

Body mass index, sleep quality, stress conditions determine menstrual cycles among female adolescents

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ABSTRACT

Menstrual cycles are an important indicator of women's health. Menstrual cycles can be affected by body mass index (BMI), sleep quality, and stress. This study aimed to analyse the relationship between BMI, sleep quality, stress and the menstrual cycle. The subjects of this research were the female adolescents at the age of at least 15 years old that had experienced menstruation for at least 2 years. The dependent variable is the menstrual cycle while the independent variables are BMI, sleep quality, and stress conditions. Observational analytic research method with Cross sectional design was used in this research. The subjects were 148 female students. The BMI data were obtained through the anthropometric measurement. The sleep quality data were taken with PSQI questionnaire, and the stress condition data obtained from PSS-10 questionnaire which were then analysed using Chi-Square test and Logistic Regression. Results of study showed that there is a significant relationship between BMI, sleep quality, stress conditions and the adolescent menstrual cycle. The results of the multivariate analysis showed that the female adolescents with abnormal BMI are at risk of having menstrual cycle disorders 1.91 times. The adolescents with poor sleep quality are at risk experiencing menstrual cycle disorders 2.05 times, and the adolescents with stress conditions at risk of the menstrual cycle disorders 2.26 times. There is a relationship between BMI, sleep quality, stress conditions and the menstrual cycle. Stress conditions most influence the regularity of the menstrual cycle.

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1. INTRODUCTION

Adolescence is a period of transition from children to adulthood, which is accompanied by various hormonal, physical, social and psychological changes [1]. In women, menstruation will occur, which is then called the menstrual cycle. Menstrual cycles are an important indicator of women's health [2]. Normal menstrual cycle if the distance between the first day of menstrual blood discharge and the first day of the next menstruation occurs with an interval of 21-35 days [3]. Normal menstrual cycles depend on the hormonal actions and interactions released from the hypothalamus-pituitary-ovary and their effects on the endometrium [4]. Shortening the menstrual cycle which causes a shorter menstrual cycle (polimenore) is associated with a decrease in fertility and miscarriage while the lengthening of the menstrual cycle (oligomenorrhoea) is associated with anovulation, infertility, and miscarriage [5].

Adolescence is a growth period where nutritional needs must be fulfilled to achieve optimal growth, where adequate nutritional intake can affect menstrual irregularities in adolescents [6]. Nutritional status is a body condition as a result of nutritional adequacy. Based on KEPMENKES [7] about the Anthropometric

Standards Assessment of the Nutritional Status of Children and Adolescents, the nutritional status of adolescents is determined from the condition of the adolescent body which is calculated based on BMI/A.

Women who have experienced menstruation experience hormonal changes that not only affect reproduction but also body temperature, respiration, nervous system, mood, and sleep [8]. Sleep disorders are experienced by 62.9% of Indonesian adolescents aged 12-15 years [9]. Puberty can interfere with sleep, which can lead to delayed sleep and low sleep quality [10]. About one third of adolescents experience sleep disorders [10] and women are known to have a higher prevalence of sleep disorders than men [11]. Sleep is related to the hormonal system and reproductive function in women [10-13]. Female adolescents experience menstruation every month, where menstruation is related to the hypothalamus-hypophysical-pituitary. The pituitary hormone is excreted in sleep conditions [13].

Stress is a non-specific body response and occurs when the body's needs are disturbed. The occurrence of stress can have an impact on physical, social, psychological, intellectual, and spiritual conditions. Stress that occurs for a long time can interfere with the physiological condition of the body [14]. This is due to the body secreting the antagonistic hormones with some of the body's hormones during stress, one of which is the hormone that plays a role in the menstrual cycle, namely Gonadotropin Releasing Hormone (GnRH). Based on the background above, the researcher conducted further research to analyze the relationship between BMI, sleep quality, and stress conditions and the menstrual cycle of female adolescents.

2. RESEARCH METHOD

The subjects of this research were the adolescents at the age of at least 15 years who had experienced menstruation for at least 2 years. The location of the research was in Magelang City, Central Java, Indonesia. The dependent variable is the menstrual cycle, and the independent variables are the Body Mass Index, sleep quality, and stress. The research method used was observational analytic using a Cross-sectional design. The number of subjects was 148 students at the age of 15-17 years selected from 4 schools using cluster random sampling. Written informed consent was obtained from all participants prior to conducting the survey. The Health Research Ethics Committee of Faculty of Medicine Universitas Sebelas Maret approved the survey protocol (01/18/06/115).

The data of Body Mass Index (BMI) variable were obtained through direct anthropometric measurements. The sleep quality data were taken with the PSQI questionnaire, and the stress data were taken with the PSS-10 questionnaire. The Indonesian version of the PSQI instrument showed good reliability with Cronbach's Alpha results of 0.79 and content validity of 0.89 and a good correlation between global scores and each component. PSS-10 in Indonesian has been tested and has a Cronbach alpha coefficient of 0.96. The body mass index is categorized as normal and abnormal while the quality of sleep is grouped into good and bad categories, and the categorizations of stress are stressful and not stressful. The data were then analyzed with bivariate analysis using the Chi-square test while the multivariate analysis used Logistic regression.

3. RESULTS AND ANALYSIS

3.1. Respondents' characteristics

The number of samples was 148. 39.9% of the respondents were 15 years old: 46.6% were 16 years old, and 13.5% were 17 years old. More respondents were in the eleventh grade by 62.2% compared to those in the tenth grade of 37.8%. Description of respondents' characteristics is shown in Table 1:

Table 1. Respondents' characteristics

Variables	n	%
Age		
15 years old	59	39.9
16 years old	69	46.6
17 years old	20	13.5
Classes		
X	56	37.8
XI	92	62.2
The Age of Menarche		
<11 years old	22	14.9
11-14 years	124	83.8
old	2	1.3
>14 years old		

3.2. The relationship between BMI, sleep quality, stress conditions and menstrual cycles

The number of samples was 148. The respondents who had normal BMI and regular menstruation were 62.5% while the irregular ones were 44.2%. The respondents who had good sleep quality and regular menstruation were 65.6%, and the respondents who experienced stress with irregular menstruation were 65.4%. The Chi-square test results showed that there was a significant relationship ($p=0.03$) between the BMI and menstrual cycle in the female adolescents. There was a correlation between sleep quality ($p=0.014$) and the menstrual cycle of the female adolescents. There was a significant relationship ($p=0.004$) between stress conditions with the female adolescent menstrual cycle. The relationship between BMI, sleep quality, stress conditions and the menstrual cycle is shown in Table 2. The Results of the analysis of the relationship between BMI, sleep quality, stress conditions and menstrual cycles shown in Table 3.

Table 2. The relationship between BMI, sleep quality, stress conditions and menstrual cycles

Variables	Menstruation		Total n	p %
	Regular n	Irregular %		
BMI				
Abnormal	36	37.5	29	55.8
Normal	60	62.5	22	44.2
Sleep Quality				
Good	63	65.6	44	84.6
Bad	33	34.4	8	15.4
Stress Conditions				
Stressful	39	40.6	34	65.4
Not Stressful	57	59.4	18	34.6

Table 3. The results of the analysis of the relationship between BMI, sleep quality, stress conditions and menstrual cycles

Variables	B	OR (Exp B)	95% CI for Exp (B)		p
			Lower	Upper	
BMI	0.646	1.908	0.936	3.890	0.075
Sleep Quality	0.717	2.047	0.822	5.099	0.124
Stress Conditions	0.814	2.257	1.075	4.737	0.031
Constant	-1.890	0.151			<0.001

The results of the bivariate analysis showed a significant relationship between BMI and the menstrual cycle ($p=0.03$). This means that BMI has an influence on the adolescent menstrual cycle. This research is in line with Anggraini's research [15] that there is a relationship between BMI and the menstrual cycle. However, after the advanced test, it was found that BMI was not related to the menstrual cycle. This does not mean that BMI has nothing to do with the menstrual cycle. The absence of a relationship in this case may be due to the unequal data distribution between the respondents with normal BMI and those with abnormal BMI by 56.1%, more than that of the respondents with normal BMI. In Table 3, it can be seen that the adolescents with abnormal BMI are 1.91 times more likely to experience irregular menstrual cycles than those with normal BMI.

Malnutrition and excess nutrition will have an impact on the decline of hypothalamic function that does not provide stimulation to the anterior pituitary to produce FSH (Follicle Stimulating Hormone) and LH (Luteinizing Hormone) [16]. These hormones are very influential on menstruation. More nutrition in female adolescents can cause menstrual disorders due to an increase in oestrogen production, which is known that in addition to the ovary adipose tissue, it can also produce oestrogen. Continual increase in oestrogen indirectly causes an increase in androgen hormone which can interfere with follicle development so that it cannot produce mature follicles [17]. Obesity conditions are related to the process of changing androgens to oestrogens. Highly nutritious and fat foods will result in weight gain in female adolescents. Cholesterol found in excessive body fat is a precursor of oestrogen so that oestrogen production tends to be excessive. The level of oestrogen in the blood will increase due to high cholesterol [18]. A rapid increase in the oestrogen level gives rise to positive feedback on the hypothalamus and pituitary gland resulting in the LH surge. The fast LH secretion lowers the hyperandrogenism of the testosterone level so that ovulation does not occur [18]. Female adolescents who have very thin nutritional status will experience obstacles with menstruation. Drastic weight loss can cause a decrease in the gonadotropin hormone for the LH and FSH secretions which result in the oestrogen going down so that it has a negative impact on the menstrual cycle. The impaired LH secretion due to weight loss can cause the shortening of the luteal phase [19]. Malnutrition

is considered to be one of the important factors that cause interference with the hypothalamic-hypophysial-ovary [20].

In Table 2, it is known that there is a significant relationship between the quality of sleep and the menstrual cycle ($p=0.014$). This means that the quality of sleep has an influence on the adolescent menstrual cycle. The results of logistic regression analysis in Table 3 indicates that adolescents who have poor sleep quality have an opportunity to experience irregular menstrual cycles 2.05 times compared to those with good sleep quality. This is in line with the research conducted by Romans [11] that there is a relationship between the quality of sleep and the menstrual cycle, menstruating women have been reported to have poorer sleep quality and greater sleep disturbance [21-23]. According to Kloss et al. [24], there is a significant relationship in the research between the quality of sleep and the menstrual cycle because hormones will be processed during sleep. When the sleep quality is not good, then the work of hormones is not optimal and consequently disrupts menstruation.

However, after the logistic regression testing, there was no correlation between the quality of sleep and the menstrual cycle ($p=0.124$). This might be due to the quality of sleep in this research only as a confounding factor. According to Lund et al. [25], poor sleep quality will cause physical and psychological health problems. Emotional, psychological, and academic stress have a negative impact on sleep. This is in line with Kozier and Erb's [26] that stress has a big impact on sleep. Cross sectional study from the National Sleep Foundation [27] showed that compared women with irregular menstrual cycle are more likely to have poor sleep quality.

In this research, there were 49.3% of respondents who experienced stress and 50.7% were not stressful. In addition, there was a significant relationship between stress conditions and the menstrual cycle. Female adolescents who experience stress are likely to experience irregular menstrual cycles 2.26 times. High stress levels were associated with menstrual irregularity [28], another study [29] reported that higher stress score was a predictor of having experienced irregular menstrual cycles. This is in line with the statement of Palm-fischbacher and Ehlert [30] that stress can cause irregularities in the menstrual cycle. According to Toufexis et al. [31], stress neurochemical reactions stimulate hypothalamic-pituitary-adrenocortical (HPA) production, then increase the glucocorticoids excretion from the adrenal gland which inhibits the secretion of gonadotropin releasing hormone (GnRH) in the hypothalamus into the pituitary portal venous system, where it regulates the synthesis of the follicle stimulating hormone (FSH) and luteinizing hormone (LH) in the anterior pituitary and their secretion into the circulation. FSH and LH stimulate follicle development, ovulation, formation of the corpus luteum, and the secretion of coordinated estradiol, progesterone, and inhibin from the ovary. These hormones control the dynamic modulation of the secretion of the gonadotropin hormone through the pituitary which causes irregular menstrual cycles. The estrogen and progesterone cycles in women also cause stress responsiveness in women during the menstrual cycle [32]. The estrogen hormone in women has a role in the hypothalamus and adrenal gland to stimulate the release of stress hormones produced by the HPA axis [33]

4. CONCLUSION

There is a relationship between BMI, sleep quality, stress conditions and the menstrual cycle. The results of the multivariate analysis show that stress conditions most influence the regularity of the menstrual cycle.

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