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The relationship between nutritional status and menstrual cycle regularity

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Abstract
In adolescence, there is a period called puberty. In young women, puberty is characterized by the onset of the first menstruation that occurs at 10-16 years old. The menstruation cycle is a clinical sign of female reproduction. Normal menstruation cycle length occurs around 21-35 days. Age, nutritional status, stress, and body fat mass affect the menstruation cycle. Less or more nutritional status can cause menstrual cycle irregularities. The aim of the study was to find out the relationship between nutritional status and the regularity of menstruation cycles in female students of the Medical Faculty Indonesia Christian University. The type of this research is an analytical survey with a cross-sectional design. The population of this study was female students of the Medical Faculty Indonesia Christian University. The sampling technique used a random sampling method to obtain 57 respondents. The chi-square statistic test showed a correlation between nutritional status and menstruation cycle regularity because of p-value = 0,000 (p <0.05). The result is that there is a relationship between nutritional status and the regularity of the menstrual cycle in female students of Medical Faculty Indonesia Christian University Class of 2015. Therefore, it is concluded that the female students must begin to know themselves and their bodies and pay attention to body changes by recording the menstrual cycle every month

Keywords: menstrual cycles, nutritional status

Introduction
Adolescents are those who are in a transitional stage between childhood and adulthood. According to WHO, the age limit for adolescents is 12 to 24 years. According to the Minister of Health of the Republic of Indonesia in 2010, the age limit for teenagers is between 10 to 19 years and not married. [1] In adolescence, there is a period called puberty. In young women, puberty is marked by the onset of the first menstruation, which usually occurs at 10-16 years old. Menstruation is periodic bleeding from the uterus that begins about 14 days after ovulation periodically due to the shedding of the uterine endometrial lining. [2]
Menstruation is a complex process involving several hormones, sexual organs, and the nervous system. Hormones have an important influence on menstruation; if the hormones are not balanced, then the cycle will be disrupted. The menstrual cycle is a clinical sign of female reproductive function. [3] The menstrual cycle is the time from the first day of menstruation until the arrival of the next menstrual period. The menstrual cycle lasts 28 days. The average normal menstrual cycle lasts around 21-35 days, while menstrual cycle disorders include polymenorrhea (<20 days), oligomenorrhea >35 days), and amenorrhea (> three months). [4] Abnormal menstrual cycles are associated with decreased fertility. [5] The menstrual cycle duration ranges from 2-8 days, with an average of 4-6 days, with blood being released ranging from 60-80 ml per cycle. [6] Age, nutritional status, stress, and body fat mass influence the menstrual cycle. Nutritional status is a measure of the condition of a person's body which can be seen from the food consumed and the use of nutrients in the body. [7]
Body Mass Index (BMI) is an index of measuring nutritional status commonly used to measure the nutritional status of adolescents and adults. Assessment of nutritional status with BMI is the value of calculating a person's weight and height. According to the 2013 Basic Health Research, the prevalence of wasting in adolescents aged 16-18 years nationally was 9.4 percent (1.9% was very thin and 7.5% was thin) and the prevalence of obesity in adolescents aged 16-18 years was 7.3 percent consisting of 5.7 percent fat and 1.6 percent obese. The province with the highest obesity prevalence was DKI Jakarta (4.2%), and West Sulawesi (0.6%) was the lowest. North Sulawesi is included in fifteen provinces with a very high prevalence of obesity. [9] Based on the description above, the researcher wants to find out whether there is a relationship between nutritional status and menstrual cycle regularity in the UKI FK students' class of 2015. The formulation of the problem in this study is "Is there a relationship between nutritional status and menstrual cycle regularity in UKI FK students class of 2015?" The research objective was to find out the relationship between nutritional status and menstrual cycle regularity in the Faculty of Medicine Universitas Kristen Indonesia students class of 2015.

Literature review
The female reproductive organs consist of the external genital organs and the internal genital organs. The external organs consist of the mons pubis, labium major pudendi, labium minus pudendi, vestibule vaginale, clitoris. The mons pubis is a fatty lump in the suprapubic area where fine hairs grow when a person enters puberty. The labium is a fold of skin that protects the vagina. The labium consists of two layers: the labium major on the outside and the labium minus on the inside. The clitoris is an erectile organ at the junction between the two albums. [9]
The internal reproductive organs consist of the vagina, cervix, uterine tubes, and ovaries. The vagina is useful as an outlet for menstrual blood, the birth canal, and receives the

penis during intercourse. In the vagina, there are three muscles that can constrict the vagina, namely the pubovaginalis muscle, urethral sphincter muscle, and bulbospongiosus muscle. The ovaries are a pair of organs that are the main organs in women located in the abdominal cavity on the left and right waist area. Function to produce ovum cells and female hormones. Estrogen functions to maintain secondary characteristics in women and helps in the process of maturation of ovum cells. Progesterone functions in maintaining the gestation period. A protective capsule covers the ovary and contains several follicles. Each follicle contains one egg. The fallopian tube is a channel extending after the infundibulum, which serves as a place of fertilization and a way for the ovum cells to reach the uterus with the help of cilia on their walls. [10]

The uterus or uterus is a hollow and muscular organ shaped like a pear with a narrow bottom and functions as a place for the growth of the embryo. The type of human uterus is simplex, with one room for only one fetus. The uterus has three types of wall layers, namely, the outermost layer is the perimetrium which functions as a protector of the uterus; the middle layer is the myometrium which is rich in muscle cells and functions for contraction and relaxation of the uterus by widening and returning to its original shape every month, the innermost layer is the endometrium which is rich in of red blood cells. If fertilization does not occur, this endometrial wall will decay along with the mature ovum cells. [11]

The hypothalamus regulates human reproductive function. The hypothalamus regulates the release of hormones that act on the gonads. Gonadotropin-releasing hormone (GnRH) secreted from the hypothalamus will bind to gonadotrophs receptors in the anterior pituitary, stimulating the release of Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH). LH stimulates the secretion of the hormone estrogen, while FSH stimulates the maturation of ovarian follicles. FSH and LH stimulate the secretion of reproductive steroid hormones such as estrogen and progesterone. Estrogen is formed by the granulosa cells in the ovarian follicles. Estrogen plays a role in the growth of the uterine muscle and the development of the inner lining of the endometrium. The corpus luteum, placenta, and several follicles secrete progesterone. Progesterone plays a role in the reproductive organs, including the mammary glands and endometrium, increases human body temperature, and helps the implantation of the ovum. Estrogen and progesterone are synthesized from a cholesterol derivative. The corpus luteum secretes estrogen and progesterone with greater amounts of progesterone. Continuous exposure to estrogen over a long period causes endometrial hyperplasia, usually accompanied by an abnormal bleeding pattern. If estrogen production is well coordinated with progesterone production during the normal menstrual cycle, periodic bleeding and shedding within the endometrium will occur regularly. [12]

Menstruation is bleeding resulting from the secretion of the endometrial lining of the uterus or uterus, which is released periodically from the vagina during the productive age period, which occurs every month. [13] A menstrual cycle is a distance between the start date of the last period and the start date of the next period. The menstrual cycle lasts 21-35 days on average 28 days. The error in the length of the menstrual cycle is approximately one day because the starting time of menstruation is not considered, and the exact time of discharge of menstrual blood from the ostium uteri externum cannot be known. In women aged 12 years, the menstrual cycle length is usually 25.1 days; at 43 years, it is 27.1 days, and in women 55 years, it is 51.9 days. [14] The duration of menstruation is usually between 3-5 days, some are 1-2 days, followed by blood a little later, and some are up to 7-8 days. For every woman, the duration of menstruation is usually the same. [15] The average amount of blood that comes out is 33.2 ± 16 cc. Most women don't feel any symptoms during menstruation, but a small percentage feel heaviness in the pelvis or pain (dysmenorrhea). The age of teenage girls at the time of their first menstruation (menarche) varies, between 10-16 years, but the average is 12.5 years. [16] The physiology of the menstrual cycle is divided into several cycles, namely the ovarian cycle (folliculogenesis phase, ovulation phase, and luteal phase), endometrial cycle (proliferative phase, luteal phase, menstrual phase), cervical cycle, and vaginal cycle. [17]

Irregular menstrual cycles have certain patterns, such as menstrual bleeding for more than eight days (hypermenorrhea), menstrual bleeding shorter than eight days (hypomenorrhea), longer cycles for more than 35 days (oligomenorrhea), shorter cycles for less than 21 days (oligomenorrhea), or no menstruation for three months (amenorrhea). [18] According to Wiknjosastro (2005), factors that affect the regularity of the menstrual cycle consist of obesity, nutritional deficiencies, diseases of the reproductive organs, smoking habits, stress, strenuous exercise taking certain drugs, and genetic disorders. Obesity can cause disturbances in estrogen metabolism through increased estrogen production, thus disrupting the menstrual cycle. Lack of nutrition will cause a decrease in estrogen production, so the menstrual cycle is hampered. Diseases of the reproductive organs can cause hormonal changes.[19] Stress can induce changes in hormonal cycles through physiological mechanisms of excessive and prolonged activation of the hypothalamic-pituitary-adrenal axis, increasing Corticotrophin Releasing Hormone (CRH) and glucocorticoids (cortisol). This cortisol improves brain function and slows down or stops non-essential bodily functions, such as cell growth, digestion, and reproduction.[20] As a result, the synthesis and metabolism of gonadotropins and estrogens are suppressed, disrupting the physiology of women's menstruation.

Excessive exercise can cause hypothalamic dysfunction, which causes impaired GnRH secretion. It disrupts the menstrual cycle. The main factor causing GnRH suppression is excessive energy use. Nutrition is a process of organisms using food that is normally consumed through digestion, absorption, transportation, storage, metabolism, and absorption of substances used to maintain life, growth, and organ function and produce energy. [21] Nutritional status is an expression of a state of balance in the form of certain variables or the embodiment of nutrition in certain variables. According to Call and Levinson in Supariasa (2012), nutritional status is influenced by two factors, namely food consumption and health level, especially the presence of infectious diseases; these two factors are the direct causes, while the indirect causes are the nutrient content in foodstuffs, eating habits, whether there is a supplementary feeding program, health maintenance, as well as the physical and social environment. [22] According to UNICEF (1998), Supariasa (2012) describes factors related to nutritional status; firstly, the direct causes are

nutritional intake and infectious diseases. Secondly, the indirect causes are household-level food availability, behavior/care of mothers and children, health, and environmental services, the three main problems, namely poverty, low education, food availability, and employment opportunities. Fourth is the basic problem, namely the political and economic crisis. [22] According to Laura Jane Harper in Supariasa (2012), factors that influence nutritional status from a socio-cultural and economic point of view are food availability, income level, education, and food use. Food availability includes the selection of plants, planting patterns, land tenure patterns, land area quality, agricultural methods, storage methods, environmental factors, reproductive stimuli, and social roles. Food use includes social status, religious beliefs, cultural beliefs, state of health, diet, food distribution within the family, family size, and scattered food. [22]

In general, anthropometry means the size of the human body. From a nutritional point of view, nutritional anthropometry relates to various measurements of body dimensions and body composition at various ages and levels of nutrition. [22] Anthropometry is generally used to see imbalances in protein and energy intake. This imbalance is seen in the pattern of physical growth and the proportion of body tissues such as fat, muscle, and water. From 2014 onwards, the Directorate of Nutrition Development, the Ministry of Health of the Republic of Indonesia, has used anthropometry to monitor the nutritional status of the community. [22]

Clinical examination is a very important method for assessing the nutritional status of people. This method is based on the changes that occur related to nutritional insufficiency. It can be seen in epithelial tissues such as skin, eyes, hair, and oral mucosa or organs close to the body's surface, such as the thyroid gland. [22] The use of this method is generally for rapid clinical surveys. This survey is designed to quickly detect general clinical signs of deficiency of one or more nutrients. In addition, this method is used to determine a person's nutritional status by carrying out a physical examination, namely signs and symptoms or history of disease. [22]

Assessment of nutritional status by biochemistry is the examination of laboratory-tested specimens carried out on various body tissues. Body tissues include blood, urine, feces, and tissues such as liver and muscle. [22] This method is used to warn that further malnutrition is likely to ensue. Many clinical symptoms are less specific, so determining physiological chemistry can be more helpful in diagnosing specific nutritional deficiencies/excesses. [22] Biophysical nutritional determination is a method of determining nutritional status by looking at functional ability and observing changes in tissue structure. [22]

The problem of deficiency and excess nutrition in adults (age 18 years and over) is an important issue because apart from having a risk of certain diseases, it can also affect work productivity. Therefore monitoring of these conditions must be carried out by everyone on an ongoing basis. [23] Body Mass Index (BMI) is a tool or a simple way to monitor the nutritional status of adults, especially about underweight and overweight. Being overweight can increase the risk of infectious diseases, while excess body weight increases the risk of degenerative diseases. Therefore, maintaining a normal weight gives a person a longer life expectancy.

This guide explains the recommended ways to achieve normal body weight based on BMI by adopting a more balanced daily diet and other healthy ways. To monitor the body mass index of adults, weight and height scales are used. BMI will determine whether a person's weight is normal, thin, or fat. BMI is only for adults aged > 18 years and cannot be applied to infants, children, adolescents, pregnant women, and athletes. [23] To find out this BMI value can be calculated using the following formula: [23]

$$\text{BMI} = \frac{Weight\ (kg)}{Height\ (m) x\ Height\ (m)}$$

Table 1. Body Mass Index category

Category		BMI(Kg/M^2)
Thin	Underweight levels are severe	< 17
	Mild underweight	17,0 – 18,4
Normal		18,5 - 25,0
Fat	A mild degree of overweight	25,1 – 27,0
	Excess weight level	> 27,0

Source: Depkes, 2011

Research method

The type of research used in this study was an analytic survey with a cross-sectional design to determine the relationship between nutritional status and menstrual regularity in female students at UKI FK Class of 2015. This cross-sectional research design was a study that measured risk factors and effects in one moment and no follow-up. This research was conducted at the Faculty of Medicine at the Indonesian Christian University in Jakarta and took place on December 14 and 15, 2018. The research population is the entire research object or object being studied. The population in this study were Medical Faculty Indonesia Christian University students class of 2015. The sample was defined as part of the population that was selected in a certain way that the researcher would observe or measure so that it was considered representative of the population. Samples were taken from populations that met the inclusion criteria. This study used a sampling technique: random sampling from the Medical Faculty Indonesia Christian University student population, namely 128 female students and 57 samples. The instruments used in this study were menstrual cycle questionnaires, scales to measure body weight and microtome to measure height. The research procedures are as follows: a) Before conducting the research, respondents were asked to read and sign the informed consent form; b) Asking respondents to fill out a questionnaire; c) Measurement of body weight using a stepping scale; d) Respondents were asked to remove their footwear and head coverings when taking their height measurements; e) Then calculate the body mass index using the formula that has been determined; and f) Data input and data analysis. The stages of data analysis were carried out through 4 stages: editing, coding, entry, and cleaning. Data analysis was performed using univariate and bivariate analysis tests. This research was conducted by considering research ethics to avoid risks that might harm the participants. The researcher gave an oral explanation regarding the purpose and method of research and provided a confidentiality guarantee for all data from participants. The research was conducted after obtaining voluntary consent from each participant by filling out and signing the consent form to participate in this study.

Result and discussion

The age frequency distribution of the respondents can be seen in the following table.

Table 2: Age-frequency of respondents

Age	Frequency	Percentage
20 years old	9	15,8%
21 years old	33	57,9%
22 years old	15	26,3%
Total	57	100,0%

Based on the table above, it was found that 20-year-old student respondents were nine people or 15.8%, 21-year-old students were 33 people or 57.9%, and 22-year-old students were 15 people or 26.3 %. Most of the Medical Faculty Indonesia Christian University female student respondents were 21 years old.

The frequency distribution of the respondents' Body Mass Index (BMI) can be seen in the following table.

Table 3: Frequency of body mass index (BMI) of respondents

BMI	Frequency	Percentage
Under	10	17,5%
Normal	32	56,1%
Over	15	26,3%
Total	57	100,0%

The table above shows the body mass index (BMI). There were ten people (17.5%) with low BMI respondents, 32 normal BMI respondents (56.1%), and 15 respondents (26.3%) with more BMI.

The frequency distribution of the regularity of the respondents' menstrual cycles can be seen in the following table.

Table 4: Frequency of regular menstrual cycles of respondents

Menstrual Cycle	Frequency	Percentage
Irregular	31	54,4%
Regular	26	45,6%
Total	57	100,0%

The data above shows that out of 57 respondents, 31 (54.4%) had irregular menstrual cycles, and as many as 26 people (45.6%) had regular menstrual cycles.

The results of the bivariate test on the frequency of nutritional status with the regularity of the menstrual cycle can be seen in the following table.

Table 5: Results of the bivariate test on the frequency of nutritional status with the menstrual cycle

BMI	Menstrual Cycle				Total	P-Value
	Irregular		Regular			
	n	%	n	%		
Under	8	80%	2	20%	10	0,000
Normal	9	28,1%	23	71,9%	32	
Over	14	93,3%	1	6,7%	15	
Total	31	54,4%	26	45,6%	57	

Based on the table above, of the ten respondents with less BMI, eight (80%) experienced irregular menstrual cycles, and as many as two (20%) experienced regular menstrual cycles. Furthermore, from 32 respondents with normal BMI, nine respondents (28.1%) experienced irregular menstrual cycles, and as many as 23 respondents (71.9%) experienced regular menstrual cycles. Furthermore, out of 15 respondents with more BMI, 14 respondents (93.3%) experienced irregular menstrual cycles, and only one (6.7%) experienced regular menstrual cycles. Based on the p-value, a value of 0.000 is obtained. Because the p-value is $0.000 < \alpha = 0.05$, it is found that there is a significant relationship between nutritional status and menstrual cycle regularity in students class of 2015.

Based on the results of the research shown in Table 4.1., the majority of 2015 students were 21 years old, as many as 33 people (57.9%). Table 4.2 shows that most Medical Faculty Indonesia Christian University 2015 students had a normal Body Mass Index (BMI) of 32 people (56.1%). Table 4.3 shows that most Medical Faculty Indonesia Christian University 2015 students had irregular menstrual cycles of 31 people (54.4%). From the results of the chi-square analysis, it was found that with the value of $p = 0.000$ ($p < 0.05$), it can be concluded that there is a significant relationship between nutritional status and the regularity of the menstrual cycle. Respondents with less or more nutritional status are more likely to experience irregular menstrual cycles.

The results of this study are in line with research conducted by (Adnyani *et al*., 2012); the results of statistical tests on the relationship between nutritional status and the menstrual cycle in young women with an error rate of 5% found that there was a significant relationship between nutritional status and the menstrual cycle in young women. One hormone that plays a role in the menstrual process is estrogen. Estrogen is synthesized in the ovaries, adrenals, placenta, testes, adipose tissue, and the central nervous system. According to the analysis, the cause of the longer menstrual cycle is due to the increased amount of estrogen in the blood due to the increased amount of body fat. High estrogen levels will provide negative feedback on GnRH secretion. [24]

The results of this study are also in line with the research of Rowland *et al*. in 2002, which stated that body fat, as measured by BMI, is related to the regularity of the menstrual cycle. Women with overweight BMI categories have longer menstrual cycles than women with normal BMI categories. [25] The cause of longer menstrual cycles in obese women is increased estrogen in the blood due to excess body fat production. Being overweight can cause menstrual cycle irregularities because the cholesterol contained in the excess body fat of overweight teenage girls is a precursor of estrogen, so estrogen production tends to be excessive. The existence of disturbances in estrogen metabolism in overweight adolescent girls will cause the menstrual cycle to become irregular. [26] Underweight status will result in being underweight and not having enough fat cells to produce the estrogen needed for ovulation and menstruation, which can result in irregular menstrual cycles. [27] These results are not in line with research conducted by (Sari and Setiarini, 2013) with the chi-square statistical test and obtaining a p-value of 0.242 ($p > 0.05$). It shows no relationship between nutritional status and the menstrual cycle. [28]

A woman who is deficient or overweight will have an impact on decreased hypothalamic function, which causes impaired GnRH secretion, thereby inhibiting stimulation of the anterior pituitary from producing FSH and Luteinizing Hormone LH. FSH stimulates the growth of about 3-30 follicles, each containing one egg, but only one follicle

continues to grow while the others are destroyed. LH functions in the maturation of the egg or ovulation (secretory phase) which later, if it is not fertilized, will experience decay (menstruation), so that if the production of FSH and LH is disrupted, it will have an impact on the production of the hormone estrogen and cause the menstrual cycle to become irregular.

Based on the results of this study, it was found that if adolescents have good nutritional status with good emotional stability accompanied by a good lifestyle and diet, it will make the hypothalamus work well so that it can produce hormones needed by the body, especially reproductive hormones so that the menstrual cycle becomes regular.

Conclusion

Based on the results of the research and discussion, it can be concluded as follows: a) Undernutrition or more nutritional status has a greater possibility of irregular menstrual cycles compared to normal nutritional status, and b) There is a relationship between nutritional status and the regularity of the menstrual cycle in female students of Medical Faculty Indonesia Christian University Class of 2015. Therefore, female students must begin to know themselves and their bodies and pay attention to body changes by recording the menstrual cycle every month. They can maintain body weight to reduce the impact of menstrual cycle irregularities. This research is expected to be continued to the next research using different methods.

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