



The Relationship Between Body Mass Index and Age of Menarche in Adolescents in the Working Area of The Gogagoman Public Health Center

Pratiwi Aristania Junus¹, Rifzul Maulina^{2*}

¹⁻² Institut Teknologi Sains dan Kesehatan RS dr Soepraoen, Indonesia

*Corresponding Author: rifzulmaulina@itsk-soepraoen.ac.id

Abstract: Menarche is the first menstrual period in a woman's life and marks the end of puberty, occurring around the age of 12-14. Early menarche is associated with several factors, including nutritional status, genetics, socioeconomic status, hormonal status, and exposure to adult mass media. This study aims to determine the relationship between Body Mass Index (BMI) and age of menarche among adolescents in the Gogagoman Community Health Center (Puskesmas). This study used a cross-sectional survey approach conducted on 55 female students who experienced menarche in January 2025, using the Kolmogorov-Smirnov test. Most respondents were from Banda Sakti District, with the highest age being 13 years old and among them in grade VII. Most respondents had a normal BMI and age of menarche within normal limits. Based on the Kolmogorov-Smirnov test, a p-value of 0.992 was obtained for the relationship between BMI and age of menarche. The conclusion is that there is no relationship between BMI and age of menarche among adolescents in the Gogagoman Community Health Center.

Keywords: Adolescents; Age of Menarche; Body Mass Index (BMI); Menarche; Nutritional Status.

1. INTRODUCTION

Several risks of hormone-related diseases, such as breast cancer¹, endometriosis², type 2 diabetes mellitus³, metabolic syndrome⁴, and cardiovascular disease⁵, are associated with a decreased age at menarche. These risks indicate that age at menarche is an important factor in health planning programs, such as providing health facilities and information related to menarche in junior high schools (SMP) and maximizing Adolescent Health Services (PKPR) in every school⁶.

Menarche is the first menstruation and marks the end of puberty. It is the most memorable indicator and event in a woman's sexual maturity⁴. Menarche occurs at 12 to 14 years of age, or 2 to 3 years after the onset of secondary sex characteristics (thelarche). The average age at menarche is 12.8 years, but in recent decades the average age at menarche has decreased⁷.

Research in industrialized countries in the Americas and Europe in the early 20th century found a decrease in the age at menarche of 2 to 3 months per decade. The average age of menarche in the United States, from before 1900 to 1988, was over 14 years, and by 1994, it had decreased to 12.43 years. The average age of menarche in Europe was 15 years for those born between 1880 and 1890 and 12 years for those born between 1970 and 1980.

The youngest age of menarche in Indonesia was 9 years, and the oldest was 18 years. The average age of menarche in Indonesia was 12.96 years, with proportions of 12-year-olds (31.33%), 13-year-olds (31.30%), and 14-year-olds (18.24%). The lowest average age of menarche was in Yogyakarta at 12.45 years, and the highest in Kupang at 13.86 years. The

average age of menarche in Banda Aceh is 69.5%, 12 to 13 years, 10.9% for girls under 11, and 19.6% for girls over 13.11

The increasingly earlier age of menarche is due to global improvements in nutrition and health from the mid-1800s to the mid-1900s.¹² The nutritional and health status of adolescent girls can be determined by their Body Mass Index (BMI). An increasingly earlier age of menarche has been associated with an increase in BMI. Earlier age of menarche is more common in girls with a high BMI than in girls with a normal BMI or who are underweight. The decline in age of menarche, not found in underweight girls, also supports evidence that BMI is the strongest factor causing a decrease in age of menarche.¹³

The National Health and Nutrition Examination Survey (NHNES) found that the BMI categorized as obese worldwide continued to increase, from approximately 9.4% to 14.5% in NHANES I (1971 to 1974), to 22.5% in NHANES II (1976 to 1980), to 30% in NHANES III (1988 to 1994), and to 30% in the 1999-2000 survey. The National Health and Nutrition Examination Survey IV (2007 to 2008) in the United States found that 34.2% of the population was overweight and 33.8% obese.

The average BMI in the United States from 2009 to 2010 was 28.7 kg/m². The average obesity rate among women was 35.8%. Surveys in Taiwan and Hong Kong showed that one in four children had a BMI categorized as obese. The International Diabetes Federation (IDF), as cited in Anggelia and Kusmaedi (2017),¹⁷ estimates that the number of obese individuals worldwide by 2025 will reach approximately 380 million, with more than half of those living in Asia. One example is China, which experienced a 15% increase in BMIs in the overweight and obese categories between 1980 (3.7%) and 2002 (19%). In seven provinces in Indonesia, BMIs varied from 18.6 to 19.5 kg/m², which is considered normal.¹⁰ The average BMI in Indonesia, especially in Manado, is underweight at 29.1%, normal at 51.5%, and overweight at 19.4%.¹⁸ Putra, Ermawati and Amir (2016) on the relationship between BMI and age of menarche in female students of SMP Negeri 1 Padang found that 27 (35.1%) respondents had a BMI in the thin category, 47 (61%) in the normal category, and 3 (3.9%) in the obese category with a p value = 0.000 (p < 0.05) and r = -0.429. The results of this study indicate that the higher the BMI, the earlier the menarche occurs.

2. RESEARCH METHOD

This study was an observational analytical study with a cross-sectional approach. The study population was all female students in the Gogagoman Community Health Center (Puskesmas) working area. The study was conducted from February to October 2025. The sampling technique used total sampling, resulting in 55 female students as respondents. The sample was taken based on those who met the following inclusion and exclusion criteria: 1) Respondents were junior high school students in grades VII to IX; 2) Respondents experienced menarche within the last month, starting from January 1, 2025; 3) Respondents were willing to participate in the study. Exclusion criteria were: 1) Respondents were absent during the study (on leave, sick leave); 2) Respondents had a medical diagnosis such as chronic diseases (breast cancer and metabolic syndrome), autoimmune diseases (Grave's disease and systemic lupus erythematosus), or long-term treatment (steroid use and chemotherapy).

The study variables were BMI as the independent variable and age at menarche as the dependent variable. The instrument used was a questionnaire to determine the age of menarche and to align the exclusion and inclusion criteria. Body weight and height were measured using a GEA scale and microtoise to obtain BMI values. This study used the Chi-Square test with an alternative test, the Kolmogorov-Smirnov test. If the test results show a p-value <0.05 , then there is a significant relationship between the two variables, whereas if the p-value >0.05 , there is no significant relationship between the two variables.

3. RESULTS AND DISCUSSION

Respondent Characteristics

Frequency Distribution of BMI in Junior High School Students in the Gogagoman Community Health Center Work Area

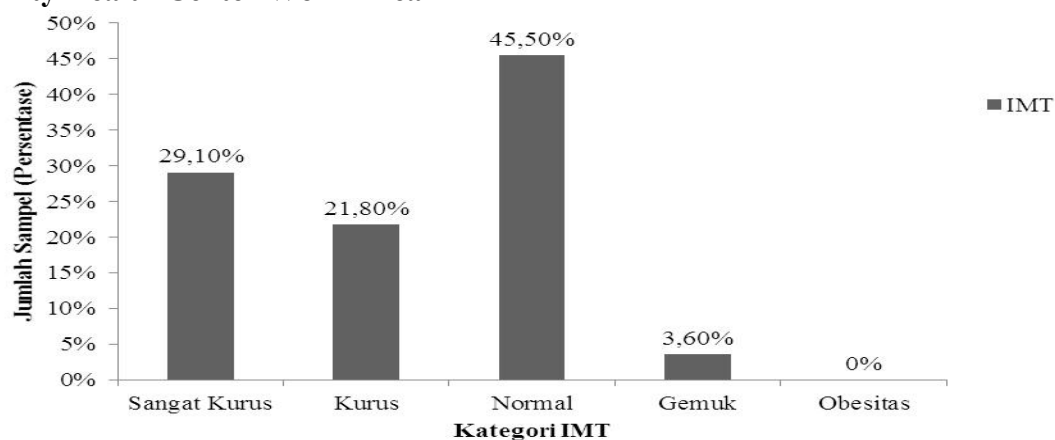


Figure 1. BMI Frequency Distribution Graphics.

Figure 1. The graph shows that most respondents have a BMI in the normal category, namely 25 people (45.5%), while 16 people (29.1%) have a BMI in the very thin category, 12 people (21.8%) in the thin category, and 2 people (3.6%) in the fat category and the obesity category was not found.

Frequency Distribution of Menarche Age in Junior High School Students in the Gogagoman Community Health Center Work Area

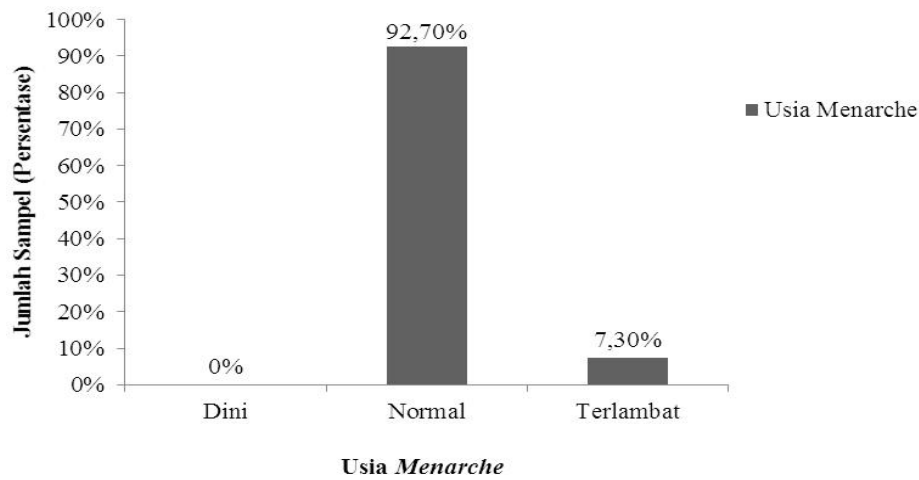


Figure 2. Frequency Distribution Graph of Age of Menarche.

Figure 2. The graph shows that the most junior high school students whose menarche was within normal limits were 51 people (92.7%), while those whose menarche was late were 4 people (7.3%) and junior high school students whose menarche was early were not found.

The Relationship between BMI and Age of Menarche in Junior High School Students in the Gogagoman Community Health Center Work Area

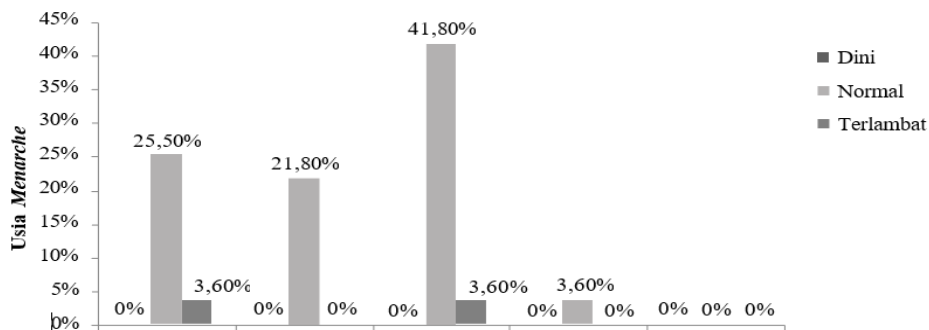


Figure 3.

Figure 3. The graph shows that the most junior high school students who had a BMI in the normal category and experienced menarche at the normal age limit were 23 people (41.8%), while those with a BMI in the very thin and normal category (3.6%) experienced late menarche. The results of the Chi-Square test (χ^2) obtained a p-value of 0.992 (> 0.05), so H_0 was accepted. This indicates that there is no relationship between BMI and menarche age in junior high school students in the Gogagoman Community Health Center Working Area.

DISCUSSION

Demographics of junior high school students at the Gogagoman Community Health Center (Puskesmas) based on school origin, age, and grade. Univariate analysis of 55 respondents showed that the highest proportion of school origins was in Banda Sakti District, with 36 students (65.4%). This is because schools in this district have the largest number of female students (1,794), and are located in urban areas, thus having a greater chance of finding respondents who experienced menarche in the past month, namely January 2025 (Primary Data, 2025). This is consistent with research by Indaryani (2009),²¹ which showed a significant difference between respondents in rural and urban areas with a p-value of <0.001 (<0.005). Residents in urban areas generally have higher socioeconomic levels and education than those in rural areas. This education influences the type of work and ultimately influences family income, which plays a significant role in determining a family's economic status. Differences in economic status and nutritional status between girls in urban and rural areas lead to significant differences in the age of puberty onset. Urban girls experience puberty earlier than rural girls. This difference in the age of puberty onset is due to better nutritional status.²² Furthermore, earlier puberty onset is associated with BMI, including genetic factors, communication media, stressors, infections, eating disorders, depression, obesity, and maturation of the hypothalamic-pituitary-gonadal axis.²³ Overweight and obese girls have a large amount of adipose tissue. Adipose tissue produces leptin. Blood leptin levels are related to the amount of body fat and BMI. Leptin levels increase in obese children and decrease in malnourished children.

Leptin plays a crucial role in puberty and the maturation of the hypothalamic-pituitary-gonadal axis. Leptin can act directly or indirectly on GnRH-producing neurons in the hypothalamus and increase GnRH production, thus triggering the onset of puberty through hormonal signals originating from adipose tissue.²²

Univariate analysis of 55 respondents showed that the highest proportion of junior high school students was 13 years old (24 students) and the highest proportion of junior high school

students were in seventh grade (37 students) (67.3%). This is consistent with the 2010 Basic Health Research (Riskesdas),⁹ which showed that the average age of menarche in Indonesian women aged 10-59 is 13, with earlier onset occurring at less than 9 years of age. The average age of menarche in Indonesia is 12.96 years. This is due to the role of nutrition and economic status in the age of menarche.¹⁰

Increased energy and nutrient intake have been associated with earlier age of menarche. This is influenced by the presence of fat mass at the onset of puberty and the occurrence of menarche, and also by maintaining reproductive capacity. This is also related to BMI, fat mass, leptin levels, racial influences, and other environmental factors. Increased BMI between the ages of 3 and 6 is a significant risk factor for girls entering puberty earlier. Leptin levels are found to be significantly higher in obese girls than in girls with a normal BMI. Serum leptin increases have been shown to occur two years before increases in serum LH and estradiol. Leptin is strongly associated with body fat mass and a decreased age at menarche.¹⁰

Univariate analysis of 55 junior high school students experiencing menarche at the Gogagoman Community Health Center in January 2025 revealed that the majority of junior high school students were in the normal category (25 students, 45.5%), followed by 16 (29.1%), 12 (21.8%), 2 (3.6%), and no obese students (Primary Data, 2025). The results of this study align with research conducted by Wulandari, Aini, and Astuti (2015)²⁴, which showed that the majority of respondents had a normal BMI (45.5%), but also included obese respondents (12.5%). A healthy BMI indicates optimal nutritional fulfillment. Optimal nutrition can help accelerate the growth and development of sexual organs, while inadequate nutrition can result in delayed sexual maturation and stunted growth.²⁵

BMI is influenced by several factors, such as nutritional intake, diet, physical activity, lifestyle, socioeconomic status, education level, knowledge level, environmental conditions, exposure to chronic diseases, and body fat percentage. ²⁶ Higher nutritional intake increases the likelihood of an individual experiencing an elevated BMI. Nutritional intake is influenced by dietary patterns, education and knowledge levels, and socioeconomic status. The more frequently a person eats, the higher their nutritional intake, and education and knowledge levels also influence the types of food consumed. Higher socioeconomic status can also increase a person's purchasing power to meet their nutritional needs. Education, knowledge, and socioeconomic status can also influence a person's lifestyle and daily activities, ultimately affecting BMI. ²⁷

Results of a univariate analysis of 55 junior high school students at the Gogagoman Community Health Center who experienced menarche in January 2025 revealed that the

highest number of junior high school students were 13 years old (24 students) and the lowest number were 15 years old (4 students) (7.3%). The age of menarche of junior high school students who experienced menarche within normal limits was 51 (92.7%), while 4 (7.3%) experienced late menarche, and no junior high school students experienced early menarche (Primary Data, 2025).

The results of this study are consistent with the 2010 Basic Health Research (Riskesdas), which showed that the average age of menarche in Indonesian women aged 10-59 is 13, with earlier occurrences occurring at less than 9 years of age. The average age of menarche in Indonesia is 12.96 years. This is due to the role of nutrition and economic status in the age of menarche. This is due to hormonal changes that affect cell maturity and exposure to estrogen from food consumption or external stimuli. Estrogen exposure comes from estrogen-derived foods (daidzein), which are found abundantly in soybeans, jicama, and the chemical pesticide Dichloro-Diphenyl-Trichloroethane (DDT). Furthermore, children who frequently enjoy "adult" content, both audio and visual, through shows and stories, can create memories in the brain and induce stimulation that will influence the secretion of sex hormones and accelerate the age of menarche.

Data obtained from statistical tests showed that 23 respondents (41.8%) with a normal BMI and experienced menarche within the normal range, while those with a very thin and normal BMI (3.6%) experienced late menarche. The results of the chi-square (χ^2) test using the Kolmogorov-Smirnov alternative test yielded a p-value of 0.992, indicating no relationship between BMI and age of menarche among junior high school students at the Gogagoman Community Health Center (Primary Data, 2025).

These results align with research by Himes, Park, and Styne (2009)²⁹, which states that BMI is not the sole determinant of delayed age of menarche and that the effect of average age of menarche on BMI assessments for overweight and obesity is small and usually not clinically significant. This is in accordance with research by Garn, La and Pilkington (1983)³⁰ and Sherar, Baxter-Jones and Mirwald (2007)³¹ which states that there is no clear evidence about the threshold level of body weight or fat mass for a decrease in the age of menarche.

There is no relationship between menarche and BMI due to the influence of genetic factors on menarche. Menarche is closely related to the peak rate of height increase. This period is determined by various factors, but the most important is genetics. ⁵ A strong relationship has been found between the age of menarche of mothers and their daughters, and an even stronger relationship between the ages of menarche of sisters. ²² Another contributing factor is nutritional status; obese girls will experience menarche earlier than thin girls. Any chronic

disease that disrupts nutritional status or tissue oxygenation will delay pubertal maturation, particularly the timing of menarche. 32 Children who frequently enjoy "adult" experiences, both audio and visual, through shows and stories, can create memories in the brain and generate stimulation that will influence the secretion of sex hormones and accelerate the age of menarche. 28 These research findings are inconsistent with Pujiani's (2012) study, 33 which found a significant relationship between nutritional status and age of menarche. What differentiates the results of this study from Pujiani's is that the study used a chi-square test with a proportionate stratified random sampling technique, while the researchers used a chi-square test with a total sampling technique, selecting junior high school students who experienced menarche within the last month (January 2025). Students with a higher BMI tended to experience menarche earlier. This is because leptin levels are secreted by the adipose glands, and leptin influences neuropeptide Y levels, which in turn influence GnRH. Changes in GnRH secretion levels also alter LH secretion levels. Furthermore, leptin levels influence oocyte maturation, which stimulates the maturation of ova produced by the ovaries. Therefore, it can be concluded that students with a high BMI will experience menarche at a younger age than those with a low BMI, as differences in the number of adipose glands result in different levels of leptin secretion. Girls with a BMI above normal are more likely to experience earlier menarche. This is due to numerous interacting factors influencing menarche. Physiologically, menarche occurs in girls after experiencing increased levels of GnRH, LH, and FSH, which typically begins at age 8. These hormones can increase estrogen levels and trigger the growth and development of sexual organs, including the thickening of the endometrium, which eventually sheds (menstruation). The triggering of GnRH is influenced by the interaction of many factors, one of which is BMI. An increased Body Mass Index in girls indicates high fat tissue, which can lead to earlier menarche due to increased leptin levels, which send signals to the brain.³⁵

Nutrition influences sexual maturity in girls who experience early menarche. Girls who have already experienced menarche tend to be more mature than those who have not. Conversely, girls who have late menarche tend to have a lower maturity than those who have already experienced menarche, even if the girls' height is the same. Girls who mature earlier will have a higher BMI, and girls who mature later will have a lower BMI at the same age.

Factors that may interact with BMI and age at menarche can influence the study results. A limitation of this study is the sample that met the specific inclusion criteria, namely junior high school students who experienced menarche in January 2025, resulting in a small sample size of 55 (1.6%) out of 3,334. In addition to the specific sample, other possible inclusion

criteria include students who did not admit to having menarche in January 2025 or were hesitant to do so, and teachers or students who felt it was taboo to tell others about menstruation. Another limitation is that this study used a cross-sectional survey method, which does not describe the disease course, incidence, or prognosis, and required a relatively large number of subjects. Furthermore, the examination in this study did not take into account several other factors, such as nutritional intake, which should be monitored periodically before menarche. By monitoring nutritional intake, we can determine the extent to which fat intake acts as a fuel for estrogen production, leading to early menarche.

This study also failed to account for other factors, such as estrogen derivatives in foods or supplements that cannot be detected. Fuadah (2016) 33 stated that the influence of estrogen on research results regarding menarche and nutritional status is due to children's high sensitivity to estrogen and its derivatives, but this depends on the type of substance, dose, and duration of exposure.

4. CONCLUSION

Based on the results of the research and discussion, the conclusion of this research is that the age of menarche is within normal limits, so there is no relationship between BMI and the age of menarche in junior high school students at the Gogagoman Community Health Center. Based on the results of the research that has been done, the researcher can suggest that the health service is expected to collaborate with schools to provide education to female students about reproductive health issues earlier, especially about menstruation, along with the acceleration of the age of menarche. Female students are also given knowledge about the right attitudes and behaviors to face menstruation and are given knowledge to maintain the health of reproductive organs when facing menstruation to prevent the emergence of reproductive health problems; For further researchers, it is hoped that research will be conducted on elementary school (S and junior high school students to find students who experience early and late menarche; Further research is needed to refine this research and other variables related to the occurrence of menarche.

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