Jurnal Ilmiah Mahasiswa Kedokteran Universitas Airlangga

JUXTA: Jurnal Ilmiah Mahasiswa Kedokteran Universitas Airlangga
2023 January, XIV (01)

ORIGINAL ARTICLE

Energy Adequacy, Body Composition, and Menstrual Cycle Disorder: A Correlation Study on Medical and Midwifery Students

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ABSTRACT

Introduction: Menstrual cycle disturbance is related to irregular reproductive hormones, which are influenced by organic and non-organic factors. This study aimed to determine the correlation between energy adequacy, body composition, and menstrual cycle disorder.

Methods: This was an observational analytic study with a case-control design. The population of this study was medical and midwifery students in the Faculty of Medicine, Universitas Airlangga, Surabaya. 72 subjects consisted of 36 women with a normal menstrual cycle between 24–38 days and 36 women with a menstrual cycle length of <24 days or >38 days. Data about body composition, energy adequacy, and menstrual cycle were all collected by questionnaire. Data were analyzed by Spearman and Continency Coefficient correlation.

Results: Most participants (66.7%) had normal body mass index (BMI), while 19.4% were overweight. Meanwhile, waist circumference in 63.9% of subjects was categorized as not obese. The participants' physical activities ranged from sedentary to vigorous (0 to 7386 MET-minutes/week). Less than one-third of the participants (27.8%) had an energy balance, while in most subjects (56.9%), energy adequacy was classified as deficit or negative energy balance. The statistics showed a p-value >0.05 in BMI (p = 0.231), waist circumference (p = 0.141), and energy adequacy (p = 0.389) with the menstrual cycle, indicating no correlation between BMI, energy adequacy, and waist circumference with menstrual cycle frequencies.

Conclusion: Statistical analysis showed no correlation between energy adequacy, BMI, and waist circumference with menstrual cycle frequency disorder in students in the Faculty of Medicine, Universitas Airlangga, Surabaya.

ARTICLE INFO

Article history:

Received 17-11-2022

Received in revised form 8-12-2022

Accepted 13-12-2022

Available online 10-01-2023

Keywords:
Body composition,
Energy adequacy,
Obesity,
Menstrual cycle.

Cite this as:
Novianto SAR, Purwanto B, Prasetyo B. Energy Adequacy, Body Composition, and Menstrual Cycle Disorder: A Correlation Study on Medical and Midwifery Students. *JUXTA J Ilm Mhs Kedokt Univ Airlangga* 2023; 14: 36–42.

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JUXTA: Jurnal Ilmiah Mahasiswa Kedokteran Universitas Airlangga
p-ISSN: 1907-3623; e-ISSN: 2684-9453
DOI: 10.20473/juxta.V14I12023.36-42

Introduction

Menstruation is a physiological process that is experienced from the ages of menarche to menopause. It is a sign that the female reproduction system is already functioning.[1] It is a periodic cyclical bleeding accompanied by desquamation of the uterine endometrium.[2] This cycle occurs with an average of 28 days.[3] The length of bleeding when it occurs is about 3–5 days, but in normal menstruation, it can also be 1–8 days with an average of 30 mL blood loss, but it can also be scanty up to 80 mL blood loss.[4] This cycle length can vary monthly and causes disturbances during, before, or after menstruation.[5] Menstrual cycle disorder can be in the form of amenorrhea (absence of menstruation for three months), oligomenorrhea (menstrual cycle of more than 35 days), or polymenorrhea (repeated cycle for or less than 21 days).[6] Other forms of menstrual disturbance include abnormal menstrual blood flow, hypomenorrhea and menorrhagia, and menstrual pain or dysmenorrhea.[4]

The prevalence of primary amenorrhea is 1.2%, while secondary amenorrhea is 6.28 %.[7] One of the studies on nursing students in Lebanon showed the prevalence of polymenorrhea was 37.5%, and oligomenorrhea was 19.3% out of 352 students.[8] Study in medical students, the menstrual period affected the quality of sleep, diet, and exercise.[9] Menstrual disturbance impacted academic and social life, such as missing classes and lower grades than others. The students also limited their social activities, such as meeting friends and co-workers.[10] Disruption of the menstrual cycle can also be one of the signs of endocrine and metabolic disorders such as polycystic ovary syndrome (PCOS), which has a 16.2 times higher risk in overweight adolescents than the normal weight.[11]

One of the recent global health concerns is the increasing prevalence of overweight and obesity among the youth. A study showed that 35 out of 76 (46%) female university students were categorized as overweight and obese.[12] Obesity is related to nutritional status, along with other factors such as nutritional adequacy and stress can induce menstrual cycle irregularity,[13,14] Low energy availability affects the energy expenditure of the body, which results in the disruption of metabolism and hormone regulation.[15] Studies showed a 7.14 greater risk of menstrual disturbance in women with severe energy deficiencies than in women with normal energy availability or mild energy deficiency.[16] Rakhmawati and Dieny stated there was a 1.89 greater risk of menstrual disorder in obese women with higher body fat composition than in women with lower body fat composition.[17]

One of the causes of amenorrhea is a result of changes in energy availability called functional hypothalamic amenorrhea (FHA). This type is commonly associated with exercise and stress and is most relevant in female athletes.[18] One study showed that of 166 medical college students, 70% did not have a decent energy intake.[19] Other studies showed a variation of nutritional imbalance in medical students, varying from being overweight to lacking essential nutrition.[20,21] According to the inconsistent study results in college students and lack of study in medical students in Indonesia that include energy availability and body composition, especially in East Java, this study aimed to determine the correlation of energy availability and body composition in relation to menstrual cycle disorder.

Methods

This case-control study was conducted from March to August 2021 in the Faculty of Medicine, Universitas Airlangga, Surabaya. 72 participants from medical and midwifery students were included (36 samples from each case and control group). 36 midwifery students with a normal menstrual cycle (between 24–38 days) as the control group and 36 medical students with an abnormal menstrual cycle (<24 days or >38 days) as the case group. Menstrual cycle frequencies were classified according to FIGO Classification 2018.[19] Students were selected by purposive sampling and through preliminary study.

Sample Determination through a Preliminary Study

Data were collected from 2nd to 4th year medical and midwifery students. Self-administered questionnaires were distributed among participants. A total of 390 participants were estimated. They were asked about their menstrual cycle over the last 90 days and categorized by <24 days, 24–38 days, or >38 days. Students who experienced menstruation (not primary amenorrhea), were 18–22 years of age, and were willing to be part of the study were included. This preliminary study deducted the case group from medical students and the control group from midwifery students. Participants who smoked, drank alcohol, used hormonal contraception, and consumed drugs containing reproductive hormones were also excluded. The questionnaire assessed participants who met the criteria on anthropometry, energy intake, and expenditure, including physical activity.

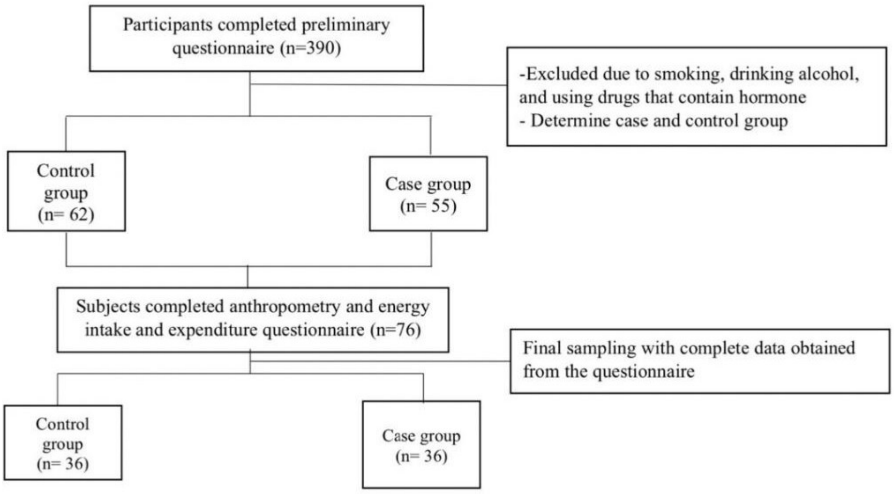

Figure 1. Participant recruitment flowchart.
Source: Research data, processed

Data Collection from Study Samples

Ethics and Consent

The participants were informed about the situation of the study and agreed to enroll with consent. Approval was granted from the Health Research Ethics Committee, Faculty of Medicine, Universitas Airlangga, Surabaya, before starting the study.

Anthropometric Assessment

Self-administered questionnaires were distributed to obtain data about subjects' weight, height, and waist circumference size. The data about weight and height were then used to determine the body mass index (BMI) with the formula of [weight (kg)/height(cm) x height (cm)] and then categorized according to the reference from the Ministry of Health of the Republic of Indonesia[15] which was divided into underweight if BMI <17.0, normal if BMI 17.1–25.0, and overweight if BMI >25.0. Waist circumference size was also categorized as obesity if ≥80 cm and not obesity if <80 cm.

Energy Adequacy Assessment

Energy intake was assessed by 1x24 hours of food recall and was converted and calculated using the Indonesian Food Composition table to estimate daily energy intake. Energy expenditure was calculated individually from the sum of basal metabolic rate (BMR) and physical activity energy. BMR was calculated with the formula of Harris-Benedict formula [BMR = 655 + (9.6xweight in kg) + (1.8xheight in cm) - (4.7xage in years)]. For physical activity, Short International Physical Activity Questionnaire (IPAQ) was used to determine the activity for seven days, and the data were processed and calculated according to the Guidelines for Data Processing and Analysis of the IPAQ.

Energy intake and expenditure that had been calculated individually with kilocalories(kcal) units were compared and categorized into negative energy balance or deficit if the ratio of energy intake/expenditure was <90%, energy balance if the ratio was 90%–120%, and positive energy balance or surplus if the ratio was >120%.

Statistical Analysis

Mean ± SD, minimum and maximum values, frequencies, and numbers (%) were reported for the univariate variable. To access bivariate correlation, Spearman's and coefficient correlation tests were performed. Data were processed using IBM SPSS Statistic 23, and a p-value <0.05 was set as statistically significant.

Results

This study was conducted at the Faculty of Medicine, Universitas Airlangga, Surabaya. Study subjects were 18–22 years old 2nd to 4th year medical and midwifery students. There were 72 subjects included in this study. 12 subjects were 4th year students, 24 subjects were 3rd-year students, and 36 subjects were 2nd-year students, in which the sum of study subjects in the case and control group in each academic year level of students was the same.

Subject Characteristics

The mean ± SD value for the age of participants was 20.29 ± 0.863 years. For energy intake, the mean values of food consumed were 1312.65 ± 429.01 kcal with 581.54 to 2815.3 kcal in range. Meanwhile, the physical activities of the participants ranged from a sedentary activity of 0 MET-minutes/week to vigorous activity with 7386 MET-minutes/week (Table 1).

Table 2 shows that most participants (66.7%) had normal BMI, while 14 of 72 participants were overweight, and 46 of 72 (63.9%) participants were classified as not obese according to waist circumference. Menstrual cycle was normal in 36 control group subjects, while in 36 case group subjects, 17 had frequent menstrual cycles, and 19 had an infrequent menstrual cycle. In energy adequacy, less than one-third of the participants (27.8%) had an energy balance, while most participants (56.9%) had a negative energy balance or deficit energy.

Table 1. Subject characteristics according to age, weight, height, energy intake, and physical activity

Subject characteristics	Minimum	Maximum	Mean ± SD
Age	18	22	20.29 ± 0.863
Weight(kg)	40	90	55.65 ± 11.15
Height(cm)	145	169	158.53 ± 4.98
Energy intake(kcal)	581.54	2815.3	1312.65 ± 429.01
Physical activity (MET-minutes/week)	0	7386	984.5 ± 1400.94

Source: Research data, processed

Table 2. Distribution of frequencies of subjects' BMI, waist circumference, menstrual cycle frequencies, and energy adequacy

Category	Frequencies	
	n	%
Body mass index		
Underweight	10	13.9
Normal	48	66.7
Overweight	14	19.4
Waist circumference		
Not obese	46	63.9
Obese	26	36.1
Menstrual cycles frequency		
Frequent	17	23.6
Normal	36	50
Infrequent	19	26.4
Energy adequacy		
Negative energy balance (deficit)	41	56.9
Energy balance	20	27.8
Positive energy balance (surplus)	11	15.3

Source: Research data, processed

Relationship between Body Composition and Energy Adequacy on Menstrual Cycle

Table 3 shows the correlation between variables that were analyzed with a correlation test for each independent variable with their correlation to the menstrual cycle. The result was said to correlate if the statistical test showed a p-value <0.05.

The statistical test with Spearman's test shows a p-value >0.05 in BMI and energy adequacy with the menstrual cycle, indicating no correlation between BMI and menstrual cycle frequencies and no significant correlation between energy adequacy and menstrual cycle frequencies. For waist circumference that was statistically analyzed with a coefficient correlation test, it showed a p-value of 0.141, meaning p-value >0.05, indicating no correlation between waist circumference and menstrual cycle frequencies in this study.

Table 3. Bivariate analysis correlation between BMI, waist circumference, energy adequacy, and menstrual cycle frequencies disorder

Variables	Menstrual cycle frequencies		p-value
	Abnormal (n = 36)	Normal (n = 36)	
Body mass index			
Underweight	3 (4.2%)	7 (9.7%)	0.231[a]
Normal	25(34.8%)	23(31.9%)	
Overweight	8(11.1%)	6(8.3%)	
Waist circumference			
Not obese	20(27.8%)	26(36.1%)	0.141*
Obese	16(22.2%)	10(13.9%)	
Energy adequacy			
Negative energy balance (deficit)	23 (32%)	18(25%)	0.389[a]
Energy balance	7(9.7%)	13(18.1%)	
Positive energy balance (surplus)	6(8.3%)	5(6.9%)	

*Contingency coefficient test
[a]Spearman's correlation test

Discussion

This study was conducted to determine the relationship between energy adequacy, body composition, and menstrual cycle in medical and midwifery students. The study in this field in this population coverage, especially in East Java, is still limited. The result of the study revealed that there was no significant correlation between energy adequacy and menstrual cycle frequencies, with a p-value of 0.389 (p-value >0.05). This study is in accordance with the study by Noviyanti, *et al*. (2018), which stated that there was no correlation between energy intake level and menstrual cycle.[22] It is also in accordance with the study of Hanapi, *et al*. (2021), on public health students that stated that macronutrient intake and physical activity did not correlate with the menstrual cycle.[23] Meanwhile, a contradictive result was found in another study involving dance college students that stated there was a correlation between energy, fat, and carbohydrate intake, as well as physical activity, with menstrual cycle disorder.[16]

Williams, *et al.* (2015) conducted an experimental study that observed the participants along three menstrual cycles and stated that calorie restriction and exercise from various levels of energy deprivation ranging from -470 to -810 kcal per day for three menstrual cycles caused menstrual cycle disturbance more frequently in women who experience greatest energy deficiency.[24] The result differences between the studies could be caused by the time difference the studies were conducted. In this study, the measurement of energy expenditure for seven days might not be enough to give an overall picture if there was a change in energy availability in the body in a state of deficiency or excess. Further study is needed with a longer duration of recording energy intake and expenditure.

Energy availability can vary from day to day. At the same time, menstrual disturbances could take months to manifest. The spectrum of manifestations varies from subclinical, such as luteal phase defect, to amenorrhea caused by functional hypothalamus disturbance or FHA. If calorie intake cannot meet energy needs and provide sufficient carbohydrates for the brain, then the gonadotropin-releasing hormone (GnRH) pulses can be disrupted, which can result in hormonal disturbances and suppression of reproductive function.

This study also revealed that BMI and waist circumference did not correlate with menstrual cycle frequencies. This is similar to another study by Prathita, *et al.* (2017), which stated that there was no correlation between BMI and body fat percentage with the menstrual cycle.[25] It is also in accordance with a study of 16–19 years old school students that stated there was no correlation between nutritional status and menstrual cycle disorder.[5] Contradictive result was found in another study by Lakkawar, *et al.* (2014), which was conducted in one of the medical colleges in India, and a study in Kathmandu medical college by Karki (2017) and Gupta (2014) in which both of the studies stated that there was a correlation between BMI and menstrual cycle irregularity.[6,26] A correlation between waist circumference and menstrual disorders was also found in another study.[27]

Body composition consist of fat mass and lean mass.[28] It can be calculated or estimated using several methods, one of which is calculating the BMI and waist circumference as was performed in this study. BMI is practical for assessing obesity, but there is also a limitation, such as it cannot distinguish fat and non-fat tissue. At the same time, waist circumference can describe fat deposits in the stomach but not measure body fat percentage.[29] Adipose tissue affects forming, converting, and storing of hormones that regulate the menstrual cycle.[16,29] The greater the percentage of fat tissue, the increase in the hormone estrogen is formed, which disrupts the balance of hormones reproduction and causes menstrual cycle disorders.[17]

The different results could be caused by another factor not included in this study, such as psychological stress. Another study stated a significant correlation between stress levels and menstrual cycle disorder.[30] There was 2.03 times greater risk of menstrual cycle disorder in subjects with stress than without stress.[17] A cohort study was performed along two menstrual cycles that stated that high perceived stress levels affected some menstrual hormone levels.[31] Stress causes the activation of the hypothalamic-pituitary-adrenal (HPA) axis and increases corticotropin-releasing hormone (CRH). CRH inhibits the secretion of GnRH in the hypothalamus.[32] An increase in CRH increases the release of adrenocorticotropic hormone (ACTH), thereby increasing cortisol in the blood and causing a decrease in GnRH, which stress can interfere with the menstrual cycle. From a normal cycle, oligomenorrhea or amenorrhea, clinical symptoms that arise depend on the degree of suppression of GnRH.[33]

Strength and Limitations

This study is one of few studies on medical and midwifery students in East Java that provides data about body composition and energy adequacy and its correlation with menstrual cycle frequencies disorder. This study provides energy adequacy from calculating energy intake from food and energy expenditure according to daily activities. Nevertheless, this study has limitation by only seven days measurement in energy requirement. Future studies are expected to take a longer time to measure energy adequacy as well as including another factor that can interfere menstrual cycle, one of which is psychological factor.

Conclusion

There was no correlation between energy adequacy, BMI, and waist circumference with menstrual cycle frequency disorder in medical and midwifery students at the Faculty of Medicine, Universitas Airlangga, Surabaya.

Acknowledgments
The authors would like to thank all the academic staff and the medical and midwifery students in the Faculty of Medicine, Universitas Airlangga, Surabaya, for their support in finishing this study.

Conflict of Interest
The authors declared there is no conflict of interest.

Funding
This study did not receive any funding.

Ethical Clearance
Approval was granted from the Health Research Ethics Committee, Faculty of Medicine, Universitas Airlangga, Surabaya (no. 8/EC/KEPK/FKUA/2021) on 18 January 2021.

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