The relationship between body composition and physical fitness with primary dysmenorrhea among adolescents in urban areas

Desiani Rizki Purwaningtyas[1*], *Anna* Fitriani[23], and *Rony* Darmawansyah Alnur[2]

[1]Department of Community Nutrition, Faculty of Human Ecology, IPB University, 1668 Bogor, Indonesia
[2]Faculty of Health Sciences, Universitas Muhammadiyah Prof. Dr. Hamka, 12130 South Jakarta, Indonesia
[3]School of Exercise and Nutrition, Faculty of Health, Deakin University, 3125 Melbourne, Australia

Abstract. Background: The relationship between body composition and physical fitness parameters with primary dysmenorrhea hasn't been confirmed robustly to the best of our knowledge. Objective: This study analysed the relationship between nutritional status, body composition, and physical fitness with primary dysmenorrhea. Methods: This cross-sectional study involved 80 adolescents from urban areas of Jakarta, Bogor, Depok, Tangerang, and Bekasi Indonesia. Body composition indicators measured by the OMRON HBF 375-Karada Scan body analyser. The fitness components observed were cardiorespiratory fitness as measured by the 3-minute YMCA step test, abdominal muscle strength by 1-minute sit-ups, abdominal muscle endurance by plank, and flexibility by sit and reach. Dysmenorrhea was measured using the WaLLLID score questionnaire. Bivariate analysis used the Pearson Correlation Test with a significance level of 0.05. Results: All respondents experienced dysmenorrhea with varying levels, intensity, locations, and duration of pain. Visceral fat percentage was significantly related to duration of pain (P=0.007) while total subcutaneous and trunk fat was significantly related to pain intensity (P=0.049). Cardiorespiratory fitness was significantly related to the location of pain (P=0.016). Conclusions: Maintaining visceral, total subcutaneous, and subcutaneous trunk fat within normal limits and good cardiorespiratory fitness control menstrual pain.

1 Introduction

Pain or cramps around the abdomen and waist during the menstrual period are symptoms of dysmenorrhea. Dysmenorrhea is divided into two types: primary and secondary dysmenorrhea. Primary dysmenorrhea occurs without any pathological disturbances in the pelvis, either inside or outside the uterus. Meanwhile, secondary dysmenorrhea occurs due to pelvic pathology such as endometriosis [1].

Dysmenorrhea is a common problem that occurs in women of reproductive age.

* Corresponding author: desianirizki@apps.ipb.ac.id

Dysmenorrhea can occur from adolescence. As one gets older, the intensity of primary dysmenorrhea pain decreases. The prevalence of primary dysmenorrhea in adolescents is relatively higher than in adults [1]. A meta-analysis by Wang et al. showed that an estimated 66.1% of adolescents who are university students worldwide experience primary dysmenorrhea, and 25.7% experience moderate dysmenorrhea symptoms. This prevalence is estimated to have increased over the last 10 years [2]. Most Indonesian women (90%) have experienced dysmenorrhea, but most of them prefer to hide it, letting the pain go away on its own rather than seeking medical treatment. Prevalence of primary dysmenorrhea in adolescents in a Jakarta area is 57.2% [3].

The problem of primary dysmenorrhea in adolescents at the global, national, and local levels is still quite high. Symptoms that arise during dysmenorrhea can disrupt adolescent activities, causing them to lie down a lot during menstruation, move less, and increase absenteeism at school. Dysmenorrhea can also lower adolescents' concentration levels, affecting their academic performance. Adolescents experiencing moderate and severe dysmenorrhea pain are eight times more likely to have poor academic performance than those with no dysmenorrhea or only mild dysmenorrhea. Dysmenorrhea also impacts adolescents' quality of life, disrupting social activities, family relationships, and friendships [4–6].

There are several risk factors for primary dysmenorrhea, such as smoking habits, stress levels, intake of certain nutrients, and nutritional status. Some studies showed a significant relationship between nutritional status based on BMI and dysmenorrhea in adolescents. Underweight and overweight adolescents are at greater risk of experiencing moderate and severe dysmenorrhea pain compared to those with normal nutritional status [7]. According to Indonesia Basic Health Research, the prevalence of overnutrition problems in Jakarta was 38% for those aged 19 years and 42.2% for those aged 20-24 years. These problems were higher than the national prevalence of 36.2% for those aged 19 years and 36.4% for those aged 20-24 years [8,9]. Other anthropometric indicators such as waist circumference, waist-to-height ratio, thigh-to-height ratio, and waist-to-hip ratio have been shown to significantly correlate with dysmenorrhea occurrence in adolescents [10]. However, there has been no research analyzing the relationship between body composition indicators such as fat mass, subcutaneous fat, visceral fat, and muscle mass with dysmenorrhea in adolescents.

Besides nutritional status, physical activity is also a significant factor related to dysmenorrhea in adolescents. Sufficient physical activity can reduce the degree of dysmenorrhea pain experienced by adolescents [11]. A meta-analysis by Armour et al. revealed that regular exercise habits of 45-60 minutes per session at least three times a week significantly reduce menstrual pain by 25 mm on a 100 mm visual analogue scale (VAS). Physical activity or exercise can reduce dysmenorrhea pain by promoting blood circulation and muscle relaxation [12]. This is related to several fitness components. However, there had been no research analyzing fitness components such as cardiorespiratory fitness, abdominal muscle strength, abdominal muscle endurance, and flexibility with dysmenorrhea occurrence in adolescents. Therefore, this study aims to analyze the relationship between nutritional status, body composition, and fitness with primary dysmenorrhea in adolescents.

2 Methods

This research was a quantitative study with a cross-sectional design. The research activities were carried out in Jakarta from January to April 2023. The population in this study was adolescent girls who lived in several big cities in Indonesia: Jakarta, Bogor, Depok, Tangerang, and Bekasi. The sampling technique used was purposive sampling, with several inclusion and exclusion criteria. The inclusion criteria applied were females aged 19-22 years in Jakarta, Bogor, Depok, Tangerang, or Bekasi; who passed the Physical Activity Readiness Questionnaire (PAR-Q and YOU) as screening tool before the fitness test; and were willing

to participate in the research activities from start to finish. The exclusion criteria were having a history of pathological disorders in the reproductive organs; currently undergoing a weight loss program; and currently following a specific diet such as a low-energy diet, high-energy diet, ketogenic diet, or vegetarian diet. The sample size was calculated using the formula for hypothesis testing the difference between two proportions based on Lameshow with P1 and P2 are 0.29 and 0.67, respectively based on previous study. The respondents in this study were 80 adolescent girls.

The independent variables in this study were nutritional status, body composition, and fitness, while the dependent variable was the occurrence of dysmenorrhea. Nutritional status was determined by measuring body weight and height. The body composition indicators measured in this study included body fat percentage, visceral fat, total subcutaneous fat, trunk subcutaneous fat, body muscle percentage, and trunk muscle percentage. Body composition data were obtained through measurements using the OMRON HBF 375 Karada Scan body analyzer. Meanwhile, the fitness components observed in this study were cardiorespiratory fitness, abdominal muscle strength, abdominal muscle endurance, and flexibility. Cardiorespiratory fitness was measured using the 3-minute YMCA (Young Men's Christian Association) step test, a simple and widely used cardiorespiratory test developed by YMCA. Respondents were asked to step up and down a 31 cm bench following a 96 bpm metronome for three minutes, then their recovery heart rate was measured. Abdominal muscle strength was measured through a one-minute sit-up test. Respondents performed correct sit-ups as many times as they could in one minute, and the number of repetitions was counted. Abdominal muscle endurance was measured through the prone plank test. Respondents were asked to perform a plank, and the duration they could maintain the plank position was recorded. Flexibility was measured with the sit & reach test. Respondents sat upright against a wall with their legs straight ahead, then bent forward to touch their toes and held the position for a few seconds while keeping their legs straight. The reach distance of the respondents' hands was recorded. Dysmenorrhea data were measured using the WaLLLID score questionnaire, which includes pain location, pain intensity, pain duration, and a decrease in performance or ability to perform daily activities during menstruation, each scored from 0 to 3.

Data for both independent and dependent variables for bivariate analysis were categorized. Nutritional status with BMI (Body Mass Index) indicator was categorized into: 1) underweight (BMI <18.5); 2) normal (BMI 18.5-25); 3) overweight (BMI >25-27); and 4) obese (BMI >27). Body fat percentage was categorized into: 1) low (<20%); 2) normal (≥20% - < 30%); 3) high (≥30% - <35%); and 4) very high (≥35%). Visceral fat percentage was categorized into: 1) normal (0.5% - 9.5%); 2) high (10% - 14.5%); and 3) very high (≥15%). Body muscle percentage was categorized into: 1) low (<24.3%); 2) normal (24.3% - 30.3%); 3) high (30.4% - 35.3%); and 4) very high (>35.3%). Trunk muscle percentage was categorized into: 1) normal (≤21.3%); and high (>21.3%). Trunk subcutaneous fat percentage was categorized into: 1) normal (≤19.5%); and 2) high (>19.5%). The level of dysmenorrhea was determined based on the total score of the components of pain location, pain intensity, pain duration, and decreased performance, each with a score of 0-3. The levels of dysmenorrhea were divided into four categories: 1) no dysmenorrhea (score 0); 2) mild dysmenorrhea (score 1-4); 3) moderate dysmenorrhea (score 5-7); and 4) severe dysmenorrhea (score 8-12). Bivariate analysis in this study used the Pearson correlation test with a significance level of 0.05. This study was approved by The Ethics Committee of Prof. Dr. Hamka Muhammadiyah University (Approval number: 03/23.11/02946).

3 Results and discussion

More than half of the respondents are 19 years old and live with their families. The nutritional status, body composition, and fitness of the respondents are shown in Table 1. More than half of the respondents had nutritional problems, either undernutrition (20%) or overnutrition (15% overweight and 18.8% obese). The prevalence of undernutrition in this study was higher than the national prevalence of adolescents. Meanwhile, the prevalence of overnutrition in this study was also above the national prevalence of adolescents based on Indonesia Basic Health Research [9].

Regarding body composition on Table 1, respondents with normal body fat percentages were less than half of the respondents (41.2%). However, the majority of respondents had normal visceral fat (87.5%). Majorly total subcutaneous fat and trunk subcutaneous fat were high. Nearly half of the respondents (47.5%) have body muscle percentages in the normal category. More than half of the respondents (61.2%) also had trunk muscle percentages in the normal category. Most respondents had high total fat and trunk subcutaneous fat, even though other body composition indicators were predominantly normal. This result contrasts with other studies in Malang, another city in Indonesia which showed subcutaneous fat levels mostly in the moderate category.

A study of adolescents in Bali found that 50% of teenagers had a high body fat percentage or were classified as obese [13]. The average body fat percentage of adolescents in this study was not much different from the average body fat percentage of female adolescents in urban area regions of Portugal (28.1%) and Poland (26.9%). Most young women in urban Poland have normal body fat and visceral fat percentages [14,15]. The body fat percentages of children and adolescent girls in Asia are similar to those of white adolescent girls in European countries [16]. Differences in body fat are mainly caused by different levels of physical activity and diet. The percentage of body fat and visceral fat in adolescents is strongly influenced by the level of energy adequacy; the proportion of energy sourced from total, animal and vegetable protein; complex carbohydrate intake; and dietary fiber intake [15]. Food consumption not only has an impact on body fat percentage but also overall body composition, including muscle mass. The average trunk muscle mass of respondents in this research (20.3%) was higher than the trunk muscle mass of young women in Malang, where the average trunk muscle mass was 16.9% [17].

Table 1. Nutritional status, body composition, and physical fitness of respondents

Independent variable	n	%	Mean±SD
Nutritional Status (BMI)			
Undernutrition (<18.5)	16	20	23±5.2 kg/m^2
Normal (18.5-25)	37	46.2	
Overweight (>25-27)	12	15	
Obese (>27)	15	18.8	
Body Composition			
Total body fat			
Low (<20%)	7	8.8	29±6.2%
Normal (20-29.9%%)	33	41.2	
High (≥30%)	40	50	
Visceral fat			
Normal (<10%)	70	87.5	5.4±8.4%
High (≥10%)	10	12.5	
Total subcutaneous fat			
Normal (≤mean)	22	27.5	24.3±6.2%
High (>mean)	58	72.5	
Subcutaneous trunk fat			

Independent variable	n	%	Mean±SD
Normal (≤19.5%)	38	47.5	20.7±5.9%
High (>19.5%)	42	52.5	
Total muscle			
High (≥30.4%)	14	17.5	26.4±3.4%
Normal (24.3-30.3%)	38	47.5	
Low (<24.3%)	28	35	
Trunk muscle			
Normal (<21.3%)	49	61.2	20.8±3
Low (≥21.3%)	31	38.8	
Physical Fitness			
Cardiorespiratory fitness			
Good	25	31.2	116.4 ± 24 bpm
Average	19	23.8	
Poor	36	45	
Abdominal muscle strength			
Poor	5	6.2	12.8 ± 6.4 rep
Very poor	75	93.8	
Abdominal muscle endurance			
Good	6	7.4	51.6 ± 26.5 s
Poor	11	13.8	
Very poor	63	78.8	
Flexibility			
Good	9	11.2	35.2 ± 11.4 cm
Average	63	78.8	
Poor	8	10	

The results of the cardiorespiratory fitness based on Table 1 showed only a small portion of respondents (31.2%) had good cardiorespiratory fitness. This is consistent with research conducted on adolescents in DKI Jakarta, which showed that only 35.6% of respondents had above-average cardiorespiratory fitness. The muscle strength and endurance of respondents in this study were also categorized as poor or insufficient. This finding is in line with a previous study which stated only 3.7% of late adolescents in DKI Jakarta were classified as having strong muscle strength [18]. Additionally, 78.8% of respondents had sufficient flexibility.

Table 2 shows the occurrence of dysmenorrhea experienced by the respondents. All respondents suffered from primary dysmenorrhea with varying levels of severity. Most experienced moderate to severe dysmenorrhea. Almost half of the respondents (47.5%) reported pain in 2-3 areas of the body, with 50% of respondents experiencing moderate pain intensity. The most commonly affected areas were the lower back and lower abdomen. The majority of respondents (85%) felt dysmenorrhea pain for 1-2 days. During menstruation, most respondents experienced a decline in performance. The severity status of primary dysmenorrhea in this study is determined by several aspects, one of which is pain intensity. The primary dysmenorrhea level aligns with the pain intensity component, where half of the respondents experienced moderate pain. This finding is consistent with another study which showed that most respondents experienced moderate dysmenorrhea [19]. The pain intensity experienced by adolescents is predominantly moderate [20].

Table 2. Dimension of primary dysmenorrhea among adolescents of urban area

Dimension of dysmenorrhea	n	%	Mean±SD
Dysmenorrhea level			
Mild	16	20	6±2
Moderate	45	56.2	

Dimension of dysmenorrhea	n	%	Mean±SD
Severe	19	23.8	
Pain location			
0 site	2	2.5	1.8±0.8
1 site	27	33.8	
2-3 sites	38	47.5	
≥ 4 sites	13	16.2	
Pain intensity			
No pain	3	3.7	1.7±0.7
Mild	26	32.5	
Moderate	40	50	
Severe	11	13.8	
Days of pain			
0 day	5	6.2	1±0.4
1-2 days	68	85	
3-4 days	7	8.8	
≥ 5 days	0	0	
Working inability			
None	10	12.5	1.5±0.9
Almost never	31	38.8	
Almost always	29	36.2	
Always	10	12.5	

Table 3 displays the relationship between nutritional status, body composition indicators, and physical fitness with dysmenorrhea. There was no relationship between nutritional status and body composition indicators with the level of dysmenorrhea, pain location, and performance decline during menstruation. Total subcutaneous fat and trunk subcutaneous fat are significantly positively correlated with pain intensity. Higher levels of total subcutaneous fat and trunk subcutaneous fat are associated with more intense menstrual pain. Meanwhile, visceral fat is significantly positively correlated with pain duration. The higher the level of visceral fat in an individual, the longer the duration of pain experienced.

In this study, nutritional status was not significantly related to dysmenorrhea status. This finding aligns with previous research conducted on high school girls in South Tangerang, which indicated that dysmenorrhea is not associated with BMI. Another study showed a contrasting result, indicating a significant relationship between nutritional status and dysmenorrhea in adolescents [19]. This difference may arise from demographic variations that can influence consumption patterns and stress levels, which are also factors affecting dysmenorrhea [21]. Nutritional status in this study was assessed using body mass index (BMI), which reflects overall body mass rather than specific aspects. More specific parameters for measuring nutritional status, such as haemoglobin (Hb) levels, could provide additional insights. Hb levels in adolescents were significantly related to dysmenorrhea, and based on regression analysis, the impact of Hb levels on dysmenorrhea was found to be stronger than that of BMI. More specific anthropometric measurements could also utilize body composition analysis [19].

All body composition indicators, including both fat mass and muscle mass, were not associated with the severity of dysmenorrhea (Table 3). However, some body composition indicators are more specifically related to dimensions of dysmenorrhea pain. Visceral fat was positively correlated with pain duration, while total subcutaneous fat and trunk subcutaneous fat were positively correlated with pain intensity. Other research had shown that body fat percentage was significantly related to dysmenorrhea status in adolescents [13]. This finding did not align with the current study, as in this study, body fat percentage did not correlate with dysmenorrhea status or the dimensions of dysmenorrhea pain (pain intensity, pain duration, pain location, and performance decline). The body fat measurements: visceral fat,

https://doi.org/10.1051/bioconf/202515301003

total subcutaneous fat, and trunk subcutaneous fat were positively correlated with dysmenorrhea pain dimensions in this study. One study indicated a significant effect of subcutaneous fat on dysmenorrhea status, suggesting that the effect of subcutaneous fat on dysmenorrhea is stronger than that of BMI [19].

In this study, subcutaneous fat was positively associated with pain intensity. An increase in visceral fat, subcutaneous fat, and trunk subcutaneous fat will elevate pain dimensions during menstruation. This finding aligns with several research results and existing theories that individuals with obesity and high-fat mass are at greater risk of experiencing menstrual pain. Obese individuals tend to have lower muscle mass. Therefore, the accumulation of fat, especially subcutaneous fat—whether total across the body or in specific areas like the trunk—can decrease muscle mass, resulting in suboptimal oxygen utilisation by the muscles in those areas. Excessive fat accumulation in adipose tissue leads to ventricular thickening and decreased cardiac output, which impacts the supply of oxygen to tissues [22].

The lack of oxygen that induces dysmenorrhea pain can also be explained through inflammatory responses, one of which involves prostaglandin mediators. Menstrual regulation is closely related to several hormones, such as progesterone. Low progesterone levels during the menstrual period increase the release of prostaglandins. After ovulation, fatty acids accumulate in the phospholipid membrane of cells. Visceral and subcutaneous fat in the body serves as form of stored body fat located in adipose tissue, primarily in the form of triglycerides. Triglycerides are broken down into glycerol and free fatty acids. Fatty acids, particularly arachidonic acid, are the main substrates for prostaglandin biosynthesis. Arachidonic acid can be metabolised through the cyclooxygenase pathway, resulting in the production of prostaglandins (PGF2α and PGE2). Cyclooxygenase and prostaglandin PGF2α stimulate vasoconstriction and increase uterine smooth muscle contractions, inducing ischemia, hypoxia, and triggering pain during menstruation. The release of prostaglandin PGF2α by adipose omentum cells increases in obese women. The omentum is part of visceral fat. Thus, higher levels of visceral fat are associated with longer durations of dysmenorrhea pain [23].

Table 3. Correlation coefficients of BMI, body composition, and physical fitness with dysmenorrhea

Variable		Dysmenorrhea level	Pain location	Pain intensity	Days of pain	Working inability
BMI	***P***	0.461	0.304	0.310	0.065	0.336
	r	0.084	0.116	0.115	0.207	-0.109
Total body fat	***P***	0.938	0.537	0.073	0.487	0.153
	r	-0.009	-0.070	0.202	0.079	-0.161
Visceral fat	***P***	0.694	0.352	0.623	**0.007***	0.429
	r	-0.045	-0.105	-0.056	0.300	-0.090
Total subcutaneous fat	***P***	0.127	0.223	**0.049***	0.101	0.952
	r	0.172	0.138	0.220	0.185	-0.007
Trunk subcutaneous fat	***P***	0.259	0.328	**0.049***	0.088	0.458
	r	0.128	0.111	0.218	0.192	-0.084
Total muscle	***P***	0.512	0.380	0.257	0.405	0.509
	r	-0.074	-0.100	-0.128	-0.094	0.075
Trunk muscle	***P***	0.795	0.412	0.275	0.409	0.139
	r	-0.029	-0.093	-0.123	-0.094	0.167
Cardiorespiratory fitness	***P***	0.391	**0.016***	0.605	0.792	0.973
	r	0.097	0.270	-0.059	-0.030	0.004
Abdominal muscle strength	***P***	0.224	0.729	0.112	0.653	0.520
	r	-0.138	0.039	-0.179	-0.051	-0.073
Abdominal muscle endurance	***P***	0.821	0.111	0.162	0.704	0.777
	r	0.026	0.180	-0.158	0.043	0.032
Flexibility	***P***	0.645	0.977	0.423	0.449	0.771

	r	-0.052	-0.003	-0.091	0.086	-0.033

Note: * significantly different ($p<0.05$)

Another factor suspected to be related to body composition is fitness level. The component of fitness in this study that significantly correlated with dysmenorrhea pain dimensions is cardiorespiratory fitness. Lower cardiorespiratory fitness was associated with a greater number of pain locations experienced during dysmenorrhea. Low cardiorespiratory fitness was characterized by low VO_2max or oxygen uptake into tissues. The mechanism linking cardiorespiratory fitness and dysmenorrhea pain is still related to hypoxia or a lack of oxygen supply. Lower cardiorespiratory fitness indicated reduced oxygen uptake into tissues, which may lead to more tissues being deprived of oxygen [22]. Therefore, during menstruation, more areas of the body may experience pain due to insufficient oxygen supply.

4 Conclusions

Nutritional status based on BMI is not significantly related to dysmenorrhea. However, several body composition indicators are significantly associated with certain dimensions of dysmenorrhea. Visceral fat levels are positively correlated with pain duration, while total subcutaneous fat and trunk subcutaneous fat correlated positively with pain intensity. Neither total muscle mass nor trunk muscle mass is significantly related to dysmenorrhea. The fitness component associated with dysmenorrhea pain dimensions is cardiorespiratory fitness. Lower levels of cardiorespiratory fitness are associated with a greater number of pain locations experienced during dysmenorrhea. The study suggests that reducing fat mass and improving cardiorespiratory fitness may help reduce dysmenorrhea symptoms. Therefore, promoting regular physical exercise among adolescents may be an effective strategy to reduce certain dimensions of dysmenorrhea,

References

1. M. Burnett, M. Lemyre. No. 345-Primary dysmenorrhea consensus guideline. J. Obstet. Gynaecol. Canada. **39**, 7:585–95. (2017) http://dx.doi.org/10.1016/j.jogc.2016.12.023
2. L. Wang, Y. Yan, H. Qiu, D. Xu, J. Zhu, J. Liu, *et al*. Prevalence and risk factors of primary dysmenorrhea in students: A meta-analysis. Value. Heal. **25**, 10:1678–84 (2022) https://doi.org/10.1016/j.jval.2022.03.023
3. R. Hermawahyuni, S. Handayani, R.D. Alnur. Faktor Risiko kejadian dismenore primer pada siswi di SMK PGRI 1 Jakarta Timur. J. Kesehat. Komunitas. **8**, 1:97–101 (2022)
4. Y. Halitopo. The relationship of the dysmenorrhea a in students with learning activities. Sci. Midwifery. **10**, 5:4149–54 (2022)
5. T.T. Mesele, H.G. Ayalew, A.T. Syoum, T.A. Antehneh. Impact of dysmenorrhea on academic performance among Haramaya University undergraduate regular students, Eastern Ethiopia. Front. Reprod. Heal. **4**:1–7 (2022)
6. R.M. Sima, M. Sulea, J.C. Radosa, S. Findeklee, B.H. Hamoud, M. Popescu, *et al*. The prevalence, management and impact of dysmenorrhea on medical students' lives-a multicenter study. Healthc. **10**, 1:2–11 (2022)
7. S.R.H. Sinurat, R.V.T. Novita. Body mass index and warm compress are associated with severity of dysmenorrhea in Jakarta private high schools. J. Ber. Ilmu. Keperawatan. **15**, 2:142–9 (2022)
8. Kementerian Kesehatan Republik Indonesia. Laporan Provinsi DKI Jakarta: Riskesdas 2018 [Internet]. Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan. https://www.litbang.kemkes.go.id/laporan-riset-kesehatan-dasar-riskesdas/ (2018.)

9. Kemenkesnasional. Laporan Nasional RKD2018 FINAL.pdf [Internet]. Badan Penelitian dan Pengembangan Kesehatan. http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL. (2018)
10. S. Mohebi, M. Parham, G. Sharifirad, Z. Gharlipour. Social support and self - care . Behavior Study1–6 (2018)
11. C.H. Ning, R.K. Vasanthi, Y.A. Muniandy. Study on the Prevalence of dysmenorrhea and its relationship with physical activity among young adults. Int. J. Heal. Sci. Res. [Internet] **10**, 10:39–45 (2020)
12. M. Armour, C.C. Ee, D. Naidoo, Z. Ayati, K.J. Chalmers, K.A. Steel, *et al*. Exercise for dysmenorrhoea. Cochrane. Database. Syst. Rev. **2019**, 9 (2019)
13. D.A.K.I. Putri, M. Widnyana, I.V. Juhanna, I.M.N Winaya. Hubungan antara aktivitas fisik dan persentase lemak dengan dysmenorrhea padaremaja perempuan di SMA Negeri 2 Tabanan. Maj. Ilm. Fisioter. Indones. **9**, 2:70–77 (2021)
14. D.V. Martinho, E.R. Gouveia, C. França, H. Lopes, A. Ihle, A. Marques, *et al.* Body composition and physical fitness in Madeira youth. Children. **9**, 12:1–15 (2022)
15. R.M. Zukowska. Selected nutrients. 2023
16. J. McConnell-Nzunga, P.J. Naylor, H.M. Macdonald, R.E. Rhodes, S.M. Hofer, H.A. McKay. Body fat accrual trajectories for a sample of Asian-Canadian and Caucasian-Canadian children and youth: A longitudinal DXA-based study. Pediatr. Obes. **15**, 1. (2020)
17. A.P. Illahika, R.K. Prabawati, W.F. Wijaya, N.C. Syaifudin, A. Choirunnisa. Analysis of body composition factors that affect trunk muscle mass in late adolescence. KnE Med. **2022**:272–282 (2022)
18. A. Fitriani, D.R. Purwaningtyas. Relationship between BMI, energy intake, macro nutrient intake and cardiorespiratory fitness among female college students in Jakarta. Icsdh **2021**:94–99 (2022)
19. A. Oktaviana, N. Imaniar, E. Dwi Widyana, I. Yuliani. Hubungan antara lemak subkutan, indeks massa tubuh, kadar hemoglobin dengan dismenore primer pada remaja putri di SMAN 1 Sumberpucung. Adol. **8**(2):176–88 (2019)
20. I.W.S. Putr, N.W. Gati NW. Gambaran skala nyeri haid (Dismenorea) pada remaja putri di Desa Tanjungrejo Kabupaten Sukoharjo. Nurs. News. J. Ilm. Keperawatan. **7**(1):1–10 (2023)
21. T. Agustina, A. Restuningtyas, Sutrisna E. Stress Affect Dysmenorrhea on Female Abdominal Obesity. Innov Assoc JBioInnov. **2019**;8(6):735–40. www.jbino.com
22. C. Sharma. R. Manmohan Sharma R, K. Kamal. Chawla. Correlation of body composition to aerobic capacity: A cross-sectional study. Int J. Appl. Res. **1**, 2:38–42. www.allresearchjournal.com (2016)
23. A. Michaud, N. Lacroix-Pépin, M. Pelletier, A. Veilleux, S. Noël, C. Bouchard, *et al.* Prostaglandin (PG) F2 alpha synthesis in human subcutaneous and omental adipose tissue: Modulation by inflammatory cytokines and role of the human aldose reductase AKR1B1. PLoS One. **9**, 3 (2014)