

Original Article

The Relationship Between Nutritional Status, Vegetable Consumption and Physical Activity with Age of Menarche in Adolescent Girls

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Abstract:

Background: Menarche is the first menstrual period and marks the maturity of an adolescent girl's body. In the last decade, there has been an increase in nutritional status of children and adolescents which is often associated with an accelerated age of menarche. Several studies have shown a strong relationship between physical activity, body mass index (BMI) with the age at which menarche occurs in teenage girls. The habit of consuming certain foods such as meat and fast food is proven to accelerate the age of menarche due to an increase in fat levels. This study aims to evaluate the relationship between age of menarche with BMI, physical activity, and vegetable consumption.

Methods: This research was conducted using cross-sectional study design. Participants had been filtered by inclusion criteria and exclusion criteria. Selected participants then had their height and weight measured, and filled out an online questionnaire regarding menarche and physical activity. Participants also underwent a 24-hour recall interview to determine their vegetable consumption.

Results: Fifty-two participants were recruited in this study. Most of them were 12 and 13 years of age (42.3% each). Based on the results of Kruskal-Wallis test, there was no relationship between age of menarche and BMI ($p = 0.071$), between age of menarche and physical activity ($p=0.251$) and between age of menarche and vegetable consumption ($p=0.753$)

Conclusion: In conclusion, based on the results of this study, we did not find any correlation between the age of menarche and BMI, physical activity and vegetable consumption among adolescent girls in West Java region.

Keywords: children, menarche, nutritional status, physical activity, vegetable consumption

Introduction

Menarche is the first menstrual period and marks the maturity of an adolescent girl's body.¹ Menstruation is a monthly cycle that occurs due to the shedding of the functional lining of the uterine endometrium during ovulation when not followed by fertilization. The average age of menarche varies between different ethnicities and races. Globally, the average age of menarche in adolescents is 12.4 years old.¹ In America, the average age of menarche is 12.43 years old while in Asian regions such as Hong Kong and Japan, the average age of menarche is 12.38 and 12.2 years old respectively.^{2,3} Meanwhile, in Indonesia, the average age of menarche is 12.96 years old.⁴

Several studies have shown a strong relationship between physical activity, body mass index (BMI), socio-economic factors, and the mother's history of menarche with the age at which menarche occurs in teenage girls. Furthermore, the habit of consuming certain foods such as meat and fast food is proven to accelerate the age of menarche due to an increase in fat levels.⁵ On the contrary, consuming fruits and vegetables are known to be able to delay the onset of menarche.⁶ The way foods influencing the age of menarche is thought to be due to estrogen hormone in the hypothalamus-hypophysis axis (HPA) that is easily affected by nutritional status of an individual. Furthermore, the HPA axis is also influenced by the body's fat percentage which is reflected by the BMI. Therefore, the BMI of an adolescent girl is strongly correlated with earlier age of menarche. Higher body's fat percentage is associated with higher serum leptin hormone level which also correlated with the age of menarche.⁷ On the other hand, physical activity is an effective way to reduce fat mass and therefore may suppress the reproductive function and delay the onset of menarche.⁸

In the last decade, there has been an increase in nutritional status of children and adolescents which is often associated with an accelerated age of menarche.¹ In Indonesia, the age of menarche in adolescents is occurring earlier from time to time. The average age of menarche for female adolescents in Indonesia between 1961-1965 period was 14.43 years old. However, after 1970, this figure decreased steadily from 14.43 to 13.63 years old in 2010. It is predicted that the average age of menarche will continue to decrease with the rate of 0.0245 years annually.⁹

Meanwhile, according to the 2007 *Survey Data Kependudukan Indonesia* (SDKI), the number of early marriage cases in Indonesia reached 50 million people with West Java being one of the provinces with the highest rate of early marriage with an astonishing rate of 36%.¹⁰ The decreasing age of menarche has increased the tendency for early marriage which is also associated with numerous health risks. Early marriage can result in several health impacts such as early pregnancy, sexually transmitted diseases and sexual violence. Moreover, early pregnancy can also negatively impact the health and

increase the risk of pregnancy, such as ectopic pregnancy, low birth weight babies and premature babies.⁹ Therefore, the age of menarche for adolescent girls in Bandung Regency needs more attention. Moreover, early age of menarche (menarche before 12 years of age) is correlated with adiposity, metabolic syndrome, and an increased risk of breast cancer. This is partly caused by increased exposure to estrogen in life.¹¹ Early or late menarche is also associated with an increased risk of experiencing coronary heart disease.¹² However, the majority of the population of Bandung Regency is from the Sundanese tribe who have a penchant for eating fresh vegetables. Fresh vegetables are vegetables that can be consumed raw or cooked after eating the main meal. This habit can affect BMI and also slow down the age of menarche, thereby overcoming the concerns about the trend of accelerating age of menarche.¹³ Therefore, research is needed to obtain the average age of menarche of adolescent girls living in Bandung Regency. This study also aims to evaluate the relationship between age of menarche with BMI, physical activity, and vegetable consumption.

Methods

This research was conducted using cross-sectional study design. Participants had been filtered by inclusion criteria and exclusion criteria. Selected participants then had their height and weight measured, and filled out an online questionnaire regarding menarche and physical activity. This was done to determine the nutritional status, physical activity and age at menarche of the subject. After that, participants underwent a 24-hour recall interview to determine their vegetable consumption. The data collection process was carried out following the COVID-19 protocol in Indonesia as this study was conducted during the pandemic era. This study was conducted at several primary and middle high schools in Bandung, West Java, Indonesia from February to September 2021.

Inclusion criteria were adolescent girls aged 9-15 years who were attending primary high school class 5,6 or secondary high school class 7 and who experienced menarche within 13 months prior to the study. Participants also agreed to participate in this study by signing the informed consent form. Exclusion criteria were adolescent females with chronic diseases or consuming any drugs that may interfere with normal menstrual cycle and those with precocious puberty.

Nutritional status was determined based on the Center for Disease Control and Prevention (CDC) growth chart classification. If the Waterloo classification of body weight was more than 110% of the ideal body weight then the Body Mass Index Chart was used to determine the nutritional status of the participants. Nutritional status was classified based on BMI-for-age chart with the following classification: participants with BMI value within 5th-85th percentiles were categorized as good nutritional status, those who were below 5th percentiles were categorized as wasted and those above 85th

percentiles were categorized as overweight/obese. Physical activity was classified as following: good physical activity when respondents exercised at least 60 minutes of moderate or vigorous activity per day, insufficient physical activity was defined when respondents exercised less than recommended and poor physical activity was defined when respondents did not exercise at all.^{14, 15} Vegetable consumption was categorized as following: good vegetable consumption when respondents consumed at least 2 cup of vegetable per day, insufficient vegetable consumption when respondents consumed less than 2 cup of vegetable per day and poor vegetable consumption when respondents did not consume any vegetable at all based on 24-hour food recall questionnaire.¹⁶

Statistical analysis was conducted by using SPSS version 24.0. Data were first analyzed to obtain an overview of demographic data as well as the factors that might influence the age of menarche. Then, bivariate data analysis was carried out on the dependent variable and independent variables to see the relationship between BMI, physical activity, and vegetable consumption habits with the age of menarche. Bivariate data analysis was carried out using the Kruskal-Wallis test because the data distribution was not normal.

Results

Fifty-two participants were recruited in this study. Most of them were 12 and 13 years of age (42.3% each). Most participants' father and mother were high school graduate (57.7% and 59.6% respectively). Mean age of menarche from all participants was 11.4 years with minimum age of 9 years and 13.7 years. Baseline characteristics of all participants were presented in **Table 1**.

Table 1. Baseline characteristics of participants

Variables	Frequency (n (%))
Age (years)	
10	1 (1.9)
11	7 (13.5)
12	22 (42.3)
13	22 (42.3)
Father's education level	
Primary school	1 (1.9)
Middle high school	6 (11.5)
Senior high school	30 (57.7)
Bachelor	15 (28.8)
Mother's education level	
Primary school	0 (0)
Middle high school	6 (11.5)

Senior high school	31 (59.6)
Bachelor	15 (28.8)
Parents' occupation	
Unemployed	7 (13.5)
Private employees	38 (73.1)
Government employees	7 (13.5)
Parental income	
Under 1,990,000 rupiah	15 (28.8)
Above 1,990,000 rupiah	37 (71.2)

Based on BMI classification, 33 participants (63.4%) had good nutritional status, 6 participants (11.5%) were wasted and 12 participants (23.1%) were overweight/obese. Meanwhile, based on physical activity classification, 43 participants (82.6%) were classified as insufficient physical activity, 5 participants (9.6%) were classified as poor physical activity and only 3 participants (5.8%) had good physical activity. On the other hand, only 46 patients underwent 24-hour food recall to determine the amount of vegetable consumed. Twenty-one participants (45.6%) were classified as insufficient vegetable consumption, 17 (36.9%) participants were classified as poor vegetable consumption and only 8 (4.3%) participants were classified as good vegetable consumption.

In this study, several statistical tests were performed. First, in order to assess the normality of the data, the Kolmogorov-Smirnov test was carried out. In this study, the normality test value obtained was $p = 0.000$ for numerical data, including data on age of menarche. This value indicated that the distribution was not normal. Next, statistical tests were carried out to assess the relationship between age of menarche as the dependent variable and several independent variables such as BMI, physical activity and vegetable consumption. Each of these independent variables was categorized into 3 categories. Therefore, to assess each relationship between the dependent and independent variables with abnormal data distribution, the Kruskal-Wallis test was conducted. Bivariate analysis results were presented in **Table 2**.

Table 2. Bivariate analysis between age of menarche and several independent variables.

Variables	Frequency (n (%))	p-value
Body mass index		
Wasted	6 (11.5)	0.071
Good	33 (63.5)	
Overweight/obese	12 (23.1)	
Physical activity		
Poor	5 (9.6)	0.251

Insufficient	43 (82.7)	
Good	3 (5.8)	
Vegetable consumption		
Poor	17 (32.7)	
Insufficient	21 (40.4)	0.753
Good	8 (15.4)	

Based on the results of Kruskal-Wallis test regarding the relationship between age of menarche and BMI, the results were $p > 0.05$, indicating no significant difference ($p = 0.071$). **Figure 1** depicts the correlation between age of menarche and BMI based on the results obtained from each sample with inclusion criteria. Next, Mann-Whitney analysis was performed to evaluate whether there was a difference of age of menarche between two BMI groups. Based on the results, there was no significant difference of the age of menarche between participants in normal BMI group and wasted group, nor the age of menarche in the normal BMI group and overweight/obese group ($p = 0.051$).

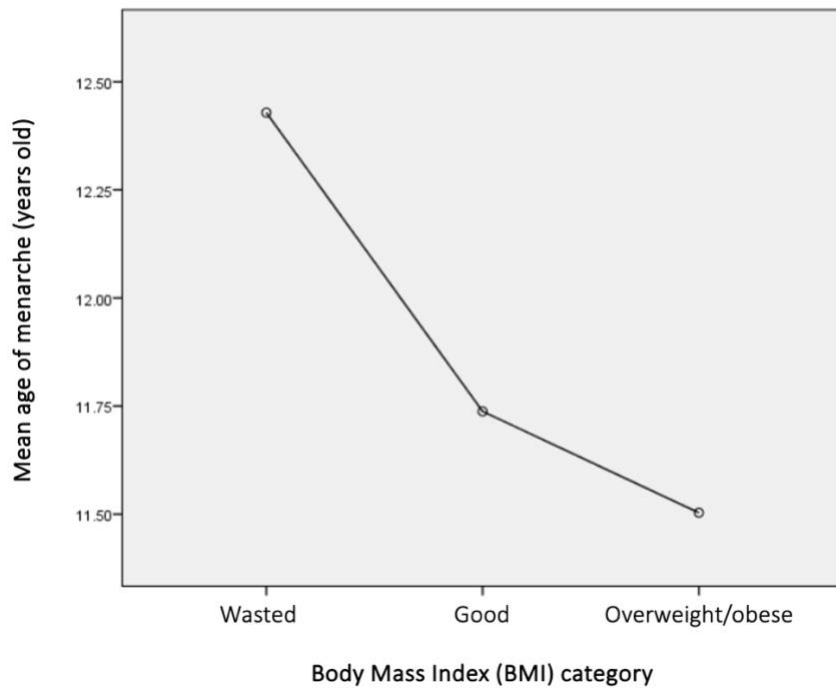


Figure 1. Correlation between age of menarche and body mass index category.

Based on the results of Kruskal-Wallis test, there was no significant relationship between age of menarche and physical activity ($p=0.251$). **Figure 2** illustrates the correlation between age of menarche and physical activity. In theory, physical activity

can reduce the acceleration of the age of menarche because it can reduce BMI. However, based on Chi-Square analysis, it was found that respondents with good physical activity had a higher BMI. However, this result was not statistically significant ($p = 0.443$).

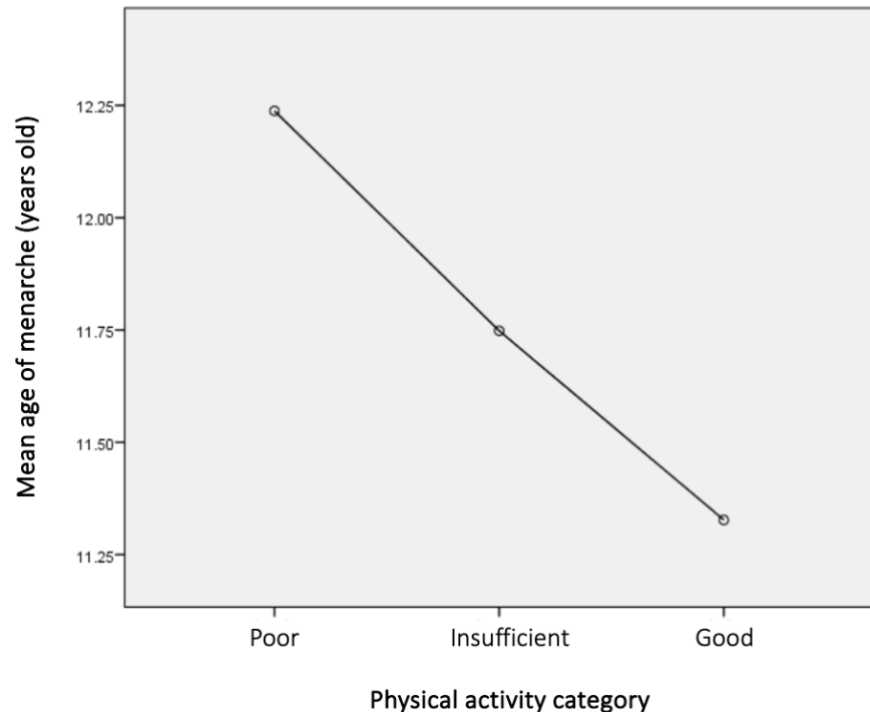


Figure 2. Correlation between age of menarche and physical activity category.

Figure 3. depicts the correlation between age of menarche and vegetable consumption. There was a trend that showed respondents who consumed at least 2 cups of vegetable experienced menarche at earlier age compared to those with insufficient or poor vegetable consumption.

To evaluate whether there was a relationship between age of menarche and other factors besides the independent variables that were focused in this research, we also conducted Mann-Whitney test to assess the relationship between age of menarche and parental income. Respondents with parents earning more than IDR 1,990,000 had a later age of menarche. From this test, the results obtained were $p > 0.05$ so the results indicated no significantly difference ($p = 0.777$).

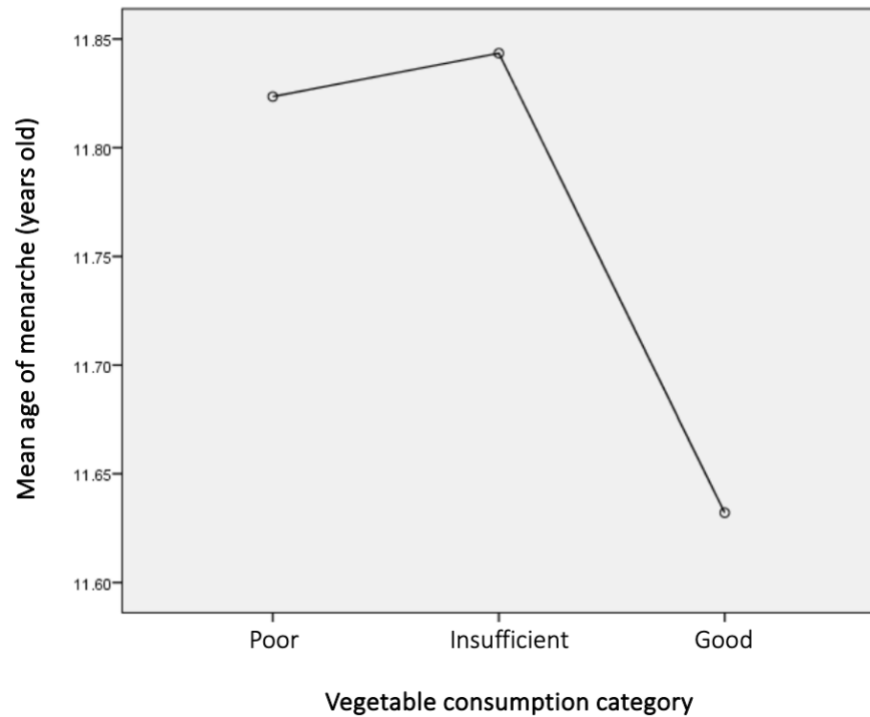


Figure 3. Correlation between age of menarche and vegetable consumption category.

Discussion

The age of menarche for adolescent girls in Indonesia is occurring earlier from time to time. The increasingly early age of menarche can escalate the tendency for early marriage as well as the various health risks it poses. Several factors are known to influence the age at which menarche occurs, including physical activity, body mass index (BMI), and nutrition. The habit of consuming meat and fast food can also accelerate the onset of menarche, due to an increase in fat levels. High levels of fat in the body's adipose tissue cause high blood leptin level which correlates with the occurrence of menarche.⁷ The fat content of adipose tissue is best depicted through BMI measurement. Physical activity can influence the age of menarche by reducing adiposity and decreasing reproductive function. Both of these things occur due to decreasing leptin levels when there is insufficient adipose tissue.⁸

On the other hand, consuming vegetables and fruit can slow down the age of menarche. This occurs due to several mechanisms that may regulate reproductive hormones by consuming more vegetables such as changes in enterohepatic estrogen circulation, reduction of estrogen bioavailability and suppression of gonadotropin production contribute to delayed age of menarche.¹⁷⁻²¹

In this study, we identified one dependent variable, namely age at menarche and three independent variables including BMI, physical activity, and vegetable consumption.

Each of these independent variables is grouped into 3 categories ordinally. From the results of the statistical test analysis in this study, there was no significant relationship between age of menarche and physical activity, BMI, or vegetable consumption.

Based on statistical analysis of BMI and age of menarche in our study, there was a tendency that menarche occurred at earlier age in adolescent girls who had higher BMI. However, this result was not statistically significant ($p > 0.05$). This is further supported by a study conducted by Fitriany et al. in which it was reported that there was no significant relationship between age of menarche and BMI.²² Furthermore, this result is also in line with research conducted by Himes et al. who reported that BMI is not the only factor that determines the age of menarche.²³ Garn et al. and Sherar et al. also stated that there was no clear evidence between body fat mass or body weight and its effect on age of menarche.^{24, 25}

On the other hand, analysis of statistical tests regarding the relationship between age of menarche and physical activity resulted in no significant correlation ($p > 0.05$). This result is in line with research conducted by Khoshnevisasl et al. who also reported no significant relationship between age of menarche and physical activity.²⁶ Furthermore, Tehrani et al. stated that physical activity does not directly affect the age of menarche, but instead, it plays a role in reducing BMI and exert secondary effects on the hypothalamic and pituitary axis.²⁷ Further evaluation in this study revealed that respondents with higher physical activity had lower BMI, although this finding was also not statistically significant ($p = 0.443$).

Statistical test analysis regarding the relationship between age of menarche and vegetable consumption showed different results between the three groups. The group with poor vegetable consumption experienced menarche at an earlier age than the group with less vegetable consumption. This is in accordance with the theory regarding the relationship between vegetable consumption and age at menarche. However, this difference is not statistically significant ($p > 0.05$). Collecting data on vegetable consumption using 24-hour recall interviews can also cause bias due to errors in sample recall. Based on the results, there was no significant relationship between vegetable consumption and the BMI of our participants.

There are similarities between the results of this study and research conducted by Rogers et al., where there was no significant relationship regarding the age of menarche between vegetarian and non-vegetarian teenagers.²⁸ In addition, although some research evidence suggests that vegetables can reduce weight in a short time, there are still inconsistencies in the results obtained.²⁸ A meta-analysis study concluded that the impact of increasing vegetable and fruit intake was miniscule and not significant if there were no instructions to limit energy from other foods. This suggests

that increasing certain foods such as vegetables may not result in weight loss if overall dietary intake is not taken into account.²⁹ Another meta-analysis that independently investigated vegetables consumption did not find any significant association between increased vegetable consumption and weight loss, but there was an association with a reduced risk of adiposity.³⁰

The results of statistical test analysis regarding the relationship between age of menarche and parental income show differences in results between the two groups. The group with parents earning more than IDR 1,990,000 had a later age of menarche and a lower BMI than the group with parents earning less than IDR 1,990,000. However, the results of this relationship analysis were not significant. Theoretically, socio-economic factors in a young woman's family can influence the age of menarche. However, from the results of the analysis the relationship between parental income and children's BMI was not significant ($p > 0.05$). The results obtained from this study are in accordance with research conducted by Afkhamzadeh et al, in which no significant relationship was found between the socio-economic status of the respondent's parents and age at menarche ($p = 0.722$).³¹ This might occur due to parents with higher incomes tend to have broader insight and knowledge, but have less time to discuss and spend time with their children. Meanwhile, parents such as housewives have more free time with their children, and have the opportunity to discuss and also monitor their daughters' nutritional status better.³¹ Apart from that, parents' openness regarding their family's income can influence information about the family's social and economic status. However, other factors may have a greater influence on the age of menarche, such as genetic factors and nutritional status that were not included in this study.

In addition, based on the results of the Chi-Square test analysis, it is known that the sample group with low-income parents has a higher BMI. This is in accordance with research conducted by Morgenstern et al., which concluded that students with lower socio-economic backgrounds have a higher risk of being overweight due to higher television viewing habits.³²

The limitation of this research is the lack of samples used in the statistical test process. The samples obtained were still less than the minimum target sample size required. This occurred due to the ongoing COVID-19 pandemic, so research had to be carried out remotely. The series of research processes carried out remotely also caused for lost to follow up for respondents who have met the inclusion criteria, hence the sample obtained was even fewer. The absence of a relationship obtained from the results of this study is mostly due to the influence of other factors, especially genetic factors, which greatly influence the age of menarche. There is a close relationship found between the age of menarche of mothers and their daughters, and also between

a daughter and her sisters. Other things that certainly influence the age of menarche are socio-economic factors, past illnesses, and also nutritional factors.

Conclusion

In conclusion, based on the results of this study, we did not find any correlation between the age of menarche and BMI, physical activity and vegetable consumption among adolescent girls in West Java region. Furthermore, there was no significant differences of age of menarche between all categorical groups of each BMI, physical activity and vegetable consumption.

In future research, additional respondents should be recruited to meet the minimum standards required. Apart from that, changes should be made to the method of assessing vegetable consumption data as well as extending the period of food recall, in order to better reflect vegetable consumption habits. Furthermore, future research should also consider controlling other factors that can influence the age of menarche. Study design should also be improved to a more long-term study, such as by using randomized controlled trial or cohort design. We also suggest that data collection in further research should be performed offline, so that researchers can interact directly with respondents and increase their compliance in filling in the required data.

From this study, we suggest that the government should increase public awareness of vegetable consumption and physical activity among the community. Because although in this study there were no significant results between age of menarche and BMI, physical activity and vegetable consumption, these three things certainly need to be considered to achieve overall physical health.

Conflict of Interest

None declared.

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