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Relationship Between Menarche Age and *Body Mass Index* (IMT) Youth in Palembang City

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Abstract

Concern regarding secular trend of declining age of *menarche* has increased in the last few decades. Prevalence of childhood and adolescents obesity in Indonesia has also increased lately while some studies suggest that increased body mass index associates with the early onset of puberty which known to be the risk factor of many health problems. This study aims to investigate whether age of *menarche* is associated with body mass index in adolescents in Palembang. Sample of this cross sectional designed study was elementary and junior high school girls from 8 schools in Palembang taken with stratified random sampling. A total of 388 respondents met the inclusion criteria. Age of *menarche* and body mass index got from the questionnaire and anthropometric examination were analysed using *Chi-square* test. Out of 388 respondents, 49.5% experienced *menarche* at the earlier age than the mean age of *menarche* of 12.36 years and 20.1% were classified as overweight and obese. The average *menarche*al age of overweight and obese respondents was earlier than those classified as normal and underweight. This study proved that there is a highly significant association between age of *menarche* and body mass index with the p-value of 0.000 (*Chi-square* test). There is a highly significant association between body mass index during peripubertal period and the age of *menarche*. Strict monitoring on body mass index of elementary and junior high school girls is necessary to prevent early puberty.

Keywords: *adolescents. body mass index. menarche. Palembang*

1. Introduction

Menarche is the first menstruation which marks the end of puberty. Since the 20th century, the occurrence of *menarche* began to shift to a younger age in almost all countries in the world. In the United States. the age of *menarche* decreased from 12.53 years of age in 1988-1994 to 12.34 years in 1999-2002.[1] Basic Health Research data for 2010 showed the average age of *menarche* in women in Indonesia was 13 years with an earlier incidence in age less than 9 years and some later until 20 years.[2]

The decline in the age of *menarche* has become an important health issue because it has an impact on increasing the risk of various health problems. The risk of developing breast and endometrial cancer increases with increased exposure to estrogen.[3.4] Cohort studies in Scotland have shown that the age of *menarche* influences the incidence of obesity in adulthood.[5] An increased risk of developing metabolic syndrome. diabetes and cardiovascular problems is also closely associated with early *menarche*.[6]

Factors that influence the age of *menarche* include genetic and environmental factors. Research by Graber et al in 1995 showed that there was a tendency for a mother's *menarche* age to predict the age of her daughter's *menarche*.[7] Girls with higher socioeconomic status and parental education and who live in urban areas tend to experience *menarche* at a younger age.[8.9] Nutritional status parameters such as Body Mass Index (BMI) have an important role in influencing the occurrence of *menarche*.[10] Various studies have shown that high BMI is associated with earlier *menarche.*[11.12] This study aims to determine the relationship between age of *menarche* and body mass index youth in Palembang City

2. Research Methods

This cross sectional study was conducted on 672 students of class V-IX in the sub-districts of Kemuning, Ilir Timur II, Kalidoni, and Plaju who were selected using a stratified random sampling technique from September to October 2016. In this study, 388 students who met the inclusion criteria were willing, being the study sample and had experienced *menarche* within a maximum of 6 months before data collection, while the study exclusion criteria were if the student consumed drugs for a period of ≥ 2 weeks continuously or had congenital disease, such as Turner syndrome.

The collection of general information and the age of students' *menarche* was carried out using a questionnaire and BMI data were obtained through measurements of height and weight grouped according to the CDC *BMI-for-Age* growth curve. The collected data were processed and analyzed to determine the relationship between *menarche* age and BMI using the *Chi-square test.*

3. Results

The research was conducted in one primary school and one junior high school respectively in the sub-districts of Kemuning, Ilir Timur II. Kalidoni, and Plaju, Of the 672 students who were the study sample, 284 students did not meet the inclusion criteria because they experienced *menarche* in a time span more than 6 months before the study was carried out.

The distribution of subjects based on general characteristics is presented in **Table 1.** Of the 388 students who were the subjects of the study, about 44.3% of the subject's father and 44.6% of the subject's mother had high school education. The largest proportion of the subject's father's occupation is entrepreneur / private (43.2%) while the mother's job is housewives (72.2%). As much as 43.8% of the subject's parents' income is more than IDR 3.500.000.00.

Table 2. presents the distribution of subjects by age category of *menarche.* The mean age of the subject's *menarche* was 12.36 years (12 years 4 months) with the proportion of students who experienced *menarche* at an earlier than average age was less (49.5%) than

students with mean *menarche* age or older (50.5%).

In this study, the fastest *menarche* occurred at the age of 9 years while the slowest at the age of 15 years. Most of the subjects experienced *menarche* at age 12 (35.8%) and age 13 years (30.4%). **Figure 1** shows the cumulative percentage of the subjects' *menarche* ages. At the age of 12 years, 57.8% of students had experienced *menarche*, then this increased to 88.2% at the age of 13. About 99.5% of students have experienced *menarche* by the age of 14.

In **Table 3.** the distribution of subjects based on BMI categories is presented. From 388 subjects, the mean body mass index was 19.11 ± 3.12. Most of the subjects belonged to the normal nutrition category, namely 264 (68%) students, while those included in the excess nutrition category were 78 (20.1%) students, Only 46 (11.9%) students were malnourished.

Figure 2. shows the mean age of menarche in the BMI group. Subjects in the excess nutrition group experienced menarche at a younger age (11.25 years) compared with the normal nutrition group (12.56 years) and less (13.13 years). This shows an inversely related relationship between *menarche* age and Body Mass Index

As shown in **Table 4.** as many as 93.5% of subjects with excess nutritional status experienced *menarche* at a younger age, while only 21.7% of subjects in the undernourished group experienced *menarche* earlier than average. Most of the subjects with normal nutritional status (58.7%) and malnutrition (78.3%) experienced *menarche* at the mean age or older. The results of the analysis of the relationship between *menarche* age and body mass index using the *Chi-square* hypothesis test with a 95% confidence level resulted in a value of $p = 0.000$ ($p < 0.05$). This shows that there is a very significant relationship between menarche age and Body Mass Index.

Table 1. Distribution of subjects based on general characteristics (N = 388)

Characteristics	N	%
Father's education		
Not in school / elementary school	29	7.5
Junior High School	47	12.1
Senior High School	173	44.6
College	139	35.8
Mother's education		
Not in school / elementary school	39	10.1
Junior High School	61	15.7
Senior High school	172	44.3
College	116	29.9
Father's job		
Not working / labor / security guard	154	39.7
Lecturer / Teacher	7	1.8
POLRI / TNI	8	2.1
PNS / BUMN / Retirees	49	12.6
Notary / Doctor / Pharmacist / Midwife	2	0.6
Entrepreneur / Private	168	43.2
Mother's job		
Not working / labor / security guard	280	72.2
Lecturer / Teacher	11	2.8
POLRI / TNI	1	0.3
PNS / BUMN / Retirees	35	9
Notary / Doctor / Pharmacist / Midwife	3	0.8
Entrepreneur / Private	58	14.9
Parents' income		
<1500000	73	18.8
1500000-2500000	80	20.7
2500000-3500000	65	16.8
>3500000	170	43.8

Table 2. Distribution of subjects by age group of menarche (N = 388)

Age of *menarche*	Average (s.b)	IK 95%
	12.36 (1.06)	12.26-12.47
	n	**%**
< average	192	49.5
≥ average	196	50.5
Total	**388**	**100**

Table 3. Distribution of subjects based on BMI category (N = 388)

BMI	Average (s.b)	IK 95%
	19.11 (3.12)	18.80-19.43
	N	**%**
Excess nutrition (IMT p >85)	78	20.1
Normal nutrition (IMT p 5-85)	264	68
Malnutrition (IMT p <5)	46	11.9
Total	**388**	**100**

Table 4. Relationship between age of menarche and Body Mass Index

BMI	Age of *Menarche*		Total	P* value
	< Average	≥ Average		
	n (%)	n (%)	n (%)	
Excess nutrition	73 (93.6)	5 (6.4)	78 (20.1)	0.000
Normal nutrition	109 (41.3)	155 (58.7)	264 (68)	
Malnutrition	10 (21.7)	36 (78.3)	46 (11.9)	
Total	192 (49.5)	196 (50.5)	388 (100)	

* *Chi-square test*

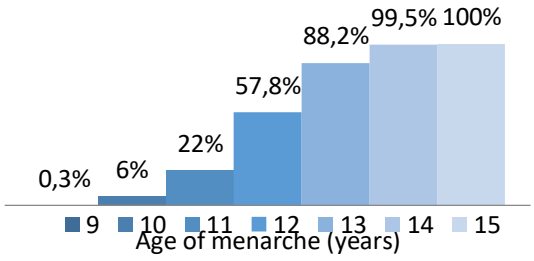

Figure 1. The cumulative percentage of the subjects' menarche ages

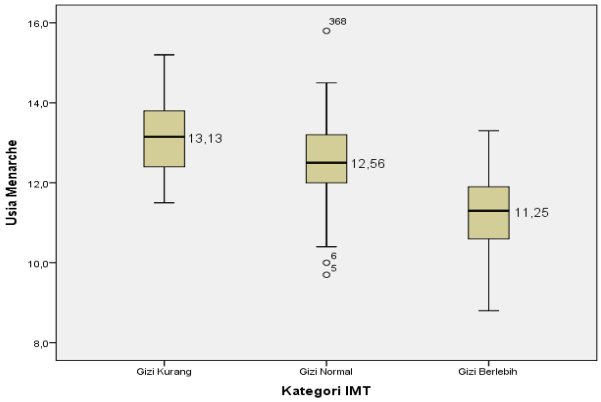

Figure 2. Mean age of menarche in BMI group

4. Discussion

The first sign of puberty in most adolescent girls is growth spurt, followed by breast growth *(thelarche),* the appearance of pubic hair *(pubarche)* and finally menstruation *(menarche).* Puberty in girls usually begins at the age of 8-13 years, whereas *menarche* occurs around 2.6 years from the onset of puberty.[13]

In the United States, the age of *menarche* decreased from 12.53 years of age in 1988-1994 to 12.34 years of age in 1999-2002.[1] *Cross-sectional* studies in Indonesia revealed that the average age of menarche in Indonesia was 12.96 years, while in Palembang it was 13.08 years.[14] In this study, it was found that the mean age of menarche in Palembang was 12.36 years. This decline in the age of *menarche* indicates a shift in the mean onset of puberty for girls in Palembang to a younger age.

Along with the decline in the age of menarche in the last few years, there is a trend of increasing the prevalence of adolescent obesity in Indonesia. The average age of menarche in Palembang is lower than that in Kupang, which is around 13.86 years old.[14] The prevalence of adolescents with excess nutritional status in Palembang (20.1%) is higher than in Kupang (8.7%).[15] This supports the hypothesis that obesity tends to trigger puberty and menarche earlier. However, Jakarta, with the highest prevalence of overweight and obese adolescents in Indonesia, shows that the average age of menarche is older than the average age of menarche in Yogyakarta which has a lower prevalence of overweight and very obese adolescents.[14.15]

Besides from genetic factors, environmental factors also influence the occurrence of menarche. Among environmental factors such as nutritional status, physical activity, and socioeconomic conditions, nutritional status has a large influence on the age of menarche.[10] In this study it was also found that the group of adolescents with nutritional status experienced menarche more at a younger age (11.25 years) than group with normal nutrition (12.56 years) and less (13.13 years).

A study of 17.077 adolescent girls in the United States indicated that obesity was an important factor contributing to earlier onset of puberty.[11] Cross-sectional studies in South Korea revealed that BMI and increased BMI in the period before *menarche* lead to early *menarche*.[16] The study of Al-Awadhi et al (2013) concluded that there was a significant negative association between age of *menarche* and obesity or *overweight* in Kuwaiti adolescents.[17] However, a longitudinal study of 68 Dutch adolescents concluded that fat mass or body fat distribution was not related to the onset of puberty.[18]

This study supports the results of previous studies conducted in Indonesia with the result that there is a very significant relationship between *menarche* age and BMI

with a value of p = 0.000 on the *chi-square* test. Research by Amaliah and Pujonarti (2010) on adolescents aged 10-15 years in Indonesia revealed that the age of *menarche* has a significant relationship with nutritional status where adolescents with normal and excess nutritional status experience 1.94 times more *menarche* than those with under nutritional status.[19] Similar results were obtained through studies in Semarang and Medan.[20.21] In contrast. research in Sumedang showed that there was no correlation between age at *menarche* and BMI.[22]

The hypothesis of Frisch and McArthur states that there is a critical fat mass to trigger the first menstruation and more fat mass to maintain reproductive capacity, but this has not been proven in several studies.[23] The national survey conducted by Batubara et al also concluded that most Indonesian adolescents will experience *menarche* in the age range of 12-14 years (mean 12.96 years) if BMI is included in the 50th percentile or more.[14] In this study, one student who experienced *menarche* at the youngest age of 9 years had a BMI in the 85th percentile range, up to 95. On the other hand, two girls experienced menarche the slowest. one of whom had a BMI below the 5th percentile on the CDC's *BMI-for-Age* growth curve.

The specific mechanisms that explain the relationship between age of *menarche* and obesity are unclear. Some opinions suggest that high BMI in peripubertal masses will lead to increased production and availability of estrogen through a series of mechanisms that predispose to early *menarche*.[24] Several studies have also reported changes in body fat mass and distribution in adolescent girls during puberty, but nothing has been proven yet that these changes are related to hormonal changes during the puberty process.[11]

Many studies agree that body fat has a large influence on the onset of puberty and *menarche*. Leptin is a major regulator of body weight and serum levels have a very strong correlation to BMI and body fat.[11] Leptin produced by adipocytes is thought to play an important role in the molecular relationship between body fat and reproductive function.[25] A study showed that there was an increase in serum leptin in 2 years before an increase in LH and serum estradiol.[26] An Ohio study showed that an increase in serum leptin levels was associated with a decrease in the age of *menarche*.[27]

Apart from BMI, there are other factors that have an important effect that directly affect puberty, namely genetics that are race-specific. Herman-Giddens et al studied 16.077 white and black girls in the United States reported that the median age of *menarche* in white adolescents was 12.88 which was slower than that of black adolescents with a median age of *menarche* of 12.16 years.[28]

A limitation in this study is that the age of *menarche* data obtained through retrospective *recall* can bias the results of the study. In addition, a larger sample representing each sub-district is needed so that the research results are more accurate. The addition of other variables related to the sociodemographic state of an area will enrich the analysis so that more specific conclusions can be made.

5. Conclusion

From the research that has been carried out in Elementary Schools and Junior High Schools in 4 sub-districts in Palembang City during September-October 2016. it can be concluded that:

1. The fastest *menarche* occurred at the age of 9 years (0.3%) while the slowest at the age of 15 years (0.5%) with the mean age of menarche in the study subjects was 12.36 years (12 years 4 months).
2. The average body mass index of the research subjects was 19.11 with the proportion of excess nutrition group of 20.1%.
3. There is a very significant relationship between the age of *menarche* and Body Mass Index (p = 0.000).

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References

1. Anderson SE. Must A. Interpreting the continued decline in the average age at menarche: results from two nationally representative surveys of US girls studied 10 years apart. Pediatrics 2005. 147 (6): 753–60.
2. Health Research and Development Agency. Basic Health Research 2010. Jakarta: Ministry of Health RI.
3. Hsieh CC. Trichopoulos D. Katsouyanni K. Yuasa S. Age at menarche. age at menopause. height and obesity as risk factors for breast cancer: associations and interactions in an international case-control study. Int J Cancer 1990.46 (5): 796-800.
4. Berkey CS. Frazier AL. Gardner JD. Colditz GA. Adolescence and breast carcinoma risk. Cancer. Am J Epidemiol 1999.85 (11): 2400-2409.
5. Pierce B. Leon DA. Age at menarche and adult bmi in the aberdeen children of the 1950s cohort study. Am J Clin Nutr 2005. 82: 733–9.
6. Jacobsen BK. Oda K. Knutsen SF. Fraser GE. Age at menarche. total mortality and mortality from ischemic heart disease and stroke: the adventist health study 1976-88. Int J Epidemiol 2009. 38 (1): 245-252.
7. Graber JA. Brooks-Gunn J. Warren MP. The antecendents of menarcheal age: heredity. family environment. and strssful life events. Child Development 1995. 66 (2): 346-59.
8. Padez C. Social Background and Age at Menarche in Portuguese University Students: A Note on The Secular Changes in Portugal. Am J Hum Biol 2003. 15 (3): 415–27.
9. Wronka I. Pawlinska-Chmara R. Menarcheal age and socio-economic factors in poland. Ann Hum Biol 2005.32 (5); 630-638.
10. Karapanou O. Papadimitriou A. Determinants of menarche. Endocrinol Biol Rep 2010. 8: 115.
11. Kaplowitz PB. Slora EJ. Wasserman RC. Pedlow SE. Herman-Giddens ME. Earlier onset of puberty in girls: relation to increased body mass index and race. Pediatrics 2001. 108 (2): 347–53.
12. Rosen fi eld RL. Lipton RB. Drum ML. Thelarche. pubarche. and menarche attainment in children with normal and elevated body mass index. Pediatrics 2009. 123 (1): 84–8.
13. Boswell HB. 2014. Normal Pubertal Physiology in Females. In: Dietrich. J.E (editor). Female Puberty: A Comprehensive Guide for Clinicians (pp. 7-30). New York: Springer. (Right)
14. Coal JR. Soesanti F. Van de Waal HD. Age at menarche in indonesian girls: a national survey. Act Med Ind 2010. 42 (2): 78–81.
15. Health Research and Development Agency. 2013. Basic Health Research 2013. Jakarta: Ministry of Health RI.
16. Oh CM. Oh IH. Choi KS. Choe BK. Yoon TY. Choi JM. Relationship between body mass index and early menarche of adolescent girls in Seoul. J Prev Med Pub Health 2012. 45; 227-234.
17. Al-Awadhi N. Al-Kandari N. Al-Hasan T. AlMurjan A. Ali S. Al-Taiar A. Age at menarche and its relationship to body mass index among adolescent girls in Kuwait. BMC Public Health 2013.1: 29.
18. De Ridder CM. Thijssen JHH. Bruning PF. Body fat mass. body fat distribution. and pubertal development: a longitudinal study of physical and hormonal sexual maturation of girls. J Clin Endocrinol Metab 1992. 75: 442–446.

19. 19. Amaliah N. Pujonarti SA. Relationship between nutritional status and menarche status in adolescents (aged 10-15 years) in Indonesia in 2010. Journal of Reproductive Health 2010. Vol. 4 No 1. 1–10.
20. Indaryani W. Susanto R. Susanto JC. Relationship between onset of puberty and socioeconomic status and nutritional status in girls. Sari Pediatrics 2010. Vol. 11 No. 5.
21. Olivia D. Deliana M. Supriatmo H. Lubis SM. Body mass index and age of menarche in young girls. Paediatrica Indonesiana 2012. 52 (6): 309–12.
22. Putri AP. Yulia S. Fadil RMR. Nugroho HS. Susanto H. Widjadjakusuma A. et. al. Correlation between body mass index and age at menarche. Althea Medical J 2015. 2: (4).
23. Frisch RE. McArthur JW. Menstrual cycles: fatness as a determinant of minimum weight for height necessary for their maintenance and onset. Science 1974. 185: 949–951.
24. Cheng G. Buyken AE. Shi L. Karaolis-Danckert N. Kroke A. Wudy SA. et. al. Beyond overweight: nutrition as an important lifestyle factor influencing the timing of puberty. Nutr Rev 2012. 70 (3): 133–152.
25. Kaplowitz PB. Link between body fat and the timing of puberty. Pediatrics 2008. 121: S208-16.
26. Garcia-Major RV. Andrade A. Rios M. Lage M. Dieguez C. Casanueva FF. Serum leptin levels in normal children: relationship to age. gender. body mass index. pituitarygonadal hormones. and pubertal stage. J Clin Endocrinol Metab 1997.82: 1849-55.
27. Matkovic V. Ilich JZ. Skugor M. Leptin is inversely related to age at menarche in human females. J Clin Endocrinol Metab 1997.82: 32-45.
28. Herman-Giddens ME. Slora EJ. Wasserman RC. Secondary sexual characteristics and menses in young girls seen in office practice: a study from the pediatric research in office settings network. Pediatrics 1997. 99: 505–512.