

The Relation between Body Mass Index and Menstrual Cycle Disorders in Medical Students of University Pelita Harapan, Indonesia

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Abstract—Introduction: There are several things affecting menstrual cycle, namely, nutritional status, diet, financial status of one's household and exercises. The most commonly used parameter to calculate the fat in a human body is body mass index. Therefore, it is necessary to do research to prevent complications caused by menstrual disorder in the future. Design Study: This research is an observational analytical study with the cross-sectional-case control approach. Participants (n = 124; median age = 19.5 years ± SD 3.5) were classified into 2 groups: normal, NM (n = 62; BMI = 18-23 kg/m²) and obese, OB (n = 62; BMI = > 25 kg/m²). BMI was calculated from the equation; BMI = weight, kg/height, m². Results: There were 79.10% from obese group who experienced menstrual cycle disorders (n=53, 79.10%; p value 0.00; OR 5.25) and 20.90% from normal BMI group with menstrual cycle disorders. There were several factors in this research that also influence the menstrual cycle disorders such as stress (44.78%; p value 0.00; OR 1.85), sleep disorders (25.37%; p value 0.00; OR 1.01), physical activities (25.37%; p value 0.00; OR 1.24) and diet (10.45%; p value 0.00; OR 1.07). Conclusion: There is a significant relation between body mass index (obese) and menstrual cycle disorders. However, BMI is not the only factor that affects the menstrual cycle disorders. There are several factors that also can affect menstrual cycle disorders, in this study we use stress, sleep disorders, physical activities and diet, in which none of them are dominant.

Keywords—Menstrual disorders, menstrual cycle, obesity, body mass index, stress, sleep disorders, physical activities, diet.

I. INTRODUCTION

ONE of the traits of being a grown female is menstruation. Menstruation is a very complex process of organs' function, namely, cerebrum, hypothalamus, hypophysis, genitals, adrenal cortex, thyroid gland, serotonin and prostaglandin [1]. Menstruation is a physiological process of a female's body, which is the periodic discharge of blood, mucus and cell remnants from the mucosa of the lining of uterus. Moreover, this happens regularly from menarche to menopause, except for when a female is pregnant and breastfeeding [2]. Menstruation will repeat itself periodically every month, which will eventually create a menstrual cycle [3]. Commonly, the menstrual cycle for women range from 21 to 35 days, and only 10-15% women have a cycle of 28 days and menstruation on 3-5 days of it [4].

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Most women of reproductive age experience premenstrual syndrome and inconsistent menstrual cycle. The prevalence rate of an inconsistent menstrual cycle based on the evaluation which has been done previously; there are 9.00-13.00% women at a reproductive age whose menstrual cycles are inconsistent [5]. A research done in India show that the majority of women claiming to have an inconsistent menstrual cycle is up to 37.90% [6]. Furthermore, the results of a research done in Bali are that 38.50% women have inconsistent menstrual cycle [7]. A research done in America also shows that 19.00% women, the age of 18-55, have menstrual disorder [8]. Inconsistent menstrual cycle has a serious effect on women's health, as a number of women with history of inconsistent menstrual cycle have later suffered from DM (Diabetes Mellitus) type 2, cardiovascular disease [9], osteoporosis [10] and infertility [11].

There are several things affecting menstrual cycle, stress, nutritional status, diet, financial status of one's household and exercises. Nutritional status can be interpreted from one's Body Mass Index (BMI). BMI is figured by weight and height. Weight greatly affects nutritional status in relation to menstrual cycle. This is due to the existence of adipocyte-derived hormone, leptin, which is a product of body fat and suspected to be able to affect menstrual cycle. The increase of leptin in one's blood can cause an increase in LH hormone, which will be related with the increase in estradiol and menstrual cycle [12].

The BMI is a measure relative size amount of tissue mass in body (bone, fat, and muscle), and there differentiate or screening tool to indicate the person as underweight, normal weight, overweight, or obese based on that value. BMI is formula is dividing weight (in kilogram) with height (in meter) squared [2]. According to WHO, a person is considered to have proportional weight if their BMI ranges between 18.5 and 23. Meanwhile if the BMI ranges between 23 and 25, they are considered obesity. BMI over the range of 25 to 30 is considered obesity [13]. Obesity as well as obesity in Indonesia have become a quite serious problem. The number of obesity continues to rise each year. Data from the Basic Health Research (RISKESDAS) in 2007 stated that the number of obesity and overnutrition cases among citizens at the age of 15 and above in Indonesia is 19.10% and in East Java 20.40%, which is above the national number. In 2010, the obesity and obesity prevalence among students ranging from 6 to 12 years old, has reached 9.20%. Not only that, but the number in Yogyakarta keeps growing at the rate of almost

twice in the course of 5 years. It was 8.00% in 1999 and has grown to 12.30% in 2004 [14].

Until now, there are still many debates being held on the relation between body composition and menstrual disorder. Based on the passage above, the researchers are interested in knowing whether or not there is a relation between BMI and menstrual disorder especially among the students of the Faculty of Medicine in Pelita Harapan University. The researchers have decided upon this topic considering how obesity is a global issue which affects human health in various ways, especially female's reproductive health.

II. RESEARCH METHOD

This research is an analytical research with the approach of cross sectional-case control, where the research object is observed only once, and the calculation is done on the characters' status or objects' variables during the check-up, with the approach and data collection done at once. The research was done in Medical Faculty of Pelita Harapan University, Indonesia from December 2017 to January 2018.

The data for this research were taken from 124 people comprising of 62 obese students (BMI of $>25 \text{ kg/m}^2$) and 62 students with normal BMI (BMI of $18-23 \text{ kg/m}^2$) as the control which fulfills the inclusion as well as the exclusion criteria. The sample for the data was chosen randomly, with the inclusion criteria of being an active preclinical student of the Faculty of Medicine in UPH from 2015 to 2017, at the age of 18-25 years and willing to fill the informed consent or to be a respondent. On the other hand, the exclusion criteria are systemic disease (endocrine disorders and coagulation disorders), smoking as well as consuming alcohol and hormonal medication. The instrument of this research was questionnaire and height and weight measuring instrument. The data will be analyzed descriptive statistically.

III. RESULT AND DISCUSSION

A. Result

This research was done in Faculty of Medicine, Pelita Harapan University of Indonesia, in March 2018. Based on the data which have been collected, 62 obese students (BMI of $>25 \text{ kg/m}^2$) and 62 students with normal BMI (BMI of $18-23 \text{ kg/m}^2$) as the control which fulfills the inclusion and exclusion criteria. From that population, a research was done on the independent variable, which is the BMI. Then, the data were processed using univariate analysis which resulted in Table I.

These respondents were categorized according to the results of their height and weight measurements. The respondents are 62 students with normal BMI (BMI of $18-23 \text{ kg/m}^2$) and 62

students with BMI obese (BMI of $>25 \text{ kg/m}^2$). The distribution results of the respondents can be found in Table III.

TABLE I
 DISTRIBUTION BASED ON AGE GROUP

Respondents (age)	n	%
18 tahun	24	19.40
19 tahun	31	25.00
20 tahun	48	38.00
21 tahun	17	13.70
22 tahun	3	2.40
25 tahun	1	0.80

TABLE II
 SAMPLE DISTRIBUTION

Body Mass Index	n	%
18-23 kg/m ²	62	50.00
$> 25 \text{ kg/m}^2$	62	50.00

The results of this research were tested statistically using Chi Square (SPSS 25.0 for Windows). Statistic test with the confidence level of 95% resulted in $p = 0.00$ ($p < 0.05$). BMI is positively related with menstrual cycle disorders. Thus, it is safe to say that BMI has a statistically significant effect on menstrual cycle disorders.

This research resulted in $p = 0.00$, which means that all factors have equal effect on the occurrence of menstrual cycle disorders, and none of them are dominant.

Discussion

This research was done by collecting primary data using questionnaire as well as weight and height measuring, directly on 124 medical students in the Faculty of Medicine, Pelita Harapan University, Indonesia. The results were based on the nutritional status of the respondents, which was evaluated through the calculation of BMI. The respondents were categorized into two groups, namely, normal BMI (BMI of $18-23 \text{ kg/m}^2$) and obese BMI (BMI of $>25 \text{ kg/m}^2$). This calculation resulted in the sample data of 62 students with obese BMI (50.00%) and 62 students with normal BMI (50.00%). From the results of this research, it was gathered that in the Faculty of Medicine in Pelita Harapan University, there are 53 students (79.10%) who have menstrual cycle disorder whereas there are 14 students (20.90%) who do not have menstrual cycle disorder. Factors that can affect menstrual cycle disorders such as stress, sleep disorders, physical activities and diet were also examined in this study, and the result that these factors also affect menstrual cycle disorders as well as BMI.

TABLE III
 DISTRIBUTION OF OBESITY STUDENTS IN MENSTRUAL CYCLE DISORDERS GROUP AND NO MENSTRUAL CYCLE DISORDERS CASE GROUP

	Menstrual Cycle Disorders		No Menstrual Cycle Disorders		P value	OR
	n	Percentage (%)	n	Percentage (%)		
Normal Body Mass Index	14	20.90	48	84.20	0.00	5.25
Obese Body Mass Index	53	79.10	9	15.80		
Total	67	100	57	100		

TABLE IV
DISTRIBUTION OF STRESS IN MENSTRUAL CYCLE DISORDERS GROUP AND NO MENSTRUAL CYCLE DISORDERS CASE GROUP

Variable	Menstrual Cycle Disorders		No Menstrual Cycle Disorders		P value	OR
	n	Percentage (%)	n	Percentage (%)		
Stressed	30	44.78	31	53.38	0.00	1.85
Unstressed	37	55.22	26	45.62		
Total	67	100	57	100		

TABLE V
DISTRIBUTION OF SLEEPING PATTERN IN MENSTRUAL CYCLE DISORDERS GROUP AND NO MENSTRUAL CYCLE DISORDERS CASE GROUP

Variable	Menstrual Cycle Disorders		No Menstrual Cycle Disorders		P value	OR
	n	Percentage (%)	n	Percentage (%)		
Sleeping Disorder	17	25.37	13	22.80	0.00	1.01
No Sleeping Disorder	50	74.63	44	77.20		
Total	67	100	57	100		

TABLE VI
DISTRIBUTION OF PHYSICAL ACTIVITIES IN MENSTRUAL CYCLE DISORDERS GROUP AND NO MENSTRUAL CYCLE DISORDER CASE GROUP

Variable	Menstrual Cycle Disorders		No Menstrual Cycle Disorders		P value	OR
	n	Percentage (%)	n	Percentage (%)		
Physical Activities	17	25.37	14	24.60	0.00	1.24
No Physical Activities	50	74.63	43	75.40		
Total	67	100	57	100		

TABLE VII
DISTRIBUTION OF DIET IN MENSTRUAL CYCLE DISORDERS GROUP AND NO MENSTRUAL CYCLE DISORDERS CASE GROUP

Variable	Menstrual Cycle Disorders		No Menstrual Cycle Disorders		P value	OR
	n	Percentage (%)	n	Percentage (%)		
Diet	7	10.45	6	10.52	0.00	1.07
No Diet	60	89.55	51	89.48		
Total	67	100	57	100		

According to Waryana, menstrual disorders vary but there are many factors affect menstrual disorders [15]. Stress can cause systemic changes in the body, because the stress center is located close to the center that regulates the menstrual cycle in the brain. Stress affects the increase basal cortisol hormone and decreases the Luteinizing Hormone (LH) that causes amenorrhea. Sleep disorders can decrease Melatonin Hormone (MH) [16]. Melatonin Hormone has an important role in regulating sleep cycle, maintaining cell health, regularity and stability of cell metabolism, improving blood flow. Changes in sleep hours have an effect in reproductive hormones that influence ovulation and menstruation [17]. Physical activities can increase hormones corticotrophin-releasing hormone (CRH) which inhibits gonadotrophin-releasing hormone (GnRH) in the body. Moderate and heavy physical activities can cause menstrual disorders [18], [19]. Low-fat diets also have relationship with the length of menstrual cycle and the duration of menstruation. People who only eat vegetables or vegetarianism are strongly associated with anovulation, abnormal menstrual cycles (less than 10 times/ year) and decreased pituitary hormone responses, short follicular phases [20].

As previously explained, weight has an important role in menstrual cycle, of which there is a deficiency or abundance, can cause menstrual cycle. Obese people have thick fat tissues in their body which produce estrogen hormone holding an important role in the process of menstruation. The more

amount of fat the more estrogen produced, hence the occurrence of menstrual disorder. The ability to reproduce is controlled by the hypothalamus with the synchronization of central nerve system which is affected by the metabolism rate. Metabolism rate itself depends on the nutrition in one's body. The increase of fat during growth is very important to said mechanism. The increase of fat gives control to the secretion of gonadotrophin hormone, which eventually makes the fat tissue a source of estrogen aside from hypophysis. Therefore, the secretion of estrogen is also affected by weight or body fat, hence why nutrition is also a primary requirement [21].

Body fat contains aromatase enzyme which is needed to produce estrogen hormone. Estrogen hormone is the hormone which stores fat. Estrogen is one of the hormones which can dissolve in fat, along with steroid, a fat substance which is the derivation of cholesterol [1]. Thus, estrogen is free to penetrate cell membrane. Hormone is deemed balanced if the hormone secretion from the brain is aligned with the hormones from the ovary, namely, estrogen and progesteron. If the hormones of the ovary are low, the hormones of the brain will be stimulating. On the other hand, if it is the other way around, then the hormones of the brain will stop stimulating. If this mechanism continues over and over again, menstruation will be consistent [22], [23].

Through the process stated above, excessive fat will cause an increase of estrogen hormone just as explained previously. This increase of estrogen in the body will consequently cause

a negative feedback to the hypothalamo-hypophyseal system in the brain, hence the formation of gonadotropin hormone being stopped or decreased. This imbalance of estrogen hormone surely has a great affect to the consistency of a female's menstrual cycle and ovulation [24].

The problems related to obesity among female are menstrual disorder with relation to obesity among teenagers and the growing number of cases of cardiovascular disease, hyperlipidemia, uterine corpus cancer and breast cancer among obese postmenopause female. The mechanism of obesity's effects on the function of ovarium is currently focused on the disorder on estrogen metabolism, the decrease of sex hormone-binding globulin (SHBG), insulin resistance and hyperinsulinemia as well as leptin disorder. Various types of lipid are stored by the fat tissues in the body, and a number of those lipid are capable of giving metabolism for steroids like androgen. Weight gain and fat tissue, especially those in the central area, can disturb the balance of steroid hormone such as androgen, estrogen and sex hormone-binding globulin (SHBG) [22], [24]. The change in SHBG level can also cause a change in the release of androgen and estrogen in the target tissue. Obesity can increase the production of estrogen which has an effect on weight and body fat [1], [25].

Aside from that, someone with obesity is identical with hypercholesterolemia which can be identified by a high level of triglycerid and LDL in their blood. LDL is actually a molecule which brings cholesterol into theca cells to be used to form androgen. Based on that mechanism, a high level of LDL can result in a high level of androgen which eventually causes an increase in the level of estrogen [26]. Additionally, hypercholesterolemia also causes the resistance of insulin receptor due to the increase in glucose which begins with the hyperactivity of gluconeogenesis and ends up causing hyperinsulinemia. Hyperinsulin causes an escalation of androgen activity through the mechanism as follows: (1) Insulin binds with IGF-1 receptor which has the same structure as insulin receptor. This bind along with LH will stimulate theca cells to produce androgen hormone. (2) Hyperinsulin suppresses the synthesis of sex hormone-binding globulin (SHBG) and IGF-binding protein (IGFBP) in the liver. Consequently, sex steroid and IGF-I (active form) increase [22].

High level of estrogen gives a negative feedback toward FSH hormone (follicle stimulating hormone) through the secretion of protein inhibin which inhibits the anterior hypophysis to secrete FSH [27]. Meanwhile toward LH, the rise in estrogen level gives a positive feedback in which the increase in LH level stimulates androgen synthesis, the increase in androstenedion level and eventually changes into estrogen in the peripheral blood cells through fat/muscle tissues. The increase in LH level can also be caused by a disorder in the leptin system. Leptin is a protein secreted by adipocyte which plays a role in controlling the intake of food and giving signals of hunger to the brain. Toward hypothalamus, leptin suppresses the synthesis and secretion of neuropeptide Y which functions to inhibit gonadotropin releasing hormone (GnRH) [28]. Toward an obese person (as

experienced by the patient in the scenario), occurs an increase in the leptin level (leptin resistance occurs toward an obese person). Thus, there is a decrease in neuropeptide Y secretion which results in an increase in GnRH secretion, followed by an increase in LH secretion. Through a research, it is found that leptin can also affect oocyte maturation through mitogen-activated protein kinase (MAPK) pathway which can activate maturation-promoting factor (MPF) to stimulate ovum maturation produced by ovarium [34]. The pathogenesis which acts as the base begins from obesity and continues as estrogen hypersecretion and LH hypersecretion as well as the inhibition of FSH secretion. The inhibition of FSH secretion causes disorder in follicular proliferation so that there is no mature follicle formed. That being said, although ovum maturation occurs, ovulation cannot occur due to immature follicle. Constantly high estrogen level causes an adequate increase in FSH level to never occur [22], [24]. Thus, it also causes the accumulation of small follicle (follicle in the antral stage with cross section of +8 mm) in the walls of the ovarium without ever experiencing ovulation [29], [30].

Immature Luteinizing Hormone will stimulate the release of progesterone and androgen hormone. In a normal cycle, this is not a serious problem as the androgen hormone will be changed into estradiol. However, for obese female, the immature androgen will not be changed into estradiol. This is because the released androgen hormone is not binding. This will then cause the egg cell to not evolve and the ovulation to not happen. Moreover, hyperglycemia can cause the immune system to cause urinary tract infection which can result in hormonal balance disorder [22], [31], [32].

Based on the results of literature review done by the researchers, there is a relation between BMI and the consistency of menstrual cycle, which is estimated because the number of nutritional status calculated using BMI is closely related to the fat level in one's body. Fat level will then affect the consistency of menstrual cycle [33].

Based on a research, it is found that there is no significant statistic between BMI and menstrual cycle pattern [35]. However, in this research, BMI is an important factor affecting inconsistent menstrual cycle. The risk of amenorrhea and oligomenorrhea increases alongside the increase of obesity. This research has shown that 30.00-47.00% of obese females have inconsistent cycle although the number of occurrences of infertility among obese female isn't too high [29], [30], [33].

From the results of statistical calculation using Chi-Square from SPSS 25.0 for Windows with a confidence level of 95%, the value of $p < \alpha$ is gained. It can be concluded that H_1 is received and H_0 is denied. This shows that there is a meaningful relation between BMI (normal and obese) and menstrual cycle disorders on the students of the Faculty of Medicine in Pelita Harapan University. This is in accordance with the research done by Saira Dars in Hyderabad, India, which shows the relation between obese BMI and menstrual disorder. In this research, $p = 0.00$ is gained, which means that all factors have equal effect on causing menstrual cycle disorders, and none of them are dominant.³³

The strength of this study is that we use control group, that makes the results are more accurate, and we compare the bias or confounding factors that can affect the menstrual cycle, which result that there are no dominating factors. This research also has several weaknesses, such as: (1) this study did not use all BMI distribution groups (underweight, normal, overweight, obese) but only used normal and obese categories, (2) this study did not categorize menstrual cycle disorders (normal range 21-35 days), whether the cycle was less than 21 days (short) or more than 35 days (long), (3) this study only assessed cycle disorders, not duration and amount of menstruation, (4) research on other factors (stress, sleep disorders, physical activities and diet) that affect the menstrual cycle are not separated according to the BMI category. Further research can be done to answer the weaknesses of this study, so that it might be able to assess what factors actually contribute most to menstrual cycle disorders and menstrual disorders in general.

IV. CONCLUSION

Students with higher BMI (obese) experience significantly menstrual cycle disorders compared to their normal weight counterparts. However, BMI is not the only factor that affects the menstrual cycle. In this study, several factors such as stress, sleep disorders, physical activities and diet can affect menstrual cycle disorders. Next study can be done to analyze all the risk factors above in order to compare which factors that influenced the most. Further specific studies should be performed in different type and grade of obese, whether they can cause the severity of menstrual disorders.

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