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Eating Habits and Age at Menarche among Junior High School Female Students in DKI Jakarta Province in 2023

Kebiasaan Makan dan Usia Menarche *pada Siswi Sekolah Menengah Pertama di Provinsi DKI Jakarta Tahun 2023*

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ABSTRACT

Background: The trend of decreasing age at menarche to be younger can impact on physical and psychological health. Nutritional factors, including dietary habits, are important and modifiable predictors of menarche age.
Objectives: To analyze dietary habits' effect on the age at menarche among junior high school students in DKI Jakarta by considering nutritional status, level of physical activity, psychological state, and socio-economic conditions.
Methods: A cross-sectional study was conducted on 420 female students from 15 junior high schools in DKI Jakarta in May 2023. Dietary habits were measured using the Semi-Quantitative Food Frequency Questionnaire, while the age at menarche and other factors were obtained through interviews, questionnaires, weight and height measurements. Data were statistically analyzed through the T Test, Mann Whitney Test, Chi-Square Test, as well as Multivariate Logistic Regression Test.
Results: The age at menarche ranged from 8.92 to 14.33 years, with an average of 11.74 years. Respondents tend to consume carbohydrates, fat, protein, sugar, and salt ≥100% of Recommended Dietary Allowances (RDA). However, 70.7% of respondents had the habit of consuming dietary fiber <100% of RDA. Low fiber diet (<29 g/day) is significantly related to earlier menarche age based on the T-test (p-value=0.006) and logistic regression test after controlling for dietary habits of fat, protein, and salt (p-value=0.047) with OR=0.569 (95% CI 0.325-0.993). The analysis also found that nutritional status and socio-economic conditions were associated with menarche age.
Conclusions: Low fiber diet has a 1.76 times chance of earlier menarche than high fiber diet. A balanced nutritional intake, including vegetables and fruits as source of fiber, is recommended to support adolescent growth and development, puberty, and general health.

INTRODUCTION

Menarche, or the first menstrual period, is the most easily remembered marker of puberty, making it an important event in a woman's life. Menarche is associated with a woman's physical and sexual maturity in term of her ability to ovulate and reproduce[1,2]. Nevertheless, menarche is an indicator that is often not considered in public health[3]. Menarche that occurs at an earlier or later age is not considered a problem by society, and it is even taboo to discuss it. As many as 7 out of 10 parents in Indonesia feel ashamed, uncomfortable, or inappropriate to discuss menstruation, even with their own children[4]. In fact, to cope well with puberty, good preparation is needed from before puberty.

In different countries, the average age of menarche is 11-13 years[5–10]. However, trends over the last decade show that the age at menarche is becoming younger both globally and nationally[6,10–13]. Cohort study in Italy showed a decrease in the age at menarche from 12.40 years in 2010 to 12.07 years in 2022[6]. In Korea, 21.4% of women experienced menarche before the age of 12 in 2001, but this increased to 34.6% in 2010-2011[10]. In Indonesia, data from women born between the 1940s and the 1990s showed a significant one-year decrease in the age at menarche, from 14.4 years to 13.4 years[13]. Early menarche has been reported to have several health consequences, including obesity, hypertension, hypercholesterolemia, cardiovascular disease, asthma, diabetes, and breast cancer[14–18]. Early menarche also opens up the possibility of early pregnancy[15]. On the other hand, later menarche is also known to have health effects, such as the risk of cardiovascular disease, cervical cancer, musculoskeletal disorders, risk of miscarriage, decreased fertility, and early menopause[19,20]. Early or late menarche can also lead to mental and psychological health problems, such as anxiety, stress, and depression[15,19,21].

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The occurrence of menarche is influenced by several factors, including the age at menarche of the mother and sister, socio-economic conditions, general health status, psychosocial conditions, environment, physical activity, and nutritional factors[8,10,22]. Among these factors, nutrition is a modifiable and one of the most important factors in pubertal development[23]. The role of nutritional factors can be seen through the habit of choosing certain foods repeatedly since pre-puberty, because it will determine the nutritional intake needed for growth and development in puberty. From the results of previous research, it is known that the habit of consuming more total fat and animal foods is associated with an earlier age at menarche. Meanwhile, the tendency to choose vegetable protein and fiber intake is associated with later puberty[24,25].

In the Special Capital Region of Jakarta, hereafter referred to as DKI Jakarta, menarche most commonly occurs at the ages of 13-14 years (37.2%) and 11-12 years (30.3%), but there is a fairly wide range of variation in menarche age from 6 to 20 years. DKI Jakarta is also the region with a status equivalent to a province that has the highest percentage of menarche ages 11-12 years and 9-10 years in Indonesia, where this age group is earlier than the average age of menarche in Indonesia, which is 12.96 years[11]. Another study in three provinces also found that the age at menarche was earlier in DKI Jakarta (9-14 years) than in West Nusa Tenggara Province (10-13 years) and East Nusa Tenggara Province (11-15 years)[4]. The earlier average age of menarche in DKI Jakarta was associated with riskier dietary habits compared to the national level. The proportion of consumption habits of sweet foods, salty foods, fatty/fried foods, processed meats, and instant noodles among residents aged 10-14 years in DKI Jakarta exceeds the national proportion. Meanwhile, the average consumption of vegetables in DKI Jakarta is lower than the national average[26]. Risky dietary habits that reflect nutritional imbalances will also indirectly affect the body's metabolism, which has an impact on children's growth and development, including the timing of puberty[27]. This study was conducted to analyze the dietary habits and age at menarche of junior high school students as a group experiencing puberty. It is hoped that the results of this study will provide useful information and recommendations regarding nutritional factors as one of the most important factors that can be modified in reproductive health, especially menarche, which is currently showing a trend toward earlier age of onset in younger people, which can have various health implications.

METHODS

This study was an analytical observational quantitative study with a cross-sectional design. The number of samples was calculated using Lemeshow's hypothesis testing formula for unpaired categorical comparative analytical research and also confirmed using the Slovin's formula, so that the sample was representative and could be generalized to the research population (all female junior high school students in DKI Jakarta). A total of 476 female students from five public junior high schools and ten private junior high schools in five administrative cities in DKI Jakarta were surveyed in May 2023. The sample of junior high schools was selected using a cluster random technique, while the sample of female students for each selected junior high school was randomly selected from female students who had obtained consent from their parents/guardians to participate in the study. Female students with a history of reproductive diseases or hormonal abnormalities/disorders or who had received hormone therapy, and female students who had not yet had menarche or could not remember when they had their first menstrual period were excluded from the study.

This study used primary data for the dependent variable (age at menarche), the independent variable (dietary habits), and other variables studied including nutritional status, level of physical activity, psychological state, and socio-economic conditions. Age at menarche was obtained by subtracting the month and year of the student's first menstrual period from the month and year of birth. The dietary habits studied included the tendency of daily consumption of carbohydrates, fat, and protein as macronutrients, which are consumed in large quantities, as well as the habit of consuming fiber, which is known to be under-consumed, and salt/sodium and sugar, which are consumed in large quantities by adolescents. Dietary habits were measured using a semi-quantitative food frequency questionnaire (Semi-FFQ) with 90 types of foods/drinks commonly consumed by adolescents, calculated using the NutriSurvey application, and confirmed using the Indonesian Food Composition Table 2017[28]. Nutritional status was assessed using the standard anthropometric index, body mass index-for-age (BMI for age), which was obtained by measuring body weight and height and age interviews, then calculated and the results were compared with the standard anthropometric table for assessing nutritional status[29]. Meanwhile, the variable of physical activity level was measured using an adapted questionnaire of the Physical Activity Questionnaire for Adolescents (PAQ-A)[30], and the psychological state as seen from the level of exposure to pornographic content was measured using a modified questionnaire of the Youth Pornography Addiction Screening Test (YPAST)[31]. Socio-economic conditions were measured using a composite indicator of the average monthly family income compared to the 2023 DKI Jakarta Provincial Minimum Wage (UMP)[32] and household ownership of durable goods. Prior to data collection, validity and reliability tests were conducted on the research instruments for the variables of psychological state, socio-economic conditions, and dietary habits.

The study data were processed by editing, coding, processing using a data processing program, and cleaning large extreme data that were too far from the average of the adolescent population. A total of 56 data, which were more than three times the average consumption of adolescents in Indonesia according to previous study[33], were cleaned to make the data distribution and analysis results were more accurate. After cleaning, the final number of data analyzed was 420 female students. Data analysis was performed using univariate, bivariate, and multivariate analysis. This study used a confidence level of 95% and a significance limit (alpha) of 5%, so significance was obtained if the p-value is ≤ alpha from the statistical test results. This research has also received

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a certificate of passing ethical review from the Ethics Committee for Research and Community Health Services, Faculty of Public Health, University of Indonesia, dated May 2, 2023 with number: Ket-175/UN2.F10.D11/PPM.00.02/2023.

RESULTS AND DISCUSSION

The distribution of respondents based on the variables studied can be seen in Table 1 and Table 2. Out of the total 420 respondents whose age ranged from 12.33 to 17.42 years (with a median of 14 years), the mean age at menarche of the respondents was 11.74 years with a variation of 0.97 years. The youngest age at menarche was 8.92 years and the oldest age at menarche was 14.33 years (Table 1). This range of age at menarche is similar to the results of a study conducted by the SMERU Research Institute in 2018, which found that the age at menarche for women in DKI Jakarta ranged from 9-14 years[4]. However, the mean age at menarche in the results of this study (11.74 years) was younger compared to the mean age at menarche for women in Indonesia based on the 2010 Basic Health Survey (Riskesdas), which was 12.96 years[11]. Similarly, with the distribution of age at menarche of respondents in this study, which produced the highest percentage at the age of 11-12 years (Table 2), this data shows a trend of decreasing age at menarche compared to the 2010 Basic Health Survey data, which reported that the age at menarche in DKI Jakarta was at most 13-14 years, and data from the 2017 Indonesian Demographic and Health Survey (IDHS), which found that the age at menarche for most Indonesian women was 13 years[11,12]. The trend toward a younger age of menarche has also been reported in several previous studies at the global and national levels[6,10,13,34]. Earlier age at menarche is often associated with improvements in women's nutrition[2]. Nutrition can affect reproductive maturity by stimulating the gonadotropin hormone, which is responsible for the secretion of reproductive hormones, thereby accelerating puberty[35].

Table 1. Distribution of age at menarche and daily consumption tendencies of junior high school female student in DKI Jakarta in 2023

Variables	Mean	SD	Median	Min	Max	95%CI
Age at menarche (years)	11.74	0.97	-	8.92	14.33	11.65-11.84
Dietary habits						
Carbohydrates (g/day)	-	-	384.5	124	938	-
Fat (g/day)	156.72	64.57	-	35	267	150.72-163.10
Protein (g/day)	-	-	129	37	259	-
Dietary fiber (g/day)	-	-	21	6	62	-
Salt (mg/day)	-	-	1,793.5	113	7,882	-
Sugar (g/day)	-	-	124.5	7	546	-

SD = standard deviation, Min = lowest value, Max = the highest value, 95%CI = 95 percent confidence level

In the variable of dietary habit, the average daily fat consumption of the respondents was 156.72 g with a variation of 64.57 g daily. The trend for daily consumption of other nutrients was explained by the median values, which were 384.5 g of carbohydrates, 129 g of protein, 21 g of dietary fiber, 1,793.5 mg of salt, and 124.5 g of sugar. The results of the study on the dietary habits of junior high school students in DKI Jakarta showed that the majority of female students tended to have high daily consumption of all the nutrients studied, except fiber. Compared with the Recommended Dietary Allowance (RDA)[36] for junior high school age girls (13-15 years old), the median daily consumption of the respondents exceeded 100% of the RDA for sugar (249%), protein (198%), carbohydrates (128%), and salt (119%). Similarly, the respondents' average daily fat consumption was 224% of the RDA. This finding follows the 2018 Basic Health Survey report on the proportion of adolescents aged 10-14 years consuming sugary foods and drinks, salty foods, fatty foods, and processed meat/chicken/fish, which was high in DKI Jakarta, exceeding the national proportion[26]. However, this study found otherwise in terms of dietary fiber consumption habits, with a median of 21 g/day or only about 72% of the RDA[36] for girls aged 13-15 years, and respondents even found that their daily fiber consumption was only 6 g/day (21% of the RDA). In line with this, data form the 2018 Basic Health Survey reported that the proportion of the adolescents aged 10-14 years old in DKI Jakarta with the habit of consuming less than or equal to two servings of vegetables and fruits per day exceeded the national proportion, with 21.3% of adolescents aged 10-14 years old not including vegetables and fruits in their daily diet[26]. Excessive intake of carbohydrates, fat, protein, salt, and sugar as well as insufficient dietary fiber, may be caused by an unbalanced number of portions or frequency of meals and a lack of variety in the food menu. Adolescents often skip breakfast and eat more snacks[37]. In fact, 49.7% of female students often skip breakfast and 56.2% of female students consume fast food at least once a week[38]. Fast food, which is popular among teenagers, also contributes to high intakes of carbohydrates, fat, protein, sugar, and salt as well as low intake of dietary fiber due to unbalanced nutrient content[35].

Table 2. Distribution of age at menarche, nutritional status, level of physical activity, psychological state, and socio-economic conditions of junior high school female students in DKI Jakarta ini 2023

Variables	Frequency	Percentage (%)
Age at menarche		
<10 years	18	4.29
10-<11 years	64	15.24

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Variables	Frequency	Percentage (%)
11-<12 years	156	37.14
12-<13 years	135	32.14
13-<14 years	45	10.71
≥14 years	2	0.48
Nutritional status		
Obese	37	8.8
Overweight	70	16.7
Normal	296	70.5
Thinness	16	3.8
Severely thinness	1	0.2
Level of physical activity		
Low	219	52.1
Medium	194	46.2
High	7	1.7
Psychological state (exposed to pornographic content)		
High level	6	1.4
Medium level	58	13.8
Low level	356	84.8
Average monthly family income		
>2x DKI Jakarta Provincial Minimum Wage in 2023	123	29.3
1-2x DKI Jakarta Provincial Minimum Wage in 2023	170	40.5
< DKI Jakarta Provincial Minimum Wage in 2023	127	30.2
Household ownership of durable goods		
Top wealth quartile	113	26.9
Upper middle wealth quartile	110	26.2
Lower middle wealth quartile	89	21.2
Bottom wealth quartile	108	25.7
Socio-economic conditions		
High	145	34.5
Medium	139	33.1
Low	136	32.4

Analysis between dietary habits and age at menarche, which was categorized based on the age at menarche of most women in Indonesia according to 2017 IDHS data (12.4 years)[12], was conducted using the Mann-Whitney Test for carbohydrate, protein, fiber, salt, and sugar consumption habits. Meanwhile, the bivariate analysis between fat consumption habits and age at menarche used the independent T-test (Table 3). The relationship between other categorical variables and age at menarche was analyzed using the chi-squared test, and the results are shown in Table 4. In this study, the analysis was also conducted using the multivariate logistic regression test with a predictive model to analyze the pure influence of the independent variables on age at menarche of junior high school students in DKI Jakarta in 2023. The multivariate logistic regression test produced three variables that were significantly related to the age at menarche, namely dietary fiber consumption habits, nutritional status (all categories), and socio-economic conditions (for the high and low categories). Apart from this, it is known from statistical tests that the variables of fat, protein, and salt consumption habits were confounding variables in the relationship between dietary fiber consumption habits, nutritional status, socio-economic conditions, and age at menarche (Table 5).

Table 3. Distribution of dietary habits and age at menarche of junior high school female students in DKI Jakarta in 2023

Dietary habits	Age at menarche								p
	Early (<12,4 years)				Late (≥12,4 years)				
	n	Mean	SD	Mean Rank	n	Mean	SD	Mean Rank	
Carbohydrates	304	-	-	200.28	116	-	-	237.29	0.005*
Fat	304	151.51	63.54	-	116	171.07	65.38	-	0.005**
Protein	304	-	-	200.98	116	-	-	235.45	0.009*
Dietary fiber	304	-	-	200.55	116	-	-	236.58	0.006*
Salt	304	-	-	204.83	116	-	-	225.36	0.121
Sugar	304	-	-	203.65	116	-	-	228.46	0.061

n = number of respondents, SD = standard deviation, p = probability value, * = significant by Mann Whitney test, ** = significant by independent T-test

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Table 4. Distribution of nutritional status, level of physical activity, psychological state, socio-economic conditions, and age at menarche of junior high school female students in DKI Jakarta in 2023

Variables	Age at menarche				Total		p	OR**
	Early (<12,4 years)		Late (≥12,4 years)					
	n	%	n	%	n	%		
Nutritional status								
Obese and overweight	93	86.9	14	13.1	107	100		Ref
Normal	203	68.6	93	31.4	296	100	0.000*	3.043
Thinness and severely thinness	8	47.1	9	52.9	17	100		7.473
Level of physical activity								
Low	154	70.3	65	29.7	219	100		Ref
Medium	144	74.2	50	25.8	194	100	0.480	0.823
High	6	85.7	1	14.3	7	100		0,395
Psychological state (exposed to pornographic content)								
High and medium level	48	75	16	25	64	100	0.721	1.172
Low level	256	71.9	100	28.1	356	100		
Socio-economic conditions								
High	116	80	29	20	145	100		Ref
Medium	105	75.5	34	24.5	139	100	0.001*	1.295
Low	83	61	63	39	136	100		2.554

n = number of respondents, % = percentage of respondents, p = probability value, OR = Odds Ratio, * = significant by chi-squared test, ** = OR for nutritional status, level of physical activity, and socio-economic conditions was obtained from the Exp(B) value in the simple logistic regression test

Table 5. The final multivariate modeling (multivariate logistic regression test) in the analysis of dietary habits and age at menarche of junior high school female students in DKI Jakarta in 2023

Variables	B	p	OR (95%CI)
Fat consumption habits	1.724	0.137	5.607 (0.579-54.310)
Protein consumption habits	-2.131	0.067	0.119 (0.012-1.159)
Dietary fiber consumption habits	-0.565	0.047*	0.569 (0.325-0.993)
Salt consumption habits	0.283	0.330	1.327 (0.751-2.344)
Nutritional status (obese and overweight)	-	0.000*	-
Nutritional status (normal)	1.109	0.001*	3.032 (1.616-5.690)
Nutritional status (thinness and severely thinness)	1.937	0.001*	6.941 (2.219-21.708)
Socio-economic conditions (high)	-	0.007*	-
Socio-economic conditions (medium)	0.193	0.515	1.213 (0.678-2.171)
Socio-economic conditions (low)	0.836	0.003*	2.307 (1.323-4.023)

B = beta coefficient, p = probability value, OR (95%CI) = Odds Ratio with a 95 percent confidence level, * = significant by multivariate logistic regression test

A significant association between dietary fiber consumption habits and age at menarche was found by bivariate (p-value=0.006) and multivariate (p-value=0.047) tests after controlling for fat, protein, and salt consumption habits. The analysis also yielded an Odds Ratio (OR) value of 0.569 (95%CI 0.325-0.993) in the multivariate test. This OR value is interpreted to mean that female students with a low dietary fiber intake based on 100% of RDA (<29 g/day) are 1.76 times more likely to experience early menarche than female students with a high dietary fiber intake (≥29 g/day). These findings are consistent with previous prospective study in Canada which found that dietary fiber and cellulose intake during the prepubertal period was associated with a later age at menarche[39]. Dietary fiber intake influences pubertal development by reducing the availability of circulating estrogen levels in the body, with higher prepubertal estrogen levels predicting a pubertal growth spurt. One possible mechanism that occurs is that increased dietary fiber intake is thought to increase fecal excretion of estrogen along with fiber, thereby affecting pubertal development, including later menarche[24,39].

The analysis between nutritional status and age at menarche showed that lower nutritional status was associated with a greater likelihood of later menarche. This finding is consistent with the results of several other studies that have found an inverse correlation between body mass index (BMI) and age at menarche[5–8,13,34]. A higher BMI, due to heavier body weight, can lead to disturbances in fat levels in the body, while fat acts as a producer of estrogen, which contributes to earlier onset of menarche[40]. Socio-economic conditions were also significantly associated with age at menarche in this study, with the risk of menarche being approximately twice later in the low socio-economic conditions category as in the high socio-economic conditions category. This is consistent with other studies that have also found an inverse correlation between socio-economic conditions and age at menarche, with the explanation that families with low socio-economic status cause malnutrition in children, which can lead to delayed menarche[20,22].

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Carbohydrate intake was significantly associated with age at menarche in bivariate analysis (p-value=0.000), but there was no association between the two in multivariate analysis. These findings are consistent with studies in England[41] and East Java Province[37] which also reported no association between carbohydrate intake and age at menarche. A meta-analysis study in 2022 also concluded that there was no relationship between carbohydrate intake and puberty[42]. A high carbohydrate diet is often associated with an earlier onset of menarche because carbohydrate intake can cause weight gain and an increase in BMI, which are known to be associated with earlier menarche. However, carbohydrates have also been found to delay the onset of menarche because carbohydrates suppress estradiol in the formation of estrogen, so they may interfere with estrogen metabolism, which plays a role in menarche[43]. From these two contradictory explanations, it can be concluded that carbohydrates are not directly related to the onset of menarche and there are other factors that influence it.

The results of the bivariate analysis between the dietary habits for fat and the age at menarche showed a significant relationship (p-value=0.005). The late menarche group had a higher average daily fat intake (171.07±65.38 g) compared to the early menarche group (151.51±63.54 g). This finding is different from the study in West Kalimantan Province, which found that high fat intake was significantly associated with earlier menarche[44]. Contrary to the bivariate test result, the multivariate test in this study showed no significant relationship between fat intake and age at menarche. This is consistent with the result of a meta-analysis study by Tang *et al.*[42], which also found no association between fat intake and pubertal timing. Meanwhile, several other studies have found statistical significance in the relationship between fat intake and age at menarche because fat intake is thought to have a potential influence on estrogen metabolism through the mechanism of converting fat in the body to cholesterol as a component in the formation of the hormone estrogen[37,44]. However, different types of fatty acids have different effects on pubertal development. Polyunsaturated fatty acids (PUFA) have been associated with the earlier onset of menarche, while monounsaturated fatty acids (MUFA) have been associated with later onset of menarche[42,43]. The different effects of different types of fatty acids on age at menarche allow for different results, including no relationship, between fat consumption habits and age at menarche, as in the results of this study.

The bivariate analysis showed an association between protein consumption habits and age at menarche (p-value=0.009), but no association was found in the multivariate tests. These findings are consistent with a study in the United States that found that the habit of consuming protein consumption from milk and meat after the age of nine was not associated with age at menarche[45]. A cohort study in England also found no association between protein intake, especially vegetable protein, and age at menarche[41], as did a study in East Java Province, which found no association between protein intake and age at menarche[37]. The lack of association between protein intake habits and age at menarche in this study may be due to the fact that protein intake seen from both animal protein and vegetable protein which have the opposite effects on age at menarche, possibly allowing mutually canceling effects. The habit of consuming animal protein is known to be associated with earlier menarche[23,25], whereas high protein intake in the prepubertal period is associated with delayed menarche[25,46]. However, the relationship between protein intake and age at menarche is not a direct one, but is influenced by many mediating factors. Dietary protein intake measured around puberty or later also has less effect on menarche than dietary intake during early childhood[45].

Dietary salt intake was not significantly associated with age at menarche by either bivariate or multivariate tests. The lack of association between salt intake and age at menarche is consistent with the study in West Kalimantan Province[44] but a study in the United States on the effects of dietary salt on the onset of puberty in mice found that mice fed a high-salt diet experienced delayed puberty compared with mice fed on a low-salt[47]. Differences in the results of analyses of the relationship between salt intake and the onset of menarche may be due to the fact that the mechanism of the effect is not fully understood. It is thought that the influence of salt intake on puberty occurs through several indirect mechanisms, including salt-induced metabolic changes that may affect the reproductive axis[47,48]. Another theory of how the body regulates salt levels is that high salt intake generally stimulates thirst, increasing fluid consumption and also increase the amount of salt excreted in the urine. To affect the mechanism of puberty, a certain concentration of salt is required, which may not have been achieved by regulating salt levels in the body. This causes variations in the relationship between salt intake and age at menarche, including the absence of a relationship between them[49].

The results of the analysis of the relationship between sugar intake and age at menarche showed that there was no significant association between the two. These results are consistent with the study in West Kalimantan Province, which concluded that no relationship between sugar intake and age at menarche[44]. However, this is not consistent with prospective studies in the United States which found that sugar consumption was positively associated with the risk of early menarche[50,51]. The mechanism of the direct effect of sugar intake on age at menarche is not yet known. It is thought that the ingestion of sugary foods/beverages acts through the rapid release of insulin, which is known to reduce sex hormone-binding globulin. Large changes in circulating sex hormones levels may trigger early menarche[50]. However, this study also found that a decrease in the age of menarche was associated with beverages with added sugar/sweeteners, but the consumption of foods/beverages with a naturally sweet taste, such as fruit, was not associated with menarche. Natural sweeteners generally have a lower glycemic index than artificial sweeteners and are thought to have different metabolic effects, so they do not affect age at menarche[50]. In this study, sugar intake was assessed by estimating daily consumption trends of 22 sweet foods and beverages, including sweet *martabak* (stuffed

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pancake), donuts, chocolate, candy, jelly, ice cream, sweetened tea/coffee/milk, fruit juice, packaged beverages, carbonated drinks, as well as sweet yogurt drinks. These various sweet foods or beverages contain different types of sugar. The combination of various types of sweet foods and beverages in this study may result in varied or inconsistent interaction effects in the relationship between sugar intake and age at menarche and no significant relationship between sugar intake and age at menarche.

The strength of this study is that the number of samples that were included in the analysis was quite large, with a total of 420 samples. The sample selection was proportionally based on schools representing five administrative cities in DKI Jakarta, where these five cities contributed the largest number of junior high school female students at the provincial level. Therefore, the study results can be generalized to the population and provide an overview of the state of dietary habits and age at menarche among junior high school students in DKI Jakarta in 2023. However, this study also has several limitations, one of which is that the data on dietary habits obtained from the Semi-FFQ only included certain types of foods or beverages that were included in the questionnaire, so it may not cover all dietary intake. In addition, the Semi-FFQ used only recorded the dietary habits of the respondents in the last three months, so there was a possibility of changes in dietary habits from the preceding period. Another limitation is that there is the possibility of the flat slope syndrome occurring, which is a tendency for over-reporting in thin respondents and under-reporting in obese respondents. In terms of study design, cross-sectional studies do not examine dietary habits during prepuberty, which may be an important exposure period in determining age at menarche. Study limitations that may arise from the respondent's side are the recall bias in answering questions on the study instrument and the possibility that respondents may conceal the actual situation, such as in psychological state questionnaires.

CONCLUSIONS

In general, the daily consumption of carbohydrates, fat, protein, salt, and sugar by the majority of junior high school students in DKI Jakarta tends to be high, exceeding 100% of the RDA. On the contrary, the daily consumption of dietary fiber is less than 100% of the RDA. Based on the analysis performed, the habit of consuming dietary fiber was significantly related to the age at menarche, after controlling for the habit of consuming fat, protein, and salt, which is female students with the habit of consuming low dietary fiber had a 1.76 times greater chance of experiencing menarche earlier compared to female students who had the habit of consuming high fiber. In addition, nutritional status and socio-economic conditions were associated with the age at menarche among junior high school female students in DKI Jakarta.

The results of this study can be used as an evaluation and reference for formulating nutrition intervention policies, including health promotion and monitoring for existing prog involving all stakeholders. Education related to a balanced nutritious diet and instilling good consumption habits can be conducted at school and community level, especially in families with prepubertal girls. Consumption of a variety of foods, including vegetables and fruits as a source of dietary fiber, should be made a habit, as low fiber intake is associated with earlier menarche, which has several health impacts. The increasingly younger average age at menarche also needs to be addressed in order to prepare adolescents for puberty and prevent the possibility of early pregnancy. Further studies on dietary habits and age at menarche can be conducted by addressing the limitations of this study.

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Author Contributions

SC: conceptualization, data curation, formal analysis, investigation, methodology, validation, writing-original draft, writing-editing; AS: conceptualization, formal analysis, methodology, validation, supervision, writing-review; SF: conceptualization, methodology, supervision, writing-review.

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