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The Interaction of Body Mass Index and Physical Activity on Menstrual Cycle Patterns in Female Students

Sri Musfiroh, Ahmad Nurjannah, Mazi Nurazmi
Faculty of Health Sciences, University of Muhammadiyah Ahmad Dahlan
Corresponding Author. Email: srimusfiroh052@gmail.com

Abstract
Background. Menstrual cycle disruption is still a fairly high reproductive health problem in adolescents and young adults. Previous research showed that 38.6% of adolescents experienced irregular menstrual cycles, and 20.4% of them had experienced amenorrhea for ≥90 days. The regularity of the menstrual cycle is influenced by a variety of factors, including Body Mass Index (BMI) and physical activity.
Aims. This study aims to analyze the interaction between Body Mass Index and physical activity on menstrual cycle patterns among regular female students at STIKes Muhammadiyah Cirebon in 2024.
This study uses an analytical quantitative design with *a cross-sectional* approach. The sampling technique used was *proportional stratified sampling* with a total of 155 female students. Data were collected using a structured questionnaire, then analyzed using the Chi-Square test with a significance level of $p \leq 0.05$.
Result. The results showed a significant relationship between Body Mass Index and menstrual cycle patterns ($p = 0.000$; $p < 0.05$). Meanwhile, physical activity showed no significant association with menstrual cycle patterns ($p = 0.08$; $p > 0.05$). These findings show that BMI status plays a more dominant role than physical activity in influencing menstrual cycle patterns among female students.
Conclusion. The conclusion of this study is that there is a partial interaction between Body Mass Index and menstrual cycle patterns, but no significant relationship was found between physical activity and menstrual cycle patterns.
Implementation. The results of this study can serve as the basis for promotive and preventive efforts to maintain optimal BMI and support the reproductive health of female students.

Keywords: Body Mass Index, Physical Activity, Menstrual Cycle, College Students

INTRODUCTION

Menstruation is a physiological process of endometrial decay that occurs periodically due to changes in the hormones estrogen and progesterone. The regularity of the menstrual cycle is an important indicator of women's reproductive health, especially in adolescence and young adulthood. A normal menstrual cycle reflects a good hormonal balance, while irregular cycles can be a sign of both physiological and metabolic disorders.

Globally, menstrual cycle disruption is still quite high. The World Health Organization (WHO) reports that about 45% of women in the world experience menstrual cycle disruptions. Another study showed that 38.6% of adolescents had irregular menstrual cycles and 20.4% had amenorrhea for ≥90 days. National data from the Basic Health Research (Riskesdas) in 2018 also shows that 13.7% of Indonesian women aged 10–59 years experience irregular periods, with a prevalence in West Java of 14.4%. This condition has the potential to cause long-term impacts such as ovulation disorders, infertility, endometriosis, and psychological disorders.

One factor suspected to play a role in the menstrual cycle pattern is Body Mass Index (BMI). BMI is an indicator of nutritional status that describes body composition and is classified into underweight, normal, overweight, and obese. Imbalances in nutritional status, both underweight and overweight, can disrupt reproductive hormone balance, potentially causing menstrual cycle disruptions. The 2023 Indonesian Health Survey (SKI) shows that there is still a high prevalence of adolescents with abnormal nutritional status, including overweight and obesity, both nationally and in West Java.

In addition to BMI, physical activity is another factor affecting hormonal balance. Too little or excessive physical activity can affect the function of the hypothalamus-pituitary-ovarian axis, which regulates the menstrual cycle. In the group of female students, lifestyle changes, academic load, and irregular activity patterns have the potential to affect reproductive health.

Given these problems, it is important to examine how the interaction between Body Mass Index and physical activity affects menstrual cycle patterns, especially among female students, a group at an early reproductive age. This research is expected to make a scientific contribution to reproductive health promotion and prevention by controlling nutritional status and managing physical activity.

Research on menstrual cycle patterns among adolescents and young women has advanced significantly in reproductive health, nutrition, and lifestyle epidemiology. Many previous studies have identified Body Mass Index (BMI) as an important determinant of hormonal balance and menstrual regularity. Abnormal BMI, both underweight and overweight, has been consistently associated with menstrual disorders due to disruptions in estrogen production and hypothalamic–pituitary–ovarian function.

In addition to BMI, physical activity has also been widely studied as a lifestyle factor influencing reproductive health. Several studies report that excessive or insufficient physical activity can affect hormonal regulation and potentially lead to menstrual irregularities. However, empirical findings remain inconsistent, with some studies reporting significant

relationships and others finding no association between physical activity and menstrual cycle patterns.

Recent research has emphasized that menstrual cycle patterns are multifactorial, influenced by nutritional status, physical activity, psychological stress, sleep quality, and hormonal status. Despite this progress, most studies still focus on single-factor analysis rather than examining the interaction between multiple determinants simultaneously.

RESEARCH METHODS

Research Design

This research is a quantitative analytical research with *a cross-sectional* approach. This design was used to analyze the interaction between Body Mass Index (BMI) and physical activity on menstrual cycle patterns, with measurements of both independent and dependent variables collected simultaneously at a single point in time (point-time *approach*).

Research Time and Place

The research was conducted at STIKes Muhammadiyah Cirebon from May to August 2024, covering the stages of proposal preparation, data collection, and final report preparation.

Population and Sample

Population

The population in this study comprises all regular female students of STIKes Muhammadiyah Cirebon for the 2023/2024 Academic Year, totaling 253 people.

Sample

The number of samples was determined using the Slovin formula with an error rate of (e) 5%, so that a sample of 155 respondents was obtained. The sampling technique uses *Proportional Stratified Sampling*, which is proportional sampling based on the study program's strata and the level of education.

The distribution of samples is carried out proportionally in the Midwifery and Pharmacy Study Program at each level (I–IV) according to the population of each stratum.

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Regular students of STIKes Muhammadiyah Cirebon who are willing to become respondents.
2. Aged 18–22 years old (late teens).
3. Followed the entire series of research until it was completed.

Exclusion Criteria

Students who were not present or did not complete the questionnaire were asked to fill it out during the research.

Data Collection Techniques

Data were collected using a structured questionnaire that included respondent characteristics, body mass index (based on weight and height measurements), physical activity levels, and menstrual cycle patterns.

Data Analysis

Data analysis was carried out using the *Statistical Package for the Social Sciences* (SPSS) program.

1. Univariate Analysis: Used to describe the characteristics of each research variable in the form of frequency and percentage distributions.
2. Bivariate Analysis. Bivariate analysis is carried out using the Chi-Square test to assess the relationship between BMI, physical activity, and menstrual cycle patterns.
    - If the p-value ≤ 0.05, then there is a significant relationship.
    - If the p-value> 0.05, then there is no significant relationship.
3. Multivariate Analysis. Multivariate analysis was carried out using multiple logistic regression to determine which variables most affected menstrual cycle patterns and to analyze the interaction between BMI and physical activity after simultaneous control. Variables with a p≤ value of 0.05 on bivariate analysis were included in the regression model. The results of the analysis are presented as an Odds Ratio (OR) with a 95% confidence interval (95% CI).

RESEARCH RESULTS

Overview of research locations

Muhammadiyah Cirebon College of Health Sciences is an accredited health college institution of B class, with 3 study programs: Bachelor of Midwifery, Midwifery Profession, and Bachelor of Pharmacy. STIKes Muhammadiyah Cirebon is one of the Muhammadiyah Charities (AUM) in Cirebon City. As a Muhammadiyah campus, STIKes Muhammadiyah Cirebon has Catur Darma Perguruan as a function of its existence as a higher education institution, namely Education and Teaching, Research, Community Service, and Al-Islam Kemuhammadiyahan. STIKes Muhammadiyah Cirebon is located on Jalan Kalitanjung no.14 - 18 A, Harjamukti, Harjamukti District, Cirebon City, West Java 45143.

Univariate Analysis

Body Mass Index

Table 1. Univariate Analysis of Body Mass Index

Body Mass Index	**N**	**%**
Skinny: <18.5	18	11.60%
Normal: 18.5-24.9	104	67.10%
Fat: 25.0-26.9	7	4.50%
Obesity: ≥27.0	26	16.80%
Total	155	100.00%

Source: Primary Data (2024)

Based on Table 1, the majority of respondents have a Body Mass Index in the normal category of 18.5-24.9, with 104 respondents (67.1%).

Physical Activity

Physical Activity Data in this study were collected using a 3-question questionnaire. Activity data results. Physical activity is categorized as Yes (doing physical activity ≥30 minutes a day) or No (not doing physical activity ≥30 minutes a day).

Table 2. Univariate Analysis of Physical Activity

Physical activity	N	%
Yes	60	38.70%
No	95	61.30%
Total	155	100.00%

Source: Primary Data (2024)

Table 2 shows that the majority of respondents do not do physical activity, with 95 respondents (61.3%).

Menstrual cycle

Menstrual cycle data in this study were collected using a questionnaire that asked respondents about their menstrual cycles from May to June 2024. The results of the menstrual cycle data are divided into 3 categories: the 21-day < Menstrual Cycle, the 21-35-day Menstrual Cycle, and the >35-day Menstrual Cycle. The following is a univariate analysis of the menstrual cycle.

Table 3. Menstrual cycle univariate analysis

Menstrual Cycle	N	%
< 21 days	1	0.60%
21-35 days	137	88.40%
>35 days	17	11.00%
Total	155	100.00%

Source: Primary data (2024)

Based on the results of Table 10, it shows that the majority of respondents have a menstrual cycle of 21-35 days, with 137 respondents (88.4%).

Bivariate Analysis

The Relationship between Body Mass Index and Menstrual Cycle

The bivariate analysis of this study, the measurement of Body Mass Index with Menstrual Cycle in respondents, was carried out using *the chi-square test*. The following bivariate analysis results are presented in the table:

Table 4. The Relationship between Body Mass Index and Menstrual Cycle

Body Mass Index	Menstrual Cycle			Total	*R*	*p- value*
	<21 happy	21- 35 happy	> 35 happy			
Skinny: < 18.5	0	18	0	18	0.049	0.000
Normal: 18.5-24,9	0	91	13	104		
Fat: 25.0-26,9	1	6	0	7		
Obesity: ≥27.0	0	22	4	26		
Total	1	137	17	155		

Source: Primary data (2024)

Based on Table 11 of the results of the chi-square statistical test, the value of p = 0.000 was obtained, namely, p < 0.05, indicating a correlation between body mass index and the menstrual cycle. The value of the correlation coefficient (r) = 0.049. So, there is a relationship between body mass index.

The Relationship between Physical Activity and Menstrual Cycle. The bivariate analysis of this study, measuring Physical Activity and Menstrual Cycle in respondents, was

carried out using *the chi-square test*. The following bivariate analysis results are presented in the table:

Table 5. The Relationship between Physical Activity and the Menstrual Cycle

Physical activity	**Menstrual Cycle**			**Total**	***R***	***p- value***
	<21 happy	**21- 35 happy**	**> 35 days**			
Yes	0	57	3	60	0.081	0.117
No	1	80	14	95		
Total	1	137	17	155		

Source: Primary data (2024)

Based on Table 5 of the results of the chi-square statistical test, the value of p = 0.117 was obtained, namely, p > 0.05; there was a correlation between the body mass index and the menstrual cycle. The value of the correlation coefficient (r) = 0.081. Thus, there is no relationship between physical activity and the menstrual cycle.

Table 6. Multivariate Analysis

Independent Variables	Sig.	*Nagelkerke R Square*
IMT	0,048	0,201
Physical Activity	0,079	

Based on the results of the analysis, it was found that only the BMI variable had an influence on the menstrual cycle with a significance value of 0.048 < 0.05. The Nagelkerke R^2 value of 0.201 indicates that the two independent variables explain 20.1% of the variation in the menstrual cycle.

DISCUSSION

Univariate Analysis

Body Mass Index

The results showed that most respondents had a normal BMI (67.1%), followed by obesity (16.8%), thinness (11.6%), and obesity (4.5%). These findings are in line with the research of Septiani Dara et al. (2023), which reported that the majority of female students were in the normal BMI category, as well as the research of Alasi and Hamdani (2017), which showed that most of the respondents had normal nutritional status (67.2%).

Body Mass Index (BMI) is an indicator to assess nutritional status based on a comparison of weight and height (Karlinah & Irianti, 2021). BMI is classified into thin, normal, overweight, and obese categories, each of which describes body fat composition (Sagabulang, 2022). BMI imbalances can affect metabolic and hormonal functions, including reproductive hormones that regulate the menstrual cycle.

Physical Activity

Most respondents (61.3%) did not meet physical activity recommendations of≥30 minutes per day, while 38.7% did. These results are in line with the research of Kusumawati Dewi et al. (2021), which showed that the majority of respondents had light physical activity. According to WHO (2018), physical activity is any body movement produced by skeletal muscles that increases energy expenditure. Excessive physical activity can cause physical and mental fatigue, which can lead an menstrual delays (Wati et al., 2019). In addition, high-intensity physical activity can inhibit the secretion of *Gonadotropin-Releasing Hormone* (GnRH), thereby lowering estrogen levels and potentially disrupting the menstrual cycle (Yuni & Ari, 2020).

Menstrual Cycle

The majority of respondents (88.4%) had a normal menstrual cycle (21–35 days), while 11.0% had a long cycle and 0.6% had a short cycle. These results are consistent with the findings of Pratiwi Dian et al. (2024), who also found that the majority of adolescents have a normal menstrual cycle.

The menstrual cycle is the time span from the first day of menstruation to the first day of the next menstrual period, with a normal range of 21–35 days (Ilmi & Selasmi, 2019). Menstruation is a process of uterine wall degeneration that occurs periodically due to hormonal changes (Silalahi, 2021). Menstrual cycle irregularities can be an indicator of reproductive system disorders, including fertility disorders and infertility (Utami, 2020).

Bivariate Analysis

The Relationship of Body Mass Index with the Menstrual Cycle

The results of the Chi-Square test showed a significant relationship between BMI and menstrual cycle ($p = 0.000$; $p < 0.05$). These findings show that nutritional status influences the pattern of menstrual cycles among female students. These results are consistent with the findings of Frandita Ivana Tanisiwa et al. (2019), Ruqaiyah (2020), and Mega Yulia et al. (2023), which report a significant relationship between BMI and the menstrual cycle. Nutritional status is one factor that affects hormonal balance (Silalahi, 2021).

Physiologically, BMI abnormalities affect body fat reserves, which play a role in estrogen production. Excess or too low body fat can interfere with hypothalamic function, which further affects the secretion of FSH and LH from the anterior pituitary, thus impacting the ovulatory and menstrual processes (Ruqaiyah, 2020). Thus, BMI is one of the important determinants of the regularity of the menstrual cycle.

The Relationship of Physical Activity with the Menstrual Cycle

The results of the Chi-Square test showed no significant association between physical activity and menstrual cycle ($p = 0.08$; $p > 0.05$). These findings are in line with the research of Nurfadilah Hilda et al. (2022), which showed no relationship between physical activity and the menstrual cycle ($p = 0.347$), and the research of Anindita Putri (2016), which also found no significant association ($p = 0.846$).

The absence of this relationship may be due to the predominance of respondents with normal menstrual cycles and to other factors that are more influential, such as nutritional status, hormonal balance, nutritional intake, and psychological factors, such as stress (Nurfadilah, 2021; Diani Damayanti, 2022). Stress can increase cortisol secretion, which inhibits LH release and, in turn, affects estrogen and progesterone levels, which play a role in regulating the menstrual cycle.

Multivariate Analysis

The results of multiple logistic regression analysis showed that of the two independent variables studied, only Body Mass Index (BMI) had a significant influence on the menstrual cycle, with a significance value of $p = 0.048$ ($p < 0.05$). Meanwhile, the physical activity variable did not show a significant effect after simultaneous testing. These findings reinforce the results of previous bivariate analysis, that BMI is a more dominant factor in influencing menstrual cycle patterns than physical activity. Physiologically, the nutritional status reflected in BMI plays a role in hormonal balance, specifically estrogen, which is produced in part by fat tissue. An imbalance in body fat levels, whether too low or excessive, can disrupt hypothalamic-pituitary-ovarian function, thereby affecting the secretion of FSH and LH, which play a role in ovulation and the menstrual cycle.

The Nagelkerke R^2 value of 0.201 indicates that BMI and physical activity together explained 20.1% of the variation in the menstrual cycle, while the remaining 79.9% was attributable to other factors not studied in this study. These factors can include psychological stress, nutritional intake, hormonal disorders, sleep quality, history of reproductive diseases, and genetic factors.

This relatively moderate determination value indicates that the menstrual cycle is a multifactorial condition influenced by biological, psychological, and environmental factors. Thus, although BMI has been proven to have a significant effect, a comprehensive approach is still needed in maintaining the reproductive health of female students.

Overall, the results of the multivariate analysis showed that, in the interaction between Body Mass Index and physical activity on menstrual cycle patterns, BMI was the variable that contributed most to menstrual cycle changes among STIKes Muhammadiyah Cirebon students.

The novelty of this study lies in its integrated analytical approach to examining the interaction between nutritional status and lifestyle behavior in relation to menstrual cycle patterns among female students.

Key novelties of this research include:

1. Interaction Analysis Between BMI and Physical Activity. This study not only examines individual relationships but also analyzes the interaction of two variables simultaneously using multivariate statistical analysis.
2. Identification of Dominant Determinant Variable. The study demonstrates that BMI is the most dominant factor influencing menstrual cycle patterns, providing clearer evidence for prioritizing nutritional status in reproductive health interventions.
3. Context-Specific Evidence in Female Students. The research provides empirical data specifically from female college students, a population group at an early reproductive age that is vulnerable to lifestyle-related reproductive health problems.
4. Quantitative Contribution to Variance Explanation. The study quantifies the contribution of BMI and physical activity to menstrual cycle variability, showing that these variables explain 20.1% of the variability, suggesting the presence of additional influencing factors.

Thus, the scientific novelty of this study can be summarized as:

1. Integrated analysis of BMI and physical activity
2. Identification of the dominant determinant (BMI)
3. Empirical evidence in young adult female students
4. Quantitative explanation of menstrual cycle variability

The existing literature has established the relationship between Body Mass Index and menstrual cycle patterns; however, limited studies have examined the interaction between Body Mass Index and physical activity simultaneously using multivariate analysis. Furthermore, the contribution of these variables explains only a portion of menstrual cycle variability, indicating the need to investigate additional biological, psychological, and lifestyle factors among female university students.

Although many studies have examined factors affecting menstrual cycle patterns, several important gaps remain in the literature.

The main research gaps identified in this study are:

1. Most previous research analyzes BMI and physical activity separately, rather Than Limited Interaction-Based Studies. than examining their interaction effects on menstrual cycle patterns.

2. Incomplete Explanation of Menstrual Cycle Variability. This study shows that BMI and physical activity explain only 20.1% of menstrual cycle variation, meaning that approximately 79.9% of influencing factors remain unexplored, such as:

- Psychological stress
- Dietary intake
- Sleep quality
- Hormonal disorders
- Genetic factors
- Reproductive health history

3. Limited Focus on University Student Populations**.** Many studies focus on adolescents in secondary schools, whereas fewer investigate reproductive health determinants among university students.

4. Lack of Multivariate and Predictive Models**.** Previous studies often rely on bivariate analysis, resulting in a limited understanding of dominant predictors and the combined effects of multiple variables.

CONCLUSION

This study concludes that Body Mass Index (BMI) is significantly associated with menstrual cycle patterns among female students, indicating that nutritional status plays an important role in maintaining reproductive health. Students with abnormal BMI, whether underweight or overweight, are more likely to experience menstrual cycle irregularities due to hormonal imbalances associated with body fat composition.

Meanwhile, physical activity was not found to be significantly related to menstrual cycle patterns in this study, suggesting that other factors, such as stress, dietary intake, sleep patterns, and hormonal conditions, may have a greater influence on menstrual regularity. Additionally, the multivariate analysis showed that BMI was the most dominant factor affecting menstrual cycle patterns, although both variables together explained only a portion of the variation in menstrual cycles.

Therefore, maintaining an optimal Body Mass Index through balanced nutrition and healthy lifestyle behaviors is essential for supporting reproductive health among female students. Future research is recommended to explore additional determinants of menstrual cycle patterns, including psychological, hormonal, and lifestyle factors, using broader samples and longitudinal study designs.

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