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Factors Related to The Incidence of Primary Dysmenorrhea in Adolescent Females at SMAIT Raflesia Depok in 2024

Faktor – Faktor yang Berhubungan dengan Kejadian Dismenore Primer pada Remaja Putri di SMAIT Raflesia Depok Tahun 2024

Syafila Syafila[1], Iin Fatmawati Imrar[1*], Sintha Fransiske Simanungkalit[1]

[1]Program Studi Gizi, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta, Jalan Limo Raya, Limo, Depok, 16515

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Correspondent:
Iin Fatmawati Imrar
iinfatmawatiimrar@upnvj.ac.id

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ABSTRACT

Background: Adolescence marks the onset of puberty, during which physiological and hormonal changes occur. In female adolescents, one of the primary indicators of puberty is the initiation of menstruation. During the menstrual phase, some adolescents experience lower abdominal pain, known as dysmenorrhea. Various factors, including body fat percentage and nutrient intake, have been identified as contributors to dysmenorrhea.

Objectives: This study aimed to investigate the association between body fat percentage, fat intake, and the levels of iron, calcium, and magnesium intake on the incidence of primary dysmenorrhea among adolescent girls at SMAIT Raflesia Depok in 2024.

Methods: The study was conducted in February 2024 at SMAIT Raflesia Depok, utilizing a quantitative, cross-sectional design. The sample comprised 103 female students from grades X and XI, aged 14 to 17 years, selected through stratified random sampling. Study variables included body fat percentage, fat intake, iron intake, calcium intake, magnesium intake, and the incidence of primary dysmenorrhea. Data were analyzed using the chi-square test.

Results: Analysis revealed a significant association between iron intake (p-value=0.009), calcium intake (p-value=0.006), and magnesium intake (p-value=0.020) with the incidence of primary dysmenorrhea. However, no significant association was observed for body fat percentage (p-value=0.349) or fat intake (p-value=0.616).

Conclusions: This study highlights a significant association between the intake of iron, calcium, and magnesium and the occurrence of primary dysmenorrhea among adolescent girls at SMAIT Raflesia Depok in 2024. These findings underscore the importance of maintaining a healthy body fat percentage and ensuring adequate nutritional intake to reduce the risk of dysmenorrhea in this population.

INTRODUCTION

Adolescence is a critical phase of transition from childhood to adulthood, characterized by significant physical, cognitive, and psychosocial growth and development, typically occurring between the ages of 10 and 19 years[1]. During this period, individuals undergo puberty, a biological milestone marked by profound physiological changes. In adolescent girls, one of the primary indicators of puberty is the onset of menstruation[2].

Menstruation is a cyclic bleeding process that occurs in the uterine corpus, beginning at menarche and continuing until the onset of menopause. Among many women, menstrual disorders are common, with one of the most frequently reported issues being abdominal pain at the onset of menstruation, known as dysmenorrhea[3]. Dysmenorrhea refers to cramping pain experienced in the lower abdomen and pelvic region, typically occurring during menstruation. Dysmenorrhea is classified into two types: primary and secondary. Primary dysmenorrhea is associated with excessive prostaglandin production in the uterus, leading to abnormal uterine contractions. In contrast, secondary dysmenorrhea is often linked to underlying pelvic pathologies or specific health conditions[4].

Globally, the prevalence of dysmenorrhea in 2022 ranged between 45% and 95% among women of reproductive age, with 2% to 29% experiencing severe pain[5]. In Indonesia, the prevalence of dysmenorrhea is estimated to affect 55% of women in their reproductive age[6]. Managing primary dysmenorrhea can involve maintaining a healthy body fat percentage and ensuring adequate intake of essential nutrients. Nutritional factors

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influencing dysmenorrhea include fat, iron, calcium, and magnesium intake.

Percent body fat is directly related to adipose tissue, which influences the balance of sex hormones such as estrogen and progesterone. Elevated levels of these hormones can stimulate increased prostaglandin production. Prostaglandins, in turn, can induce vasoconstriction and muscle spasms, resulting in primary dysmenorrhea[7]. Excessive fat intake is also linked to elevated estrogen production, contributing to hormonal imbalances and the overproduction of prostaglandins[8,9]. Further, oversecretion of prostaglandins induces vasoconstriction and muscle spasms which result in dysmenorrhea[10].

Micronutrients such as iron, calcium, and magnesium also play significant roles in the pathophysiology of dysmenorrhea. Iron deficiency increases the risk of dysmenorrhea due to its role in hemoglobin synthesis and oxygen transport. Reduced oxygen delivery to the reproductive organs can cause vasoconstriction and menstrual pain[11]. Moreover, calcium is involved in nerve impulse transmission and muscle relaxation. Insufficient calcium levels may impair muscle relaxation after contraction, leading to spasms and pain[12]. Additionally, magnesium contributes to the contractility and relaxation of uterine smooth muscle and inhibits prostaglandin synthesis, thereby alleviating menstrual discomfort[13].

According to data from the Central Bureau of Statistics in 2022, Depok City had 83,330 adolescent girls aged 10–14 years and 81,314 aged 15–19 years. SMAIT Raflesia, an integrated Islamic senior high school in Depok, reports that female students constitute 58.4% of its total student population. A preliminary study conducted on 13 students at SMAIT Raflesia found that 7 participants (53.8%) experienced severe dysmenorrhea. Previous research has identified associations between body fat percentage, nutrient intake, and the incidence of primary dysmenorrhea. However, most studies have assessed dysmenorrhea severity primarily through pain scales, such as the Numerical Rating Score (NRS), focusing on pain intensity levels. This study employs a combined approach using the NRS and the WaLLID score, which evaluates pain intensity and locations, range, duration, and frequency of pain that interferes with daily activities.

Based on these considerations, the present study aims to investigate the association between body fat percentage, fat intake, and iron, calcium, and magnesium intake with the incidence of primary dysmenorrhea among adolescent girls at SMAIT Raflesia in Depok.

METHODS

This study was conducted in February 2024 at SMAIT Raflesia Depok using a quantitative approach with a cross-sectional design. The population comprised all Grade X and XI students at SMAIT Raflesia Depok, totaling 157 individuals. A sample size of 103 students aged 14 to 17 years was determined using Lemeshow's formula for hypothesis testing with different proportions. The sample was selected through a stratified random sampling method, with names randomly chosen from each class using the "Wheel of Names" application. Selected students were subsequently invited to participate in the study. Ethical approval was obtained from the National Development University "Veteran" Jakarta (approval number 146/V/2024/KEP) on May 6, 2024.

The study involved one-time data collection, irrespective of the participants' menstrual cycle phases, and utilized primary data. The independent variables examined included percent body fat, fat intake, iron intake, calcium intake, and magnesium intake, while the dependent variable was the incidence of primary dysmenorrhea. Percent body fat was measured using Bioelectrical Impedance Analysis (BIA) and categorized as normal (14–31%) or abnormal (≤13% or ≥32%). Data on fat, iron, calcium, and magnesium intake were collected using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) and categorized based on the Nutrient Adequacy Rate (NAR). Fat intake was classified as sufficient or excessive (≥120% of the Recommended Dietary Allowance [RDA]), while iron, calcium, and magnesium intake were categorized as sufficient or insufficient based on RDA standards. The incidence of primary dysmenorrhea was assessed using a validated and reliable dysmenorrhea questionnaire that combined the Numerical Rating Scale (NRS) and WaLLID Score, with validity and reliability scores of 0.361 and 0.618, respectively. Participants were identified as having dysmenorrhea if their NRS score was ≥1 and their WaLLID Score was ≥6.

Additional research instruments included explanation sheets provided to all participants, informed consent forms, and self-identity questionnaires that collected demographic information such as name, age, class, and phone number. Data analysis was performed using IBM SPSS Statistics 25, with univariate analysis describing respondent characteristics, including age, nutritional status, and study variables, while bivariate analysis, using the chi-square test, assessed relationships between variables. A significance threshold of p-value < 0.05 (5%) was applied.

RESULTS AND DISCUSSIONS

The distribution of respondent characteristics includes age, nutritional status, father's education, mother's education, father's occupation, mother's occupation, and study variables. As shown in Table 1, respondents ranged in age from 14 to 17 years, with the majority exhibiting normal nutritional status. Regarding parental education, most respondents reported that their parents had attained a high level of education. Regarding parental occupation, most fathers were employed in the private sector, while most mothers were not engaged in formal employment. Body fat percentage analysis revealed that most respondents had normal body fat levels. Furthermore, fat intake was adequate for the majority of respondents, whereas iron, calcium, and magnesium intake were deficient in the majority. The incidence of primary dysmenorrhea among respondents was 54.4%.

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Table 1. Characteristics of Adolescent Girls at SMAIT Raflesia Depok (2024)

	Frequency (n)	Percentage (%)
Age (Years)		
14	2	1.9
15	22	21.4
16	61	59.2
17	18	17.5
Total	103	100.0
Nutritional Status		
Normal	65	63.1
Overweight	26	25.2
Obese	12	11.7
Total	103	100.0
Father's Education		
Low	5	4.9
High	88	85.4
Don't Know	10	9.7
Total	103	100.0
Mother's Education		
Low	7	6.8
High	87	84.5
Don't Know	9	8.7
Total	103	100.0
Father's Occupation		
State Civil Servants (ASN)	14	13.6
Army/Police	10	9.7
Employee	54	52.4
Entrepreneur	12	11.7
Not Working	13	12.7
Total	103	100.0
Mother's Occupation		
State Civil Servants (ASN)	14	13.6
Employee	21	20.4
Entrepreneur	8	7.8
Not Working	60	58.2
Total	103	100.0
Percent Body Fat		
Normal	86	83.5
Abnormal	17	16.5
Total	103	100.0
Fat Intake		
Sufficient	81	78.6
Excess	22	21.4
Total	103	100.0
Iron Intake		
Sufficient	23	22.3
Insufficient	80	77.7
Total	103	100.0
Calcium Intake		
Sufficient	9	8.7
Insufficient	94	91.3
Total	103	100.0
Magnesium Intake		
Sufficient	15	14.6
Insufficient	88	85.4
Total	103	100.0
Incidence of Primary Dysmenorrhea		
Dysmenorrhea	56	54.4
No Dysmenorrhea	47	45.6
Total	103	100.0

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Table 1 indicates that respondents ranged in age from 14 to 17 years, with the majority being 16 years old. This age range represents the middle stage of adolescence, a period characterized by significant physical maturation toward adulthood. Adolescents in this stage typically experience secondary sexual development, including hip widening, breast growth, and the appearance of hair in specific areas. Adolescent girls within this age group generally have undergone menarche and have begun experiencing regular menstrual cycles[14]. Analysis of nutritional status revealed that the majority of respondents (65 individuals, 63.1%) had normal nutritional status. This indicates a balance between the quality and quantity of nutritional intake and physiological needs. Overnutrition and obesity among adolescents can arise from various factors, including unhealthy lifestyle choices, frequent consumption of high-fat foods, and lack of physical activity[15]. Adolescents with higher nutritional status face an increased risk of developing degenerative diseases, highlighting the importance of monitoring dietary patterns, including frequency, type, and portion size of food consumed[16].

Furthermore, the body fat percentage analysis showed that most respondents (74 individuals, 71.8%) had normal body fat levels. Abnormal body fat percentages can be influenced by factors such as poor dietary habits and excessive fat consumption. Prolonged intake of dietary fat exceeding physiological requirements can lead to fat accumulation, as the body stores up to 96% of excess fat when fat oxidation does not increase proportionally[17]. Fat intake analysis revealed that most respondents (81 individuals, 78.6%) consumed adequate amounts of dietary fat, with an average daily intake of 63.1 grams, as assessed by the SQ-FFQ.

However, micronutrient intake among respondents was generally deficient. The average daily iron intake was 13.1 mg, calcium was 405.5 mg, and magnesium was 153 mg (Table 1). These values fall significantly short of the recommended dietary allowances for adolescent girls aged 13–18 years. Deficient micronutrient intake was attributed to insufficient consumption of food sources rich in iron, calcium, and magnesium derived from both animal and plant-based foods.

Table 1 also reveals that the majority of respondents experienced primary dysmenorrhea. Similar findings were reported in a 2020 study conducted in Bangkinang, where 58.8% of adolescent female respondents (47 out of 80) experienced dysmenorrhea[18]. Primary dysmenorrhea in adolescent girls can adversely affect individual productivity and academic performance, causing psychological distress and reduced focus during lessons. Students with severe dysmenorrhea may exhibit decreased participation in group discussions, question-and-answer sessions, and other classroom activities. In extreme cases, students may be unable to attend school due to their inability to cope with the associated pain and discomfort[19].

Table 2. Bivariate Analysis of Nutritional Predictors of Primary Dysmenorrhea

	Incidence of Primary Dysmenorrhea				Total		p-value
	No Dysmenorrhea		Dysmenorrhea				
	n	%	n	%	n	%	
Percent Body Fat							
Normal	41	39.8	45	43.6	86	83.4	0.349
Abnormal	6	5.8	11	10.6	17	16.5	
Fat Intake							
Sufficient	38	36.8	37	41.7	72	78.6	0.616
Excess	12	8.7	19	12.6	31	21.4	
Iron Intake							
Sufficient	16	15.5	7	6.8	23	22.3	0.009*
Insufficient	31	30.1	49	47.5	80	77.6	
Calcium Intake							
Sufficient	8	7.8	1	1.0	9	8.7	0.006*
Insufficient	39	37.8	55	53.4	94	91.3	
Magnesium Intake							
Sufficient	11	10.6	4	3.9	15	14.6	0.020*
Insufficient	36	34.9	52	50.4	88	85.4	

The bivariate analysis was conducted using the chi-square test to examine the correlation between variables. The analysis revealed no significant association between body fat percentage and the incidence of primary dysmenorrhea (p-value = 0.349) or between fat intake and the incidence of primary dysmenorrhea (p-value = 0.355). In contrast, the results indicated significant associations between micronutrient intake and primary dysmenorrhea. Specifically, iron intake was significantly associated with the incidence of primary dysmenorrhea (p-value = 0.009), as were calcium intake (p-value = 0.006) and magnesium intake (p-value = 0.020).

Relationship between Percent Body Fat and Incidence of Primary Dysmenorrhea

Table 2 reveals no statistically significant correlation between percent body fat and primary dysmenorrhea incidence (p-value = 0.349). This finding aligns with prior research conducted among female students (n = 148, aged 17-25) in Semarang (2023), which reported no significant association (p-value = 0.056)[20].

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A 2017 study conducted in Bukittinggi among 106 female students (ages 18-25) yielded comparable findings. The results indicated that primary dysmenorrhea prevalence was similar among adolescents with normal fat mass, affecting 30.79% of respondents, whereas 30.95% remained asymptomatic. Notably, statistical analysis revealed no significant difference in mean fat mass between adolescents experiencing primary dysmenorrhea and those without (p-value = 0.89). However, the study acknowledged limitations due to restricted access to facilities and diagnostic tools, underscoring the necessity for comprehensive gynecological examinations to elucidate underlying factors contributing to primary dysmenorrhea[21].

However, contrasting results emerged from an Indian study (2016) involving 90 adolescent girls, indicating a significant positive correlation between percent body fat and primary dysmenorrhea severity (p-value < 0.001)[22]. These disparate findings underscore the need for comprehensive gynecological examinations to elucidate underlying factors contributing to primary dysmenorrhea[22].

Excess percent body fat, particularly subcutaneous fat, disrupts sexual hormone balance, notably estrogen and progesterone levels[7]. Elevated estrogen and progesterone trigger uterine lining proliferation, releasing proinflammatory mediators, including excess prostaglandins[7,23]. Post-ovulation estrogen surges stimulate prostaglandin production, increasing myometrial contractions, blood vessel compression, and impaired menstrual blood flow, culminating in abdominal pain and dysmenorrhea[23]. Conversely, low percent body fat risks estrogen imbalance, perpetuating hormonal dysregulation and dysmenorrhea[24].

Percent body fat exhibits fluctuations across various menstrual cycle phases, influenced by hormonal changes and fluid shifts. Previous studies have consistently demonstrated significant variations in body composition, including body fat mass, throughout the menstrual cycle. The premenstrual (luteal) phase is characterized by increased water retention, potentially attributed to elevated progesterone levels. Progesterone-mediated changes in renal output contribute to fluid retention, subsequently affecting body fluid volume[25]. These fluctuations can significantly impact body composition measurements, including percent body fat. This study measured the percent body fat without considering individual menstrual cycles, which may introduce variability. To enhance accuracy, future research should incorporate menstrual cycle phase assessments. Additionally, the predominantly normal body fat percentages among respondents may have influenced results, highlighting the need for controlled studies.

Relationship Between Fat Intake and the Incidence of Primary Dysmenorrhea

Table 2 indicates no statistically significant correlation between fat intake and primary dysmenorrhea incidence (p-value = 0.355), consistent with Japanese research findings (2019) among women aged 19-24, demonstrating no association between dietary fat consumption and menstrual pain/dysmenorrhea[26].

Similarly, a study conducted in Makassar (2020) among 64 adolescent girls (aged 13-18) found that fat intake had no discernible effect on dysmenorrhea incidence (p-value = 0.615). Notably, the majority of respondents (56.3%) experiencing dysmenorrhea and 57.8% of non-sufferers reported insufficient fat intake. These results suggest that fat consumption may not significantly contribute to primary dysmenorrhea development in this population[27]. In this study, our findings indicated that fat intake did not significantly affect the incidence of dysmenorrhea among the respondents, as the majority reported low fat consumption. Our study's findings may be influenced by respondents' uniform dietary habits due to consuming similar school canteen meals.

In contrast, research conducted in Lumajang (2018) among 87 female students (aged 15-20) indicated that excessive fat intake exacerbated dysmenorrhea severity[28]. Conversely, a Surabaya-based study (2020) involving 89 female students (aged 17-22) identified a significant positive correlation between fat intake and dysmenorrhea incidence (p-value = 0.025), implying that increased fat consumption elevates dysmenorrhea risk[29].

Hormonal fluctuations during the menstrual cycle precipitate physical, psychological, and behavioral changes, including altered appetite and food intake patterns. Menstruation often intensifies cravings for sweet or high-fat foods, leading to increased fat consumption[30]. Elevated fat intake contributes to excessive estrogen production, disrupting hormonal balance and decreasing progesterone levels[8,30]. This imbalance triggers prostaglandin overproduction, causing uterine contractions, vasoconstriction, ischemia, and dysmenorrhea symptoms[9,29]. Research indicates that individuals with a high intake of dietary fats may be at increased risk for micronutrient deficiencies. This is often attributed to a reliance on high-fat processed foods that tend to displace other food options that are rich in essential micronutrients[32]. Inadequate micronutrient intake may increase the risk of dysmenorrhea.

Conversely, Polyunsaturated fatty acids (omega-3) exhibit therapeutic potential in alleviating dysmenorrhea. A Jakarta-based study (n = 60, aged 18-22) demonstrated a significant inverse correlation between omega-3 intake and dysmenorrhea incidence (p-value = 0.001)[33]. Notably, respondents with moderate-to-severe dysmenorrhea had significantly lower omega-3 consumption. Omega-3 fatty acids' anti-inflammatory properties, mediated through reduced inflammatory cytokine levels and Polyunsaturated Fatty Acid (PUFA) activity, contribute to analgesic effects during menstruation[10]. Future research should investigate specific types of fat intake to elucidate associations between fatty acids composition and dysmenorrhea.

Relationship Between Iron Intake and the Incidence of Primary Dysmenorrhea

Table 2 demonstrates a significant association between iron intake and the incidence of primary dysmenorrhea (p-value = 0.009). These findings are

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consistent with a 2023 study conducted in Semarang involving 123 adolescent girls aged 13–15 years. The study found that the majority of adolescent girls with dysmenorrhea had insufficient iron intake (47 participants, 78.33%) compared to those with sufficient iron intake (31 participants, 49.21%). The study further reported that inadequate iron intake was significantly associated with a higher incidence of dysmenorrhea (p-value = 0.001)[34].

Similarly, a 2016 study conducted at a vocational school in Surakarta yielded comparable results, identifying a significant relationship between iron intake and dysmenorrhea (p-value = 0.000). Participants with insufficient iron intake experienced more severe dysmenorrhea than those with adequate iron intake[35].

Iron plays a critical role in hemoglobin synthesis, which is essential for oxygen transport in the body. Inadequate iron intake reduces hemoglobin production, impairing oxygen delivery to blood vessels. When oxygen levels in the blood vessels supplying the reproductive organs are diminished, vasoconstriction, or narrowing of the blood vessels, occurs, resulting in menstrual pain[11]. Additionally, iron is vital for hemoglobin formation in the bone marrow. Insufficient iron intake depletes plasma iron levels, limiting the iron supply to the bone marrow and disrupting hemoglobin synthesis. This can lead to anemia, a condition that weakens the immune system and increases susceptibility to pain during menstruation. These physiological mechanisms highlight the role of iron deficiency in the development and severity of dysmenorrhea[35].

Relationship Between Calcium Intake and the Incidence of Primary Dysmenorrhea

Table 2 shows a significant association between calcium intake and the incidence of primary dysmenorrhea (p-value = 0.006). This finding aligns with a previous study conducted in Jakarta in 2020, which involved 116 female students aged 17–25 years. That study demonstrated a significant association between calcium intake and dysmenorrhea, revealing that female students with insufficient calcium intake had a 2.196 times higher risk of experiencing primary dysmenorrhea compared to those with sufficient calcium intake[36].

Similarly, a 2020 study conducted in Kendal reported comparable results. This study included 31 adolescent girls in the case group and 31 in the control group. The findings indicated that only 3 participants (9.7%) with adequate calcium intake experienced dysmenorrhea, while 28 participants (90.3%) with insufficient calcium intake reported dysmenorrhea. Furthermore, the analysis revealed that adolescents with insufficient calcium intake had a 9.664 times greater risk of developing dysmenorrhea compared to those with adequate calcium intake[37].

Calcium intake plays a crucial role in the incidence of dysmenorrhea due to its involvement in muscle contraction processes. Muscle contractions occur in response to depolarization, protein interactions, and other stimuli. In this process, calcium is essential for the interaction between the actin and myosin proteins within muscles. These proteins, which are responsible for muscle contraction, require elevated calcium levels to function effectively. Increased calcium levels are achieved either through calcium influx from extracellular sources or by releasing calcium from intracellular stores. This rise in calcium activates various signaling pathways to regulate muscle contraction[38]. Calcium also plays a significant role in alleviating muscle stress. Adequate calcium levels are necessary for the proper functioning of muscles, including the uterine muscles, thereby reducing the likelihood of cramping. Additionally, low calcium intake is associated with water retention, which can exacerbate menstrual pain[39].

Relationship Between Magnesium Intake and the Incidence of Primary Dysmenorrhea

Table 2 indicates a significant association between magnesium intake and primary dysmenorrhea incidence (p-value = 0.020). These findings align with prior research conducted among 148 female students (ages 17-25) in Padang, which also reported a statistically significant association between magnesium intake and primary dysmenorrhea[40].

A similar study conducted in South Jakarta in 2020 examined adolescent female athletes and reported comparable findings. The study included two groups of participants: 32 adolescent female athletes who experienced dysmenorrhea and 32 who did not. The mean magnesium intake among athletes with dysmenorrhea was 707.10 ± 259.76 mg/day, whereas the control group had a significantly higher intake of 1,286.44 ± 231.41 mg/day, demonstrating a statistically significant difference between the two groups (p-value = 0.001)[41].

Magnesium plays a critical role in membrane stabilization and functions in calcium regulation, including controlling the sodium-potassium (Na-K) pump. Low magnesium levels can enhance neurotransmission, leading to excessive muscle stimulation. Magnesium levels within cells are influenced by various factors, including progesterone. Before menstruation, an increase in magnesium levels within cells can elevate progesterone levels. Conversely, a deficiency in cellular magnesium can lower progesterone levels, leading to heightened uterine muscle contractions and dysmenorrhea[43]. Magnesium also collaborates with calcium in facilitating uterine muscle contraction. It regulates calcium levels in smooth muscle cells of blood vessels by inhibiting calcium entry and blocking its release from the sarcoplasmic reticulum. A reduction in intracellular calcium decreases muscle contraction and promotes relaxation. Therefore, increased magnesium intake can aid in muscle relaxation, preventing spasms and alleviating menstrual pain[44].

Strengths and Limitations

This study contributes to the existing literature by employing an innovative questionnaire approach to investigate dysmenorrhea's causal factors, providing a fresh perspective. However, this study has two primary limitations. First, lacking information on participants' menstrual cycles may introduce bias in assessing dysmenorrhea pain severity. Second, the fat intake questionnaire did not provide a detailed categorization of fatty acid types, which potentially impacted the results.

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CONCLUSIONS

This study examined the association between body fat percentage, fat intake, iron, calcium, magnesium, and primary dysmenorrhea incidence among adolescent girls at SMAIT Raflesia Depok (2024). Results indicate significant associations between primary dysmenorrhea and iron, calcium, and magnesium intake. Conversely, body fat percentage and fat intake showed no significant associations. Hopefully, future collaborations between schools, local health centers, and universities can facilitate counseling, education on dysmenorrhea risk factors and management, and nutrition guidance on the dangers of excessive fat consumption and the importance of micronutrient supplementation for female students.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

This study was self-funded and conducted independently, with no conflicts of interest.

AUTHOR CONTRIBUTIONS

SS: conceptualization, investigation, methodology, analysis, original draft writing, and editing; IFI: review writing, supervision, and editing; SFS: review writing, supervision, and editing

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