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ORIGINAL ARTICLE

THE INFLUENCE OF BODY MASS INDEX ON THE MENSTRUAL CYCLE IN ADOLESCENTS

Pengaruh Indeks Massa Tubuh terhadap Siklus Menstruasi pada Remaja

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ABSTRACT

Background: Imbalanced nutritional status in adolescents can affect the menstrual cycle. In 2018, the WHO stated that as many as 80% of women in the world have irregular menstrual cycles. More specifically, this condition is experienced by 11.70% of adolescents aged 15-19 years and 14.90% of women in urban areas. **Purpose:** To analyze the effect of body mass index (BMI) on the menstrual cycle in adolescents at Junior High School State 19 Surabaya. **Methods:** This quantitative research employed an observational analytic method with a case-control design at SMP Negeri 19 Surabaya. As many as 104 participants (52 cases with irregular menstrual cycles and 52 controls with regular cycles) were randomly selected in a 1:1 ratio. Data collection occurred from February to May 2024, and bivariate analysis was conducted using the Chi-square test. **Results:** This study showed that overall BMI had a significant effect on menstrual cycle regularity (p = 0.001). Students with normal BMI have a greater chance of experiencing regular menstruation than overweight/obese (OR = 4.694; 95% CI = 1.536 - 14.344; p = 0.007). Meanwhile, the categories of very thin (OR = 0.985; 95% CI = 0.235 - 4.127; p = 0.983) and underweight (OR = 0.433; 95% CI = 0.072 - 2.622; p = 0.363) did not show a significant influence on menstrual regularity (p > 0.05). **Conclusion:** Body mass index affects menstrual cycle regularity in adolescents. Maintaining nutritional status is important to minimize the risk of menstrual cycle disorders and ensure reproductive health.

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ABSTRAK

Latar Belakang: *Status gizi yang tidak seimbang pada remaja dapat memengaruhi siklus menstruasi. Pada tahun 2018, WHO menyatakan bahwa sebanyak 80% wanita di dunia mengalami siklus menstruasi yang tidak teratur. Secara lebih spesifik, kondisi ini dialami oleh 11,70% remaja usia 15–19 tahun dan 14,90% wanita di daerah perkotaan.* ***Tujuan:*** *Menganalisis pengaruh indeks massa tubuh (IMT) terhadap siklus menstruasi pada remaja di SMP Negeri 19 Surabaya.* ***Metode:*** *Penelitian kuantitatif ini menggunakan metode analitik observasional dengan desain kasus-kontrol di SMP Negeri 19 Surabaya. Sebanyak 104 partisipan (52 kasus dengan siklus menstruasi tidak teratur dan 52 kontrol dengan siklus teratur) dipilih secara acak dengan rasio 1:1. Pengumpulan data dilakukan dari Februari hingga Mei 2024, dan analisis bivariat dilakukan menggunakan uji Chi-square.* ***Hasil:*** *Penelitian ini menunjukkan bahwa secara keseluruhan IMT berpengaruh signifikan terhadap keteraturan siklus menstruasi (p = 0,001). Siswa dengan IMT normal memiliki peluang lebih besar mengalami menstruasi teratur dibandingkan dengan yang kelebihan berat badan/obesitas (OR = 4,694; 95% CI = 1,536 – 14,344; p = 0,007). Sementara itu, kategori sangat kurus (OR = 0,985; 95% CI = 0,235 – 4,127; p = 0,983) dan kurang berat badan (OR = 0,433; 95% CI = 0,072 – 2,622; p = 0,363) tidak menunjukkan pengaruh yang signifikan terhadap keteraturan menstruasi (p > 0,05).* ***Simpulan:*** *Indeks massa tubuh berpengaruh terhadap keteraturan siklus menstruasi pada remaja. Menjaga status gizi penting untuk meminimalkan risiko gangguan siklus menstruasi dan menjaga kesehatan reproduksi.*

INTRODUCTION

Adolescence is a period when individuals experience changes in cognitive (knowledge), emotional (feelings), social (interaction), and moral (morals) aspects. Adolescence is a transitional period or a connecting period between childhood and adulthood (1). According to the Minister of Health Regulation Number 25 Year 2014, adolescents are classified as individuals between the ages of 10 and 18. Adolescent girls will experience menstruation as part of their life cycle. Adolescent girls usually start menstruating at the age of twelve (2). Menstruation is the process of shedding blood, mucus, and tissue cells from the uterine lining, which occurs periodically and cyclically, usually about 14 days after ovulation (3).

According to the Ministry of Health of the Republic of Indonesia (2018), the average age of adolescent girls in East Java when they first experienced menstruation was 12 years and 5 months. The age of adolescent girls is equivalent to the age of adolescent girls in junior high school (4). The menstrual cycle is usually measured from the first day of menstruation to the beginning of the next cycle. The menstrual cycle usually lasts 28 days, with a normal range of 21 to 35 days (5). The WHO (2020) reported that 45% of women worldwide experience irregular periods, while according to Basic Health Research Data in 2018, as many as 13.70% of Indonesian women and 14.90% of women living in urban areas experience irregular periods (6).

The menstrual cycle is defined as the period between the first day of menstruation and the first day of the next menstruation. The cycle is influenced by various factors, including the balance of reproductive hormones. Shortening of the follicular phase can lead to a shorter menstrual cycle, known as polymenorrhea. This condition is often associated with decreased fertility and an increased risk of miscarriage. Conversely, if the menstrual cycle becomes longer (oligomenorrhea), it may be related to ovulation disorders and infertility. Irregular menstrual cycles may be indicative of hormonal disorders or certain medical conditions that require further attention (7).

If menstrual cycle disorders are not treated promptly, the body may lose excessive amounts of blood, risking anemia. This condition can lead to decreased hemoglobin levels, which results in fatigue, weakness, and decreased endurance (8). In addition, menstrual cycle irregularities can be an indicator of disturbances in the metabolic system

and hormonal balance. This imbalance has the potential to disrupt the ovulation process, which in turn can lead to infertility. If left without proper treatment, this condition can also increase the risk of other reproductive diseases, such as polycystic ovary syndrome (PCOS) and endocrine disorders (9).

There are various factors that can cause menstrual cycle disorders, such as stress, nutritional status, diet, sleep duration, and physical activity. Stress due to psychosocial pressures, including anxiety and frustration, can disrupt the balance of reproductive hormones. In addition, an unbalanced diet, suboptimal nutritional status, and poor sleep duration can affect menstrual hormone regulation. Excessive or too low physical activity also has the potential to disrupt ovulation, leading to irregular menstrual cycles (10).

Body mass index (BMI) is one of the factors that can affect the menstrual cycle. Weight and height can be calculated by comparison to calculate BMI, the measurement can show the proportion of body fat. A high or low body mass index can affect the menstrual cycle and result in conditions such as pain during the menstrual cycle, and no menstruation (11). Adolescent girls often diet to maintain their body shape. The dietary pattern adopted can affect nutritional status, which in turn has an impact on the menstrual cycle. If the diet is unbalanced or too restrictive, adolescents are at risk of nutritional deficiencies, which can lead to menstrual disorders such as irregular menstrual cycles (12).

According to Minister of Health Regulation No. 2/2020, the nutritional status of children aged 5-18 years, including adolescent girls, can be assessed using the body mass index. The World Health Organization (WHO) states that a BMI that is below or above normal limits can affect the regularity of the menstrual cycle. An imbalance in nutritional status, either in the form of underweight or overweight, can cause hormonal disturbances that have an impact on reproductive health (13). According to the WHO (2007), the normal limit of BMI in adolescents is determined based on their age. Nutritional status plays a crucial role in maintaining the regularity of the menstrual cycle. To have a normal menstrual cycle, the body needs at least 22% fat and a BMI of more than 19 kg/m². This balance allows fat cells to release the hormone estrogen, which is important in triggering the ovulation phase in women. If body fat levels are too low, estrogen production may be impaired, increasing the risk of irregular or even interrupted menstrual cycles (14).

Research conducted by Sartika et al (15) analyzed the relationship between BMI and menstrual cycle regularity in seventh-grade students at MTsN 3 Agam. Using the Chi-square test with the help of SPSS software, this study obtained a p-value = 0.050, which indicates a significant relationship between BMI and menstrual cycle. These results indicate that IMT imbalance has the potential to cause menstrual cycle disorders, so this factor needs to be considered in maintaining adolescent reproductive health. Some adolescent girls with normal BMI (33.30%) and obese (13.30%) experienced abnormal menstrual cycles. The statistical test results obtained a p-value=0.007 ($p<0.05$), which indicated a significant relationship between BMI and menstrual cycle regularity. This finding supports that weight imbalance can affect menstrual cycle disorders in adolescent girls (16).

Junior High School State 19 Surabaya was chosen as the research location because the majority of adolescent girls experience menarche at the age of 12, which is at the junior high school level of education. This study limited the subjects to junior high school adolescent girls because this age group is in the phase of adaptation to the newly experienced menstrual cycle. At this stage, the menstrual cycle tends to be unstable and can be influenced by various factors, such as nutritional status, body mass index, diet, physical activity, and psychological conditions. By examining this age group, research can obtain a clearer picture of the factors that contribute to the regularity or irregularity of the menstrual cycle from an early age. This study aims to analyze the effect of BMI on menstrual cycle regularity in adolescents at Junior High School State 19 Surabaya. It is hoped that this study will help obtain a deeper understanding of the relationship between nutritional status and menstrual patterns, which can then be the basis for efforts to prevent and treat menstrual disorders in adolescents.

METHODS

This study was conducted at SMP Negeri 19 Surabaya, starting from October 2023 to May 2024, using a case-control research design. The study population consisted of two groups, namely the case group involving adolescent girls with irregular menstrual cycles at Junior High School State 19 Surabaya, and the control group consisting of adolescent girls with regular menstrual cycles at Junior High School State 19 Surabaya. The number of subjects was calculated using the proportion difference formula (Lwanga and Lemeshow, 1997).

Based on previous research, the odds ratio (OR) value of 5.08 was obtained with a 1:1 ratio between the case and control groups. Thus, the minimum number of subjects for each group was 52 respondents, so the total number of subjects was 104 participants. This study used simple random sampling to obtain subjects in the population.

The inclusion criteria for the case group were adolescent girls who had experienced menstruation, had irregular menstrual cycles, and were at least 12 years old. while the inclusion criteria for the control group were adolescent girls who had experienced menstruation, had a regular menstrual cycle, and were at least 12 years old. Body mass index is the independent variable in this study, while menstrual cycle is the dependent variable. This study categorized menstrual cycles based on their regularity. A menstrual cycle was classified as regular if it lasted between 21 and 35 days with a consistent pattern each month. Conversely, it was classified as irregular if it lasted less than 21 days, more than 35 days, or showed inconsistent variations in cycle length. BMI in this study was categorized according to WHO standards. The BMI categories were very thin (<17.0 kg/m²), thin (17.0–18.4 kg/m²), normal (18.5–24.9 kg/m²), and overweight or obese (≥25.0 kg/m²). These classifications were used to analyze the relationship between nutritional status and menstrual cycle regularity among participants.

Primary data were obtained through measurement of individual nutritional status based on the ratio between body weight and height. Measurements were taken using OneMed scales, OneMed stature meter, and menstrual calendar. The data collected included body weight, height, and menstrual cycle, which were then statistically analyzed using the SPSS application. The analysis included a description of each independent variable against the dependent variable, testing the relationship between the independent and dependent variables in subjects in the population. The analysis included a description of each independent variable against the dependent variable, followed by statistical testing to examine the relationship between the independent and dependent variables. Additionally, logistic regression analysis was performed to determine the strength of the association between BMI and menstrual cycle regularity after adjusting for potential confounders.

Universitas Airlangga Faculty of Dentistry Research Ethical Clearance Commission approved this study in an approval letter numbered 0304/HRECC.FODM/IV/2024.

RESULTS

Menstrual Cycle Characteristics of Participants

This study involved 104 participants, with a 1:1 ratio between the case and control groups. Based on Table 1, the number of adolescent girls who have regular and irregular menstrual cycles is 52 participants each. This division was done to ensure the balance of data in the analysis so that the results of the study could be more accurate and relevant in describing the relationship between the variables studied.

Table 1
Menstrual Cycle Distribution of Participants

Menstrual Cycle	n	%
Regular	52	50
Irregular	52	50
Total	104	100

Crosstabulation Analysis of Body Mass Index (BMI) and Menstrual Cycle

Based on Table 2, the crosstabulation results indicate that menstrual cycle regularity varies across different BMI categories. The majority of adolescents in this study had a normal BMI (54.81%), and among them, a higher proportion experienced regular menstrual cycles (75.00%) compared to those with irregular cycles (34.62%). In contrast, adolescents who were overweight or obese (18.27%) had a lower percentage of regular menstrual cycles (11.54%), suggesting a possible association between excess body weight and menstrual irregularities. Similarly, underweight adolescents (11.54%) had a higher proportion of irregular menstrual cycles (19.23%), which could indicate potential hormonal imbalances affecting cycle regulation. These findings suggest that maintaining a healthy BMI is important for menstrual cycle regularity. Nutritional status plays a crucial role in reproductive health, emphasizing the need for balanced dietary intake and healthy lifestyle habits among adolescents.

Age Characteristics of Participants' Menarche

Based on Table 3, the analysis showed that most of the participants in the control group experienced menarche at a normal age, which amounted to 86.5%. The same was found for the majority of participants in the case group, where 75% of them had a normal age of menarche. This finding indicates that the normal age of menarche was more

prevalent in both groups compared to other categories.

The Influence of Body Mass Index (BMI) on Menstrual Cycle: Logistic Regression Results

Based on Table 4, The logistic regression analysis demonstrated that BMI significantly influences menstrual regularity ($\chi^2(3) = 16.23$, $p = 0.001$). Adolescents with normal BMI were significantly more likely to have regular menstruation compared to those in the overweight/obese group (OR = 4.69, 95% CI [1.54 – 14.44], p = 0.007). In contrast, there was no significant difference in menstrual regularity between the very skinny (OR = 0.99, p = 0.98) or underweight (OR = 0.43, p = 0.36) groups when compared to their overweight/obese counterparts. These findings suggest that an imbalanced BMI, particularly overweight/obesity, may contribute to menstrual irregularities, highlighting the importance of maintaining an optimal BMI for reproductive health.

Table 2
Crosstabulation of Body Mass Index and Menstrual Cycle

Body Mass Index	Menstrual Cycle				Total	
	Regular		Irregular			
	n	%	n	%	n	%
Very Skinny	5	9.62	11	21.15	16	15.38
Underweight	2	3.85	10	19.23	12	11.54
Normal	39	75	18	34.62	57	54.81
Overweight and Obesity	6	11.54	13	25	19	18.27
Total	52	100	52	100	104	100

Table 3
Crosstabulation of Menarche Age and Menstrual Cycle

Body Mass Index	Menstrual Cycle				Total	
	Regular		Irregular			
	n	%	n	%	n	%
Very Skinny	7	13.50	13	25	20	19.20
Underweight	45	86.50	39	75	84	80.80
Total	52	100	52	100	104	100

Table 4
Logistics Regression Analysis of Body Mass Index and Menstrual Cycle

Variable	B	S.E.	Wald	df	Sig.(p)	Exp(B)	95% CI for Exp(B)
Overall BMI	-	-	-	3	0.001	-	-
BMI (1) Very Skinny (Ref: Overweight/Obese)	-0.02	0.73	0.00	1	0.98	0.99	0.24 − 4.13
BMI (2) Underweight (Ref: Overweight/Obese)	-0.84	0.92	0.83	1	0.36	0.43	0.07 − 2.62
BMI (3) Normal Ref: Overweight/Obese	1.55	0.57	7.36	1	0.007	4.69	1.54 − 14.44

DISCUSSION

Based on the study results, the analysis showed that overall body mass index (BMI) has a significant impact on the regularity of the menstrual cycle in adolescent girls. The findings indicate that students with a normal BMI are more likely to experience regular menstruation compared to those who are overweight or obese. Meanwhile, the very skinny category did not show a significant effect on the menstrual cycle. This finding is in line with research conducted by Pahlawan et al (17), which states that low levels of body fat can reduce estrogen levels, which can potentially affect infertility. Conversely, longer menstrual cycles can occur due to increased estrogen levels caused by excess fat in the body. BMI plays a role in influencing the regularity of the menstrual cycle through its impact on hormones and reproductive functions in the body. Research shows that being overweight or obese can trigger changes in the production of reproductive hormones, such as estrogen and progesterone, potentially disrupting the hormonal balance in the menstrual cycle. This imbalance can lead to instability in various phases of the menstrual cycle, including irregular or even non-occurring ovulation. As a result, this condition can lead to disruptions in the regularity of the menstrual cycle (18). Other findings also suggest that high BMI may cause the absence of menstruation and lengthening of the menstrual cycle. The length of the menstrual cycle is caused by increased body fat increase. The menstrual cycle is strongly influenced by body fat. Body fat plays a role in the secretion of reproductive hormones (19).

Body mass index is one of the parameters used to estimate the percentage of fat in the body. Body fat acts as a compound that contributes to the synthesis of the hormone estrogen (20). An underweight body mass index not only affects the growth and function of the body's organs but can also disrupt the reproductive system. This condition often results in menstrual cycle irregularities but can improve if nutritional intake is properly met. Long-term nutritional deficiencies can result in decreased reproductive function due to hormonal imbalances, especially steroid hormones, which play a role in the regulation of the ovulation cycle (21). The better a person's BMI, the lower the chance of menstrual disorders, including menstrual cycle irregularities. In addition, adequate nutritional intake plays a role in optimizing reproductive function. In the luteal phase of the menstrual cycle, when progesterone production increases, the body's nutritional needs also increase. If these needs are not met, it can cause disturbances in the menstrual cycle. Therefore, the fulfillment of adequate nutrition is very important to maintain a smooth menstrual cycle and support reproductive health (22).

Besides body mass index, other factors that affect the menstrual cycle are stress, diet, and physical activity. Stress can increase the hormone cortisol, which affects the balance of reproductive hormones, causing menstrual irregularities. An unbalanced diet, especially as a result of extreme dieting, can disrupt the balance of hormones that regulate the menstrual cycle. Physical activity, whether too low or excessive, can also affect energy balance and nutritional status, impacting the regularity of the menstrual cycle (23).

Research Limitations

This study has several limitations that should be considered. The sample was limited to adolescent girls from a single school, which may affect the generalizability of the findings. Self-reported data on menstrual cycle regularity and BMI may introduce recall bias or inaccuracies. Additionally, this study did not account for other potential confounding factors, such as stress levels, dietary habits, and physical activity, which may also influence menstrual regularity. Future research should consider a larger and more diverse sample, objective BMI measurements, and a more comprehensive assessment of factors affecting menstrual health.

CONCLUSION

This study found a significant association between BMI and menstrual cycle irregularities, where adolescents with a normal BMI were more likely to have a regular cycle than those who were overweight or obese. Meanwhile, underweight and very skinny adolescents showed no significant difference in menstrual cycle regularity compared to their overweight or obese peers. These findings emphasize the importance of maintaining a healthy BMI to support menstrual regularity and reproductive health in adolescents.

CONFLICT OF INTEREST

There is no conflict of interest in this research.

AUTHOR CONTRIBUTIONS

All authors played an active role in the preparation of this article. KDA: Review & Editing,

Research Supervisor; ASD: Data Collection, Data Analysis; TAM: Conceptualization, Writing-Early Draft; TH: Writing-Review & Editing.

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