruptions in sleep patterns interfere with hormonal regulation necessary for ovarian function, ultimately contributing to menstrual irregularities.

The study's findings indicating that stress is a dominant factor in menstrual irregularities are supported by well-established biological mechanisms. The hypothalamic-pituitary-adrenal (HPA) axis, a primary component of the body's stress response system, interacts closely with the reproductive system. Stress-induced elevation of cortisol levels disrupts the hormonal balance necessary for ovulation and regular menstruation. Additionally, stress can impair the release of gonadotropin-releasing hormone (GnRH), which influences the production of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) in the pituitary gland—hormones critical for ovarian function. Therefore, stress, through elevated cortisol levels and hormonal imbalance, significantly contributes to menstrual irregularities.

These findings align with a study conducted by Fitriani et al. involving adolescent girls aged 15 years and older who had experienced menstruation for at least two years. Logistic regression analysis revealed a significant association between stress and menstrual irregularities, with an odds ratio (OR) of 2.257 (95% CI:1.075–4.73; p-value=0.031)<sup>42</sup>. Elevated stress levels were significantly associated with menstrual irregularities, reaffirming the critical role of stress in menstrual health.

This correlation is further supported by findings from Lutviani et al., who demonstrated that higher stress scores predicted a greater likelihood of menstrual

irregularities. Their study observed that individuals experiencing high-stress levels were significantly more prone to report menstrual disturbances compared to those with lower stress levels<sup>41</sup>. These studies collectively emphasize the significant impact of stress on menstrual cycle regularity and reproductive health.

The study has several strengths, including the use of a representative sample that enhances the generalizability of the findings. Furthermore, the research instruments employed, such as the Short Form Food Frequency Questionnaire (SQ-FFQ), Pittsburgh Sleep Quality Index (PSQI), and Perceived Stress Scale (PSS-10), have demonstrated strong validity and reliability, supporting the accuracy of data collection. However, the study has limitations that warrant further investigation. It did not assess hormonal levels, physical activity, nutritional status, or other potential risk factors influencing menstrual cycles, leaving areas for future research to address.

### CONCLUSIONS

This study highlights the complex interplay of factors influencing menstrual cycle regularity. Bivariate analysis revealed significant associations between fat intake, sleep quality, and stress levels with menstrual disorders. However, multivariate analysis identified stress as the primary determinant of menstrual cycle irregularity. These findings are consistent with the interaction between the body's stress response system and the reproductive system. Chronic stress activates the hypothalamic-pituitary-adrenal (HPA) axis, leading to increased cortisol levels, which can disrupt the hormonal balance necessary for ovulation and regular menstruation. Poor sleep quality may exacerbate this effect by disrupting melatonin production, which not only regulates sleep cycles but also influences the secretion of hormones such as cortisol and estrogen. As such, sleep quality can be considered a confounding factor in the relationship between stress and menstrual cycle irregularity. The findings of this study underscore the importance of a healthy lifestyle for female university students, emphasizing the need to monitor fat intake, improve sleep quality, and manage stress to maintain reproductive health. By adopting a healthy lifestyle, female students can enhance both their overall well-being and reproductive health.

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### CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors declare that they have no conflicts of interest related to this article. This research was entirely self-funded by the authors, with no financial, professional, or personal relationships that could influence the objectivity or integrity of the study. The authors confirm that the research was conducted

independently, free from external influences or personal interests that could have affected the outcomes or conclusions.

### AUTHOR CONTRIBUTIONS

SF: conceptualization, methodology, data curation, formal analysis, writing-original draft, and editing; NIS: supervision, validation, writing-review and editing; YCO: supervision, validation, writing-review & editing.

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