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RESEARCH ARTICLE

Exploring the Threads of Youth: Stress, BMI, and Menstrual Health in Hang Tuah 2 Senior High School, Sidoarjo

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Abstract

Background: Menstrual cycle disorders are common problems among adolescent girls and are associated with reproductive health issues. Factors such as Body Mass Index (BMI) and stress are believed to influence menstrual irregularities. This study aims to examine the relationship between BMI, stress, and menstrual cycle irregularities as a preventive measure to maintain optimal menstrual health. Method: This observational analytical study utilized a non-probability sampling technique. Data analysis was conducted using Spearman's Rho Correlation test and Cross Tabulation test at a significance level of 0.05. Results: The analysis showed a significant positive correlation between BMI and menstrual irregularities ($p = 0.010$, $r = 0.258$) and between stress and menstrual irregularities ($p = 0.001$, $r = 0.480$). Stress exhibited a stronger association with menstrual irregularities than BMI. Conclusion: This study highlights the relationship between BMI and stress with menstrual irregularities in female adolescents at SMA Hang Tuah 2 Sidoarjo. These findings emphasize the need for targeted interventions addressing nutritional and psychological support to improve menstrual health. Monitoring BMI and managing stress are essential strategies to enhance reproductive health in adolescents. Further research is recommended to explore effective interventions to address these factors and improve adolescent well-being.

Keywords: BMI, Stress, Menstrual Cycle, students, adolescents

Abstrak. Latar Belakang: Gangguan siklus menstruasi adalah masalah umum yang sering dialami oleh remaja perempuan dan berkaitan dengan masalah kesehatan reproduksi. Faktor seperti Indeks Massa Tubuh (IMT) dan stres diyakini memengaruhi ketidakaturan siklus menstruasi. Penelitian ini bertujuan untuk mengkaji hubungan antara IMT, stres, dan ketidakaturan siklus menstruasi sebagai langkah pencegahan untuk menjaga kesehatan menstruasi yang optimal. Metode: Penelitian ini menggunakan metode analitik observasional dengan teknik pengambilan sampel non-probabilitas. Analisis data dilakukan menggunakan uji Korelasi Spearman's Rho dan uji Tabulasi Silang pada tingkat signifikansi 0,05. Hasil: Analisis menunjukkan adanya korelasi positif yang signifikan antara IMT dan ketidakaturan siklus menstruasi ($p = 0,010$, $r = 0,258$) serta antara stres dan ketidakaturan siklus menstruasi ($p = 0,001$, $r = 0,480$). Stres menunjukkan hubungan yang lebih kuat dengan ketidakaturan siklus menstruasi dibandingkan dengan IMT. Kesimpulan: Penelitian ini menyoroti hubungan antara IMT dan stres dengan ketidakaturan siklus menstruasi pada remaja perempuan di SMA Hang Tuah 2 Sidoarjo. Temuan ini menekankan pentingnya intervensi yang terfokus pada dukungan nutrisi dan psikologis untuk meningkatkan kesehatan menstruasi. Pemantauan IMT dan pengelolaan stres merupakan strategi penting untuk meningkatkan kesehatan reproduksi pada remaja. Penelitian lebih lanjut diperlukan untuk mengeksplorasi intervensi yang efektif dalam menangani faktor-faktor tersebut guna meningkatkan kesejahteraan dan hasil kesehatan remaja.

Kata Kunci: IMT, Stres, Siklus Menstruasi, siswa, remaja

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INTRODUCTION

Menstrual disorders are conditions experienced by someone who refers to an irregular menstrual cycle. The disorders that appear are different for each person, such as irregular menstrual cycles, excessive pain, too little or too much blood volume to excessive bleeding. These menstrual disorders often occur in adolescence and can be caused by certain factors, influenced by changes in body weight, stress conditions, unstable hormones, drugs, diet and body activity. Changes in body weight are related to a person's nutritional status and affect menstrual cycle disorders. A tool to measure nutritional status that affects changes in body weight can use the Body Mass Index (BMI). In general, BMI is divided into: underweight, normal weight), overweight, obese. This is in accordance with the opinion that menstrual disorders can be experienced by someone with a lower or higher BMI, with symptoms of menstruation experienced feeling painful and an irregular menstrual schedule (Umbu et al., 2022).

Factors that influence Body Mass Index are divided into 2 factors, namely internal factors and external factors. Internal factors include: genetics, age, gender, health conditions and body composition. External factors include: diet, physical activity, mental health, stress, access to healthy food, social, economic and lifestyle habits.

Furthermore, stress is also part of several factors that cause menstrual cycle disorders, reinforced by the opinion that high levels of stress, depression, and psychological counseling will be associated with an increased risk of irregular menstrual cycles (Yu et al., 2017a). Menstrual cycle disorders have several causes, one of which is prolonged stress that interferes with daily activities. Stressful conditions cause the body to experience pathological changes as a form of adjustment to body conditions (Wang et al., 2020).

Stress is a condition when a situation becomes complex involving psychological, physiological, and behavioral aspects of humans to adapt and overcome pressures that arise from outside and inside. According to The American Institute of Stress (2020), stress is a condition with emotional, psychological to physical tension which is the body's response to dealing with life's problems. Stress consists of normal stress, mild stress, moderate stress, severe stress and very severe stress, normal stress is a natural response that does not affect a person's physical condition, while severe stress is a major pressure that can cause insomnia, headaches, and irritability. Changes in stress conditions affect a person's body which is adjusted to pathological changes in the body (Wang et al., 2020).

Factors that influence stress are divided into internal factors and external factors. Internal factors include: physical condition and motivation. External factors include: family, social environment, physiological and psychological stressors.

Stress is a human thing and has become a part of a person's life. Research shows that 41.46% experience normal stress. A natural part and in line with a person in dealing with life's problems is called normal stress. As many as 17.07% experience mild stress, this stress often occurs in a person's life. Mild stress conditions can benefit a person in increasing alertness and avoiding any possible bad events that will occur. The physiological aspects of a person in mild stress are not affected, but from a psychological point of view it can cause a person's psychological energy to run out unknowingly (Destia, 2016). The number of moderate stress presentations is in the second highest position after normal stress, which is 26.83%. Moderate stress causes a person to easily feel tired, panic, and sensitive to existing situations or easily offended, these things can happen within hours to days (Psychology Foundation of Australia, 2014). In severe stress, the percentage of 10.98% is a condition where someone feels unneeded, has no motivation to live, surrenders to circumstances, easily becomes weak, lethargic, tired and withdraws, in the long term this condition can last for several weeks or even months. In severe stress tends to have more attention and need direction. Severe stress if not handled has the potential to become severe depression (Deviliawati, 2020).

According to the Psychology Foundation of Australia (2014), stress has 5 levels of classification, including: normal stress, mild stress, moderate stress, severe stress, very severe stress. Adolescents are children aged 10 to 19 years. The World Health Organization (WHO) says that signs such as physical changes that are seen directly or indirectly until the state of sexual maturity is the beginning of adolescence (Armayanti et al., 2021). An abnormal menstrual cycle in adolescents is associated with reproductive health problems. In the study, it was found that 75% of adolescents experienced irregular menstrual schedules which were associated with menstrual problems (Armayanti et al., 2021).

The problem of irregular menstrual cycles often occurs in adolescent groups, becoming the author's background in conducting research on a sample of female adolescents who are currently in high school. On this occasion, the author focuses on research on "The Relationship between Body Mass Index and Stress with Menstrual Cycles in Female Adolescents at SMA Hang Tuah 2 Sidoarjo" by considering personal experience and looking at the grouping of BMI and stress levels of female adolescents related to menstrual cycle disorders.

The menstrual cycle is a cycle that occurs between the first day of menstruation and the first day of the next menstruation, this is a recurring event and occurs every month for 21 to 35 days. In each menstrual phase, it will occur for 3 to 7 days. Stress levels, body weight, physical activity, genetics, body condition, and disease conditions such as ovarian disorders affect the menstrual cycle. A study conducted on 287 people and 32 adolescents found that adolescents had an average BMI of 29.29 with a disturbed menstrual cycle (Ilmu et al., 2021). Hormonal mechanisms, such as estrogen, have a very large impact on the menstrual cycle. The ratio of estrogen and androgen hormones influenced by adipose tissue will have abnormal levels in someone who experiences menstrual cycle disorders. Overweight women often produce more estrogen which will then cause an increase in androgen hormones. This condition can inhibit the development of follicles in obtaining mature follicles (Karina S et al., 2017).

Factors that influence the menstrual cycle include: psychological factors, genetic factors, hormonal disorders and nutritional factors. Menstrual cycle disorders occur when there are abnormalities in the endometrial cycle in the uterine lining which include, stages of endometrial proliferation, endometrial desquamation, endometrial secretory changes (Margareth, 2017). Disorders in the menstrual cycle can be classified as polymenorrhea, oligomenorrhea, or amenorrhea. These disorders can be caused by an imbalance or abnormalities in sex hormones in women (Ukibe et al., 2017).

Polymenorrhea is a disease that occurs due to hormonal imbalance in the hypothalamic-pituitary-ovarian axis and causes disruption of ovulation. In other words, this condition shortens the time required for a regular menstrual cycle to occur. In polymenorrhea, the menstrual

cycle lasts no more than 21 days with indications that cause a woman to experience more than one menstrual cycle in one month (Hikma et al., 2021). Oligomenorrhea It is the immaturity of the hypothalamic ovarian endometrial axis that causes oligomenorrhea that occurs in adolescence. Physical and emotional stress, chronic illness, and lack of nutrition can also be risk factors for oligomenorrhea. This condition is characterized by menstruation lasting more than thirty-five days, oligomenorrhea must be treated properly, because it can be a sign of metabolic syndrome if accompanied by obesity and infertility (Toar, 2022). Amenorrhea is characterized by the absence of menstruation for a duration of more than three months continuously.

SMA Hang Tuah 2 Sidoarjo was strategically selected as the research site due to several pivotal reasons. First, the school represents a diverse demographic profile, encompassing a wide range of socioeconomic backgrounds that are crucial for understanding the varied impact of BMI and stress on menstrual cycles among adolescents. Secondly, as a well-established educational institution, SMA Hang Tuah 2 Sidoarjo caters to a significant number of female adolescents, providing a robust sample size necessary for comprehensive data analysis. The geographical location of Sidoarjo also provides a unique sociocultural context that may influence lifestyle habits, stress levels, and health awareness, offering a rich tapestry for community health studies. The primary aim of this study is to elucidate the relationship between BMI, stress, and menstrual cycle regularity specifically amongst female students, facilitating targeted health interventions in this population. From a public health perspective, understanding these relationships can inform educational and health strategies designed to address adolescent health issues at their root, promoting overall wellness and potentially reducing the incidence of menstrual disorders. Consequently, the findings of this study will not only benefit the immediate study population but also serve as a crucial reference for policymakers and health educators focused on improving adolescent health outcomes across similar communities.

METHOD

Study Design

Sampling was carried out by purposive sampling of students who met the BMI criteria. Meanwhile, the questionnaire is a tool in determining the level of stress and menstrual cycle of students. Research with an analytical observational design, using a cross-sectional approach. Data collection at the same time to examine whether there is a relationship between risk factors (independent variables) and consequences (dependent variables) (Komara E., 2023). The research method uses quantitative research by applying analytical observational design using primary data through distributed questionnaires. The purpose of the study was to gain a good and in-depth understanding of how the correlation of Body Mass Index and stress with the menstrual cycle in female adolescents at SMA Hang Tuah 2 Sidoarjo with BMI and stress as independent variables and the menstrual cycle as the dependent variable.

Population and Sample

Population is the subject of research as a whole from the number of individuals or groups (Komara E., 2023). The population in this study was all female students of Hang Tuah 2 Sidoarjo High School totaling 627 people, including: 200 class X female students, 221 class XI female students, 206 class XII female students. Part of the population itself is called a sample that has similar properties and characteristics to the population itself. There are two types of samples: inclusion samples, which include the general properties of a research subject from the target population that can be studied; exclusion samples, eliminating subjects that fall into the research inclusion characteristics.

The inclusion criteria for respondents were female students aged between 15-18 years with a positive consent form and a BMI within the range of 18.5 to 24.9. The exclusion criteria included those with chronic health conditions affecting stress levels or menstrual cycles, those on medications influencing such factors, and students who did not complete the stress level questionnaires. Taking into account the availability of research samples, with a known population size, it is searched using the cross-sectional sample formula. Based on the calculation results using the cross-sectional sample formula, it can be seen that the number of female students who must be taken for the research is at least 84 female students, while in the research, the sample that will be used is 100 female students.

There are two techniques in sampling, including non-probability sampling and probability sampling. The sampling technique that considers the principle of opportunity depending on the researcher's policy is called non-probability sampling. For sampling carried out in this study using the non-probability sampling method, the type of purposive sampling in sampling, enters the criteria that are relevant to the research objectives (Komara E., 2023).

Data Collection Procedures

The study undertook a direct approach, gathering data from primary sources. The researchers meticulously processed and analyzed the information sourced from questionnaires completed by the students. Following data collection, the researchers presented the findings in a clear and structured manner, subsequently drawing conclusions through rigorous statistical analysis.

Research Instruments

The main research instrument includes a standard questionnaire. The research instrument in measuring stress levels is the Depression Anxiety Stress Scale (DASS) - 42. Regarding the validity and reliability of DASS-42, it has been demonstrated to have excellent internal consistency (Cronbach's alpha > 0.90) and is widely validated across divergent populations (Lovibond & Lovibond, 1995). Its construct validity has been confirmed through extensive research in assessing stress, anxiety, and depression in various settings.(Lovibond & Lovibond, 2015).The questionnaire consists of 42 questions used to assess stress, depression and anxiety levels. The score used by DASS - 42 shows that a higher score is a higher level of severity. The questionnaire also classifies stress levels and menstrual cycles into several categories.

Data Analysis

Based on the data collected through the questionnaire, the researcher intends to analyze the correlation between the dependent and independent variables. The analysis will be carried out through 2 stages, univariate and bivariate tests. Univariate analysis, the simplest method, aims to

provide data that describes all variables, including dependent and independent variables, and to identify the characteristics of each research subject. The purpose of bivariate analysis is to find a correlation between independent and dependent variables, this relationship is measured based on an ordinal scale. Because these two variables are only measured once, the Spearman's Rho correlation test is used, which is a non-parametric bivariate test method.

Ethical Considerations

The study was conducted in adherence to ethical guidelines, with approval secured from the Hang Tuah University Research Ethics Committee. Permission to proceed was also obtained from Hang Tuah 2 High School Sidoarjo. Prior to participation, informed written consent was collected from all individuals involved in the study. To ensure data confidentiality, participant information was anonymized, and data were securely stored. The ethical clearance for this research was granted under the reference number: No. I/089/UHT.KEPK.03/VIII/2024.

RESULTS OF STUDY

Table 1 presents an overview of the study respondents categorized by Body Mass Index (BMI), stress levels, and menstrual cycle status. Regarding BMI classifications, 25% (25 respondents) were identified as underweight. A significant portion, 49% (49 respondents), fell within the normal weight range. Meanwhile, 19% (19 respondents) were categorized as overweight, and 7% (7 respondents) were classified as obese.

In terms of stress levels, 26% (26 individuals) exhibited normal stress. Mild stress was observed in 24% (24 respondents), while moderate stress encompassed 25% (25 individuals). Severe stress was reported by 18% (18 respondents), and very severe stress was noted in 7% (7 individuals).

When examining menstrual cycle criteria, a majority of 55% (55 respondents) reported normal menstrual cycles. However, 17% (17 individuals) experienced polymenorrhea, 26% (26 respondents) faced oligomenorrhea, and 2% (2 individuals) reported secondary amenorrhea. This distribution highlights the diverse range of health profiles within the respondent group, offering a thought-provoking context for further analysis.

Table 1. Characteristics of the study respondents (N=100)

BMI	Frequency	Percentage
Underweight	25	25.00
Normal Weight	49	49.00
Overweight	19	19.00
Obese	7	7.00
Stress		
Normal	26	26.00
Mild	24	24.00
Moderate	25	25.00
Severe	18	18.00
Very Severe	7	7.00
Menstrual Cycle		
Normal	55	55.00
Polymenorrhea	17	17.00
Oligomenorrhea	26	26.00
Secondary Amenorrhea	2	2.00

Tabel 2 Cross Tabulation of BMI and Stress with Menstrual Cycle

	Menstrual Cycle				
	Normal n(%)	Polymenorrhea n(%)	Oligomenorrhea n(%)	Secondary Amenorrhea n(%)	Total n(%)
BMI					
Underweight	7(28.0)	14(56.0)	3(12.0)	1(4.0)	25 (100)
Normal weight	44(89.8)	2(4.1)	2(4.1)	1(2.0)	49(100)
Overweight	3(15.8)	1(5.3)	15(78.9)	0(0.0)	19(100)
Obese	1(14.3)	0(0.0)	6(85.7)	0(0.0)	7(100)
Total	55(55.0)	17(17.0)	26(26.0)	2(2.0)	100(100)
Stress					
Normal	19 (73.1)	4 (15.4)	3 (11.5)	0 (0.0)	26 (100.0)
Mild	18 (75.0)	2 (8.3)	4 (16.7)	0 (0.0)	25 (100.0)
Moderate	16 (64.0)	3 (12.0)	6 (24.0)	0 (0.0)	24 (100.0)
Severe	2 (11.1)	6 (33.3)	9 (50.0)	1 (5.6)	18 (100.0)
Very Severe	0 (0.0)	2 (28.6)	4 (57.1)	1 (14.3)	7 (100.0)
Total	55 (55.0)	17 (17.0)	26 (26.0)	2 (2.0)	100 (100.0)

Table 2 illustrates the distribution of menstrual cycle irregularities across different stress levels. Among the 26 participants experiencing normal stress levels, the majority–73.1% (19 individuals)–maintained normal menstrual cycles, while 15.4% (4 individuals) had polymenorrhea, and 11.5% (3 individuals) experienced oligomenorrhea. In those with mild stress, out of 25 participants, 75.0% (18 individuals) had normal cycles, 8.3% (2 individuals) faced polymenorrhea, and 16.7% (4 individuals) encountered oligomenorrhea.

As stress levels increased to moderate, among the 24 individuals assessed, 64.0% (16 participants) remained with normal cycles. However, polymenorrhea affected 12.0% (3 individuals), and oligomenorrhea was seen in 24.0% (6 individuals). When observing severe stress levels among 18 participants, the trend shifted notably: only 11.1% (2 individuals) maintained normal cycles, 33.3% (6 individuals) dealt with polymenorrhea, 50.0% (9 individuals) experienced oligomenorrhea, and 5.6% (1 individual) encountered secondary amenorrhea. Finally, the very severe stress category included 7 participants, none of whom had normal cycles. Here, 28.6% (2 individuals) experienced polymenorrhea, a significant 57.1% (4 individuals) faced oligomenorrhea, and 14.3% (1 individual) suffered from secondary amenorrhea. This progression illustrates a clear pattern of increased menstrual cycle irregularities with escalating stress levels.

Tabel 3 Results of Hypothesis Test of BMI, Stress level and Menstrual Cycle.

Spearman's rho		Menstrual Cycle
BMI	Correlation Coefficient	0,258**
	Sig. (2-tailed)	0,010
Stress	Correlation Coefficient	0,480**
	Sig. (2-tailed)	0.001
	N	100

****. Correlation is significant at the 0.01 level (2-tailed).**

The analysis of the relationship between Body Mass Index (BMI) and the menstrual cycle reveals a statistically significant correlation, with a significance value of 0.010 ($p < 0.05$). The correlation coefficient for this study is calculated at 0.258, indicating a low level of correlation, though positively aligned, meaning that as BMI increases or decreases, similar directional changes can be observed in menstrual cycle regularity.

Moreover, the correlation between stress levels and the menstrual cycle presents more pronounced findings. As depicted in Table 3, the relationship boasts a significance value of 0.001 ($p < 0.05$), establishing a significant connection between stress levels and menstrual cycle variations with a correlation coefficient of 0.480. This moderate positive correlation indicates that higher stress levels are associated with greater menstrual irregularities– a more robust association than that observed with BMI. In summary, while both BMI and stress show positive correlations with menstrual cycle irregularities, stress exerts a greater influence, meriting close attention in adolescent health discussions.

DISCUSSION

Analysis of the Relationship Between BMI and Menstrual Cycle

Analysis of the relationship between BMI and menstrual cycle in this study can be explained that, based on the Spearman test, with the results of the significance value $p < a$, has a value of 0.010, and a positive direction of the relationship. This finding illustrates the relationship between BMI and the menstrual cycle. Adolescent girls who have a BMI of underweight, overweight, obesity tend to have menstrual cycle disorders. In examining the cross-tabulations, several intriguing patterns surface relating BMI and stress to menstrual cycle variations. For BMI, it is observed that underweight individuals experience a high percentage of polymenorrhea (56.0%) compared to other groups. Overweight and obese categories exhibit substantial proportions of oligomenorrhea at 78.9% and 85.7% respectively, suggesting a strong relationship between higher BMI and longer menstrual cycles. This pattern aligns with previous research(Vashishta & Gahlot, 2022a), indicating hormonal imbalances due to adipose influence on estrogen production affecting cycle regulation.

Conversely, when examining stress levels, the trend seems to evidence a progressively worsening menstrual disorder prevalence with increasing stress severity. For instance, only 11.1% of individuals experiencing severe stress reported normal menstrual patterns, while the majority faced oligomenorrhea (50.0%). This mirrors existing literature(Yu et al., 2017b), illustrating stress as a catalyst that triggers alterations through the hypothalamic-pituitary-adrenal axis, disrupting reproductive hormones like FSH and estrogen.

Both BMI and stress demonstrate significant correlations with menstrual irregularities. The results suggest the potential of synergistic interactions between nutritional status and psychological stress in affecting menstrual health. It is essential to consider multifactorial etiologies in addressing menstrual disorders, integrating the interplay of physiologic, nutritional, and psychological factors.

Another study by, Vashishta and Gahlot produced a significant correlation between Body Mass Index (BMI) and the menstrual cycle has a value significant ($p = 0.0008$) (Vashishta & Gahlot, 2022b). In another study, the results of data analysis on the relationship between BMI and the menstrual cycle were also found, there was a significant correlation as indicated by the Chi-square test with a result of $p = 0.05$ and p value = 0.015 (Dian Ika Pratiwi et al., 2024).

The malnutrition status experienced by adolescent girls tends to have irregular menstrual cycles, one of the risks that occurs in malnutrition is severe anemia, this has an impact on the reproductive conditions of adolescent girls. In anemia, the level of iron intake is insufficient according to the body's needs, this results in decreased endurance, excessive fatigue, and reproductive health disorders (Anggraini & Ruhana, 2021). Previous studies have shown that subjects who have fat, carbohydrate, and protein intake that does not match the normal levels needed by the body, either excessive or insufficient, and have a habit of consuming foods with high fat content, junk food with salt, fat, and sugar levels that exceed normal limits, tend to have menstrual cycle disorders (Sitoayu et al., 2017). In other studies, there is evidence that protein levels in the body have a significant relationship to the menstrual cycle (Davidson et al., 2023). Excessive vegetable protein intake is associated with the occurrence of an extension of the follicular phase, by stimulating the production of the hormone estrogen. This causes menstrual cycle disorders. (Fernanda et al., 2021). Not only protein, excessive carbohydrate intake has an impact of increasing the risk of menstrual cycle disorders by 3.83 times. This is due to the effect of carbohydrate intake levels on shortening the luteal phase (Sitoayu et al., 2017).

Research conducted by Davidson shows a significant correlation between iron intake and the menstrual cycle. Insufficient iron intake also causes hemoglobin levels to decrease, which functions as a carrier of oxygen to the brain and body. In a state of reduced oxygen in the brain, it can have an impact on decreased brain performance which affects the hypothalamus and ultimately inhibits the hormones progesterone and estrogen which then affects menstrual cycle disorders (Wahyuni et al., 2020).

The role of nutrition in the menstrual cycle is very important. Changes in the menstrual cycle are related to hormonal disorders such as female sex hormones. The hormone estrogen is produced in the adrenal glands, ovaries, placenta, and fat tissue. Obesity and excess calories can increase estrogen in the blood (Andini, 2022). Fat in the body is the basic ingredient of estrogen, high levels of androgen are one of the causes of excess fat, androgen hormones are hormones that will then be converted into estrogen. This causes negative feedback on the secretion of gonadotropin releasing hormone (GnRH). In a state of decreased GnRH, the secretion of FSH, estrogen and progesterone decreases so that the egg cells become

immature and cause disruption to the menstrual cycle, resulting in a lengthening of the menstrual cycle. Excess weight that occurs in adolescents affects longer menstrual cycles (oligomenorrhea) (Vashishta & Gahlot, 2022b).

Chronic irregular menstrual cycles or chronic anovulatory are more often experienced by BMI with overweight to obesity (Donna, 2021). Nutritional deficiencies can result in reduced production of GnRH which plays a role in the release of LH and FSH hormones leading to decreased levels of hormones that play a role in the ovulation process in the menstrual cycle. Women with a low or thin BMI can experience menstrual disorders due to decreased body fat reserves and hormone synthesis. In conditions of decreasing estrogen levels, it causes positive feedback from GnRH, which means that there can be a decrease in LH secretion (Dian Ika Pratiwi et al., 2024). Decreased LH causes a shortening of the luteal phase causing the endometrium to peel off earlier, resulting in a short menstrual cycle (polygomenorrhea) (Saei Ghare Naz et al., 2020). Menstrual cycle disorders can be caused by conditions of overweight and underweight.

In a study conducted by Andini, in level I D III Midwifery students, there was no correlation between BMI and the menstrual cycle. Non-parametric statistical analysis with the Chi-square test in this study had a p value> 0.05, meaning that there was no relationship between BMI and the menstrual cycle (Andini, 2022). In addition to BMI, in this study several factors that cause menstrual cycle disorders include diet, hormones, physical activity, stress and several other factors. The relationship between BMI, stress, and menstrual cycle dysfunction is enshrined in the delicate orchestration of hormones and biological processes. From a biomechanical standpoint, adipose tissue functions beyond mere fat storage; it is an active endocrine organ secreting adipokines like leptin which plays a critical role in energy homeostasis and reproductive function(Fasshauer & Blüher, 2015). With elevated BMI, excessively high levels of leptin and other adipokines can disturb the GnRH release, crucial for regulating menstrual cycles through FSH and LH secretion(Sun & Zhu, 2024). Conversely, low BMI results in insufficient leptin, translating to incomplete reproductive function and hypothalamic amenorrhea(Kyriakidis et al., 2016).

Stress, however, interweaves with these processes through its activation of the hypothalamic-pituitary-adrenal (HPA) axis. The continuous release of cortisol disrupts normal HPA functioning, often suppressing GnRH pulsatility, altering the balance of sex steroids, and inhibiting the ovulatory process (Oakley et al., 2008). The synergy between the HPA axis and gonadotropin regulation illustrates how psychological stress can independently manifest menstrual irregularities, even in the absence of significant BMI changes. The interplay of cortisol, insulin, and leptin further complicates these dynamics, hinting at an intricate coaction that mandates an integrative medical approach.

Analysis of the Relationship Between Stress and Menstrual Cycle

Based on the results of the Spearman test, it shows a p value <α with a significance value of 0.001, meaning that there are significant results between stress and the menstrual cycle, and have a positive relationship direction. Increasing stress levels correlate with an increased risk of menstrual cycle disorders. The correlation coefficient value of 0.480 means the criteria are moderate or quite strong. The moderate correlation between stress and menstrual cycle variation underscores a pivotal element in understanding menstrual health beyond BMI influences. While BMI undeniably shapes hormonal balances, it is the insidious grip of stress that exerts a distinct influence, capable of disrupting the hypothalamic-pituitary-adrenal axis as established in the literature(Yu et al., 2017b). This moderate correlation, as observed in our study, suggests that stress emerges as a significant, potentially overlooked player in menstrual health, demanding a multidisciplinary approach integrating psychological support alongside nutritional interventions. Recognizing stress's role as more than just a background factor highlights the necessity for comprehensive management strategies in promoting hormonal and reproductive well-being.

Research conducted at MAS Al-Kautsar Al-Akbar supports the findings of this study. There is a significant correlation between stress and menstrual cycle disorders, with a p value = 0.002 in the Spearman test (Pasphariny, 2017). This is in accordance with research conducted on second-year students of Akbid Panca Bhakti Bandar Lampung, that there is a relationship between stress and the menstrual cycle, with a p value = 0.000 (p <α = 0.05) and research by Shakira et.al.(Distyvanya et al., 2024). The number of respondents who did not experience stress and irregular menstrual cycles was 6 female students (14.6%), stress and regular menstrual cycles were 16 female students (32.7%), stress and irregular menstrual cycles were 33 female students (67.3%) and no stress and regular menstrual cycles were 35 female students (85.4%) (Aryani, 2019). The direction of the relationship in the two studies above is positively correlated, which means that the higher the stress level, the more severe the menstrual cycle disorders.

Research conducted by Yu, Han and Nam, there is a positive relationship between stress problems and menstrual cycle disorders among Korean female adolescents (Yu et al., 2017a). The risk of menstrual cycle disorders tends to increase with increasing stress levels. Stress is the body's reaction to environmental or external stimuli that make a person feel threatened or unsafe. This activates the body's protective mechanism with a response from the hypothalamic-pituitary-adrenal (HPA) axis. This causes the hypothalamus to secrete CRH (Corticotropic Releasing Hormone). The anterior pituitary will release ACTH (Adenocorticotropin Hormone) which is stimulated by CRH. Then, ACTH encourages the adrenal glands to produce cortisol (glucocorticoid, which is a "stress" hormone) (Hemakom et al., 2024). Cortisol inhibits GnRH secretion by decreasing the production of Follicle stimulating hormone (FSH) (Setiyono et al., 2015). Reproductive function is inhibited by stress by blocking the Hypothalamus-Pituitary-Gonad pathway through inhibition that occurs in GnRH. The FSH hormone plays a role in stimulating ovulation and estradiol (estrogen) secretion. Low estrogen can cause the menstrual cycle to become longer. The hormone cortisol changes the balance of hormones that play a role in the menstrual cycle to become unbalanced.

Opinions that contradict research conducted on female students of the Faculty of Medicine, Andalas University, show that there is no relationship between stress and the menstrual cycle. In this study, the value of p = 0.616 (p > α) was found using the Spearman test (Yudita et al., 2017). Several factors can influence the results of this study, one of which is the condition of the respondents when filling out the questionnaire also influences, such as family factors, environmental factors and health conditions. In addition, stress can be individual and subjective so that it can change over time. The findings of this study underscore

the importance of implementing community-based interventions aimed at monitoring and optimizing Body Mass Index (BMI) and managing stress among adolescents. Such initiatives could include educational programs in schools to raise awareness about maintaining a balanced diet and fostering stress management techniques like mindfulness and resilience training. Furthermore, community health clinics can play a pivotal role in providing resources and personalized counseling to address these pivotal factors. By focusing on these aspects, we can enhance not only menstrual health but also overall adolescent well-being, laying a foundation for healthier future generations.

LIMITATIONS OF STUDY

The limitations found in this study can be described as follows: The researcher faced difficulties in inviting respondents to participate, supervising the questionnaire filling process, and coordinating the responses given. The filling of the questionnaire by respondents was carried out during the new high school school year, which was a challenge for the researcher in motivating respondents to fill out the questionnaire. In addition, because respondents from each class had different schedules, the researcher could not take measurements simultaneously. Lack of knowledge in some high school students regarding menstrual cycle disorders, so the researcher provided education first before the questionnaire could be filled out.

Although these challenges may have introduced biases and impacted the uniformity of data collection, they also highlight the realities of field research in dynamic environments. The variability in respondent schedules and initial knowledge levels means the study's findings should be interpreted with caution regarding their applicability to broader settings. This context-specificity might limit the generalizability but also serves as a call for tailored, localized interventions.

Despite these hurdles, the research provides significant insights into the associations between BMI, stress, and menstrual health, underscoring the need for holistic approaches in adolescent health strategies. The value of this study lies in its contribution to a nuanced understanding of how environmental and individual factors intersect to influence health outcomes, paving the way for future research to build upon these foundational insights.

CONCLUSION

The findings of this study reveal noteworthy correlations between Body Mass Index (BMI), stress, and menstrual cycle irregularities among female adolescents at SMA Hang Tuah 2 Sidoarjo. A significant relationship with a positive, albeit low, correlation ($r = 0.258$) exists between BMI and menstrual cycle disorders. Similarly, stress demonstrates a moderate positive correlation ($r = 0.480$) with menstrual irregularities, emphasizing its greater impact. These associations highlight the critical need for targeted interventions to optimize both BMI and stress management, contributing to healthier menstrual cycles.

Recommendation

To leverage these insights, we propose the development of comprehensive adolescent health programs that integrate nutritional education and stress management techniques. Schools, in collaboration with healthcare professionals, should implement workshops focusing on balanced diets and psychological resilience training to enhance students' overall well-being.

We also recommend that government bodies establish policies prioritizing adolescent reproductive health by providing resources for regular health screenings and educational campaigns. Such policies should aim to promote a supportive environment within schools that encourages active lifestyle choices and mental health awareness. By undertaking these measures, we can pave the way for improved menstrual health outcomes and foster a future generation of healthier adolescents.

Conflict of Interest

The authors declared there were no conflict of interest in this study.

Authors' Contribution

All authors contribute equally to the writing of this manuscript, and thanks given to doctor Ronald Pratama Adiwinoto for helping statistical analysis of the study data, and also given to Dr Hanung Prasetya and Mr I Made Dwi Mertha Adnyana for proof-reading and fruitful discussion regarding the manuscript writing.

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