

## MAPPING IDEA &amp; LITERATURE FORMAT | RESEARCH ARTICLE

# The Relationship Between Nutritional Status and Age at Menarche in Adolescent Girls: A Literature Review

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## ABSTRACT

Menarche or first menstruation is an important indicator in the reproductive development of teenage girls. The age of menarche can be influenced by various factors, one of which is nutritional status. The unbalanced nutritional status, both deficiencies or excesses, can cause menarche to occur earlier or later, which will ultimately have an impact on the physical and psychological health of teenagers. This study aims to determine and conclude the results of various scientific articles regarding the relationship between nutritional status and age of menarche in teenage girls. This study uses a literature review method by analyzing ten articles from the Google Scholar database, which has been accredited by the SINTA (Science and Technology Index) 1-4. The inclusion criteria included articles published in the period 2015-2025, in Indonesian, with the subject being teenage girls who have experienced menarche and are in good health. The results of the analysis showed that the average age of menarche in teenage girls was around 11 - 12 years. Most teenage girls who experienced menarche have good nutritional status (51%). Of the ten articles reviewed, eight showed a significant relationship between nutritional status and age of menarche. Based on the ten articles, it can be concluded that there is a significant relationship between nutritional status and age of menarche in teenage girls. Increased or decreased nutritional status can accelerate or delay the time of menarche. Therefore, monitoring the nutritional status of teenagers is very important to support optimal reproductive health.

**Keywords:** Adolescent Girls, Age of Menarche, Literature Review, Nutritional Status.

## I. Introduction

Adolescence is a transitional period from childhood to adulthood between the ages of 10 and 19 (Darmawan et al., 2019). This period is marked by growth, development, and the emergence of opportunities to face health issues (Batubara, 2024). Compared to health in other age groups, health issues in adolescents are more complex, related to nutritional problems, reproductive issues, teenage pregnancy, unsafe abortions, Sexually Transmitted Diseases (STDs), and HIV/AIDS (Adawiyah, 2020; Angraini et al., 2022; Hadisaputra et al., 2022; Materialisme et al., 2024). Issues faced by adolescents often stem from a lack of information, understanding, and awareness of behaviors necessary to implement reproductive health adequately (Fitriyadi

et al., 2023; Risky Azizah et al., 2023). Teens who receive social support will feel more loved and valued, so that they are better prepared psychologically and not afraid to face the physical and emotional changes of puberty. Social support also helps adolescent girls get the correct information about reproductive issues, maintain personal hygiene, and manage the emotions and stress that may arise during this transition period (Arifuddin A. Pasinringi et al., 2022). Currently, the world is in an era of globalization, where the development of information is increasingly rapid, along with shifts in social dynamics and behavioural patterns that impact reproductive health, particularly reproductive health in teenagers (Rahmawati & Susanti, 2019). (Sharma, 2022) In her research, she mentioned that the issues of adolescent girls, especially in developing countries, are the lack of knowledge about menstruation or menarche. Menarche can be defined as the beginning of menstruation in females and an early sign of entering the reproductive period (Chen et al., 2022; Jung et al., 2023; Nuraida et al., 2023; Syam et al., 2022). The arrival of menarche also signifies that the vital organs of adolescent girls are ready for fertilization (Alam et al., 2021). The prevalence of menarche in Northern Europe has decreased from 16 – 17 to 13, while in the United States, the age of menarche has decreased from 17 to 14 years (Dwi Anggraini et al., 2023). Indonesia ranks 15th out of 67 countries with a decline in menarche age of 0,145 per decade, with an average menarche age of adolescent girls being 13 years in 2013 (Yani et al., 2023). In 2018, according to reports from respondents who have experienced menstruation, 20% of teenagers in Indonesia experienced menarche at an average age below 12 years, with occurrences as early as age nine and as late as age 17 (L. Hartati & Irmawati, 2024; Rahayu et al., 2023).

Menarche can occur at varying ages in each individual. The age of menarche is considered normal if it occurs between the ages of 12 and 15 years. The age of menarche in adolescent girls can be influenced by factors such as nutritional status, fast food consumption, genetics, living environment, socioeconomic status, physical activity, and exposure to mass media (Ramraj et al., 2021). Early menarche can increase the risk of cardiovascular diseases, obesity, breast cancer, metabolic disorders, and psychological disorders, while delayed menarche is one of the causes of osteoporosis (Karim et al., 2021). The occurrence of earlier menarche is influenced by the intake of nutrients such as fat, calcium, and fiber. Foods high in fat and low in fiber will affect the functioning of estrogen and progesterone hormones, ultimately impacting the growth and development of the reproductive system (Villamor, 2016). This is in line with research conducted in Germany on 222 subjects, which found that a poor diet quality, such as high total fat and saturated fat intake and low fiber intake before puberty, is associated with early menarche (Jung et al., 2023). The involvement of micronutrients such as calcium, especially in milk, can influence the levels of estrogen and growth factors in sending physiological signals for the regulation of somatic growth and maturation of reproductive organs. This will cause adolescent girls to experience puberty earlier (Ramraj et al., 2021).

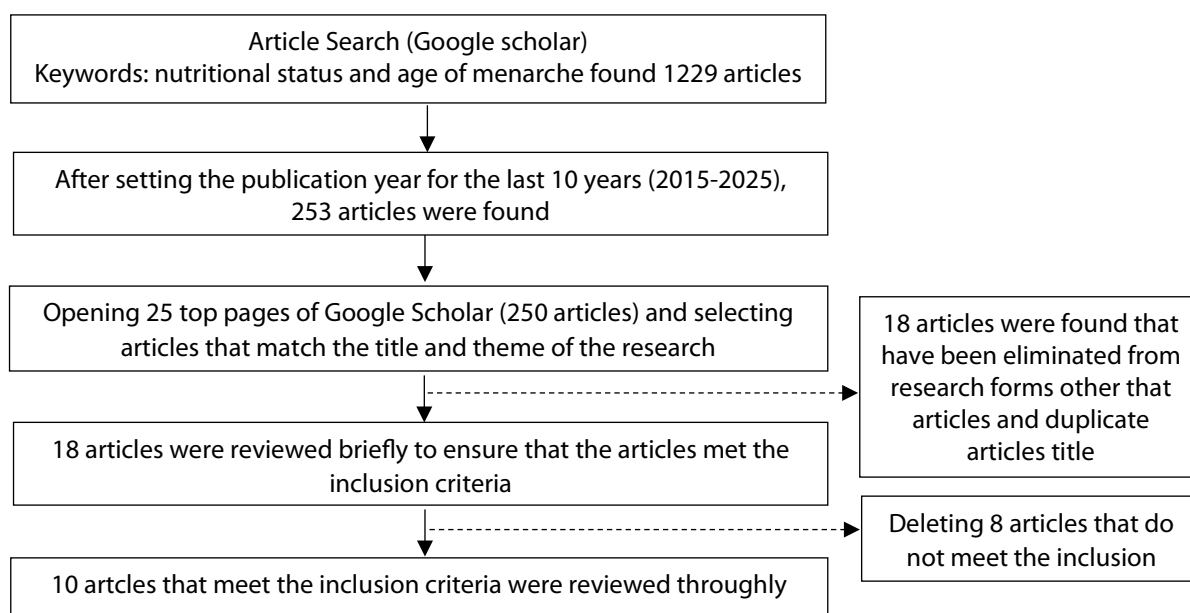
Adolescent girls with better nutritional status have a faster sexual development before puberty (prepubertal) compared to adolescents with malnutritional status (L. Hartati & Irmawati, 2024). Girls with more body fat are more likely to experience menarche earlier than thin girls. This is because fat accumulation in adipose tissue can increase leptin levels. Leptin triggers the release of Gonadotropin Releasing Hormone (GnRH), which subsequently influences the secretion of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) in stimulating follicle maturation and estrogen formation (Dwi Anggraini et al., 2023). Furthermore, estrogen hormones provide positive feedback to the hypothalamus and pituitary glands, increasing Luteinizing Hormone (LH), which affects menarche (Yazia, 2019). Adolescents who experience improved nutritional status will lead to faster maturation of reproductive organs (Alam et al., 2021). This is consistent with the research conducted by (Yani et al., 2023) in adolescent girls at Junior High School 8 Banda Aceh stating that nutritional status affects early menarche, where adolescent girls with better nutritional status will influence hormones that play a role in sexual development such as estrogen, FSH (Follicle Stimulating Hormone) and LH (Luteinizing Hormone) which will trigger early menarche.

Research by Alam et al. (2021) shows that respondents with good nutritional status who experienced normal menarche age were 43,75%, while those who experienced abnormal menarche age were 56,25%. Meanwhile, respondents with poor nutritional status who experienced abnormal menarche age reached 84,62%, and only 15,38% experienced normal menarche age. The statistical test results show a significant

relationship between nutritional status and menarche age in adolescent girls at Junior High School 10, Bulukumba, Ujung Loe District, Bulukumba Regency, with  $p$  value = 0,020 and OR = 4,28. This study concludes that nutritional status is a significant factor influencing menarche age, where adolescent girls with good nutritional status tend to experience puberty and menstruation within the normal time range. Another study by Arban et al. (2024) found a significant relationship between nutritional status and menarche age in adolescent girls at Junior High School 8 Makassar, with a  $p$ -value = 0,014. This study reinforces previous findings that nutritional status is one of the factors influencing the timing of menarche. Although many studies show a relationship between nutritional status and the age of menarche, most of these studies used a quantitative approach with a cross-sectional design, conducted in limited areas with a relatively homogeneous population. In addition, there is still a lack of research that summarizes and compares results from various sources to assess the overall consistency of findings. This condition creates a research gap, namely the absence of a comprehensive literature review on the relationship between nutritional status and menarche age that encompasses various perspectives and geographical contexts in Indonesia. Based on the description, the researcher is interested in conducting a literature review study to examine and summarize the results of various scientific articles discussing this topic. This approach is expected to provide a broader, deeper, and more comprehensive understanding of the relationship patterns between nutritional status and menarche age and strengthen the scientific literature in adolescent reproductive health in Indonesia.

## II. Research Method

This research uses a literature review or systematic literature review approach. This approach was chosen because it aligns with the research objective of comprehensively examining previous research findings and discussing the relationship between nutritional status and menarche age in adolescent girls. With this method, the researcher does not conduct primary data collection directly but reviews, assesses, and synthesizes information from various published scientific studies. Literature searches were conducted through the academic search engine Google Scholar, using search keywords such as "nutritional status and age of menarche", "menarche in adolescent girls", and "age of menarche". The search period was limited to 2015-2025 to ensure that the articles reviewed are current research studies relevant to the latest developments in the field.



**Figure 1. Article Search Framework**

From the initial search results, a total of 1,229 articles were found. After filtering based on titles and abstracts, 250 articles were opened and further evaluated. The selection process was then continued by applying the following inclusion and exclusion criteria:

a. Inclusion Criteria:

1. The article is written in Indonesian.
2. The article is published in a nationally accredited scientific journal registered in the SINTA (Science and Technology Index) ranking system levels 1 to 4, managed by the Ministry of Research and Technology of Indonesia.
3. The research uses a quantitative design, specifically a cross-sectional approach or case-control study, as these two designs are most commonly used to examine the relationship between nutritional variables and menarche.
4. The research subjects are adolescent girls who have experienced menarche and are in good physical health.

b. Exclusion Criteria:

1. Articles that are not available in full text.
2. Articles whose research focus is not relevant to the study topic.
3. Duplicate articles or those published in unaccredited journals.

After filtering based on these criteria, 10 articles were finally selected for further analysis in this study. This study also notes that the reviewed articles used various sampling methods, such as:

- a. Simple random sampling
- b. Purposive sampling (based on specific considerations)
- c. Total sampling (where the entire population is used as the sample)
- d. Stratified proportional random sampling (proportional random sampling based on strata)

These articles' nutritional status data were generally measured using the Body Mass Index for Age (BMI/A) indicators, assessed through Z-scores, referring to WHO standards. Meanwhile, data on age at menarche were obtained through questionnaires or direct interviews. It was categorized as usual if menarche occurred between 11 and 13 years, and not normal if it occurred outside this range (either earlier or later). To ensure data validity and reliability, only articles that used precise and standardized measurements were selected for analysis. Additionally, all selected articles had undergone a peer-review process and were published in accredited national journals, ensuring their scientific credibility. Although this research does not introduce new methods, it makes original contributions by:

- a. Summarizing and comparing findings from various studies with similar designs.
- b. Identifying research gaps that have not been widely addressed in previous reviews.
- c. Providing a theoretical and empirical foundation for future research and policy formulation in adolescent reproductive health.

As part of scientific transparency, this research also acknowledges several limitations of the methods, such as dependence on secondary data collected by other researchers, variations in sample sizes and analysis methods across articles, and limited access to paid international journals. Nevertheless, the findings of this study still make an important contribution to expanding scientific understanding of the relationship between nutritional status and age at menarche in Indonesia.

### III. Results and Discussion

#### 3.1. Result

##### 3.1.1. Characteristics of Articles Based on Research Methods

The author reviews 10 research articles published from 2015 to 2025, with the majority of 9 articles (seen in Table 1) using a cross-sectional design and one article using a retrospective design. The cross-sectional design was chosen because it is practical and efficient in collecting data at one point, although it has limitations in determining cause-and-effect relationships. Meanwhile, the retrospective design is more appropriate for tracking risk factors but requires careful research in determining the sample and inclusion-exclusion criteria.

**Table 1. Characteristics of Articles Based on Research Methods**

| No. | Reference                       | Research Design | Sampling Method                         | Instrument of Data Collection |              |
|-----|---------------------------------|-----------------|-----------------------------------------|-------------------------------|--------------|
|     |                                 |                 |                                         | Nutrition al Status           | Menarche Age |
| 1   | (Makarimah & Muniroh, 2018)     | Cross-sectional | Simple Random Sampling                  | BMI/A                         | Questionarry |
| 2   | (Enggar et al., 2022)           | Cross-sectional | Purposive sampling                      |                               |              |
| 3   | (T. S. P. Hartati et al., 2022) | Cross-sectional | Purposive sampling                      |                               |              |
| 4   | (Asfahani et al., 2019)         | Retrospektif    | Purposive sampling                      |                               |              |
| 5   | (Alam et al., 2021)             | Cross-sectional | Total sampling                          |                               |              |
| 6   | (Amiruddin et al., 2023)        | Cross-sectional | Stratified proportional random sampling |                               |              |
| 7   | (Niu & Rahmatia, 2019)          | Cross-sectional | Total sampling                          |                               |              |
| 8   | (Taufiqurrahman et al., 2018)   | Cross-sectional | Purposive sampling                      |                               |              |
| 9   | (Mutasya et al., 2016)          | Cross-sectional | Simple Random Sampling                  |                               |              |
| 10  | (Br Napitupulu et al., 2018)    | Cross-sectional | Stratified proportional random sampling |                               |              |

Based on Table 1 above, the data collection method is explained in 10 articles. There are 2 using simple random sampling, four articles using purposive sampling, two articles using total sampling, and two others using stratified proportional random sampling. The data on menarche age were collected through a questionnaire. At the same time, nutritional status was measured using the Body Mass Index according to Age (BMI/A) based on weight and height measurements and then analyzed using the Z-score.

##### 3.1.2. Characteristics of The Research Subjects

The characteristics of the subjects in the study are adolescent girls. The characteristics of adolescent girls were not subjected to a relationship test but only to a description of the characteristics of the research subjects. The age group of the subjects is classified into three groups.

**Table 2. Girls' Adolescent Age Group**

| Reference                       | Number of Samples | Age (%)     |             |             |
|---------------------------------|-------------------|-------------|-------------|-------------|
|                                 |                   | 10-12 Years | 13-15 Years | 16-19 Years |
| (Makarimah & Muniroh, 2018)     | 37                | 100         | -           | -           |
| (Enggar et al., 2022)           | 45                | 84,4        | 15,6        | -           |
| (T. S. P. Hartati et al., 2022) | 87                | 31,0        | 69,0        |             |
| (Asfahani et al., 2019)         | 166               | 27,8        | 71          | 1,2         |
| (Alam et al., 2021)             | 74                | 82,4        | 17,6        | -           |
| (Amiruddin et al., 2023)        | 152               | 22,4        | 77,6        | -           |
| (Niu & Rahmatia, 2019)          | 45                | 35,6        | 64,4        | -           |
| (Taufiqurrahman et al., 2018)   | 153               | 100         | -           | -           |
| (Mutasya et al., 2016)          | 72                | 58,3        | 41,7        | -           |
| (Br Napitupulu et al., 2018)    | 65                | 100         | -           | -           |
| <b>Average</b>                  |                   | <b>64,2</b> | <b>35,7</b> | <b>0,1</b>  |

Based on Table 2, most of the research subjects were aged 10-12 years (64,2%). This age marks the early puberty phase, characterized by menarche as an indicator of reproductive maturity. During this period, nutritional needs increase to support growth. The main characteristic among adolescent girls is menstruation. Menstruation is a physiological occurrence that occurs as a sign of maturation of the female reproductive system. Menarche is the first menstruation, usually occurring between 10 and 14 years old. (Musmiah et al., 2019). Adolescence is a critical period where adolescents need nutrients for physical growth and preparation for the maturity of the reproductive organs. To meet these needs and development, girls need adequate nutrients such as protein, fats, carbohydrates, vitamins, and minerals (Utami, 2017). Irregular eating patterns in teenagers, frequent consumption of fast food that is high in calories and low in nutrients, as well as the habit of skipping breakfast, can affect an unbalanced nutritional status, such as malnutrition or overnutrition, which can influence the timing of menarche, making it occur earlier or later. An unbalanced diet can cause nutritional status to be deficient or excessive, which can affect the timing of menarche (Amalia et al., 2024).

### 3.1.3. Menarche Age in Adolescent Girls

Menarche age is when a girl experiences her first menstruation, generally occurring between the ages of 10 and 15, although it can be earlier or later. Niu (2019) in her research categorized menarche age into two: normal menarche age (11-13 years) and abnormal menarche age (<11 years and >13 years). The categories of menarche age of adolescent girls can be seen in Table 3 below.

**Table 3. Menarche Age Category of Adolescent Girls**

| Reference                       | Average age of menarche (Years) | Menarche Age (%)     |                                    |
|---------------------------------|---------------------------------|----------------------|------------------------------------|
|                                 |                                 | Normal (11-13 years) | Abnormal (<11 years and >13 years) |
| (Makarimah & Muniroh, 2018)     | 10,8                            | 64,9                 | 35,1                               |
| (Enggar et al., 2022)           | 12,0                            | 93,3                 | 6,7                                |
| (T. S. P. Hartati et al., 2022) | 11,5                            | 87,4                 | 12,6                               |
| (Asfahani et al., 2019)         | 12,8                            | 98,8                 | 1,2                                |
| (Alam et al., 2021)             | 11,7                            | 33,8                 | 66,2                               |
| (Amiruddin et al., 2023)        | 12,4                            | 73,7                 | 26,3                               |
| (Niu & Rahmatia, 2019)          | 12,7                            | 68,9                 | 31,1                               |
| (Taufiqurrahman et al., 2018)   | -                               | 47,7                 | 52,3                               |
| (Mutasya et al., 2016)          | 12,3                            | 86,2                 | 13,8                               |



| Reference                    | Average age of menarche (Years) | Menarche Age (%)     |                                    |
|------------------------------|---------------------------------|----------------------|------------------------------------|
|                              |                                 | Normal (11-13 years) | Abnormal (<11 years and >13 years) |
| (Br Napitupulu et al., 2018) | 9,8                             | 55,4                 | 44,6                               |
| <b>Average</b>               |                                 | <b>71,0</b>          | <b>29,0</b>                        |

Menarche age refers to the age at which an adolescent girl first experiences menstruation, marking the beginning of her reproductive period. Generally, menarche occurs between 10 and 15 years, with the normal range between 11 and 13 years. This classification distinguishes normal and abnormal menarche, where menarche occurring before age 11 or after age 13 is considered abnormal. Based on the results presented in Table 3 from the ten articles reviewed in this study, it was found that the majority of adolescent girls (71%) experience menarche within the normal age range. The average age of menarche reported across various studies ranged between 11 and 12 years. However, some studies reported variations in menarche age. For instance, Br Napitupulu et al. (2018) found that the average age of menarche was 9.8 years, indicating cases of early menarche. Several factors influence the variation in menarche age, including nutritional status, physical activity, genetic factors, socioeconomic status, and lifestyle.

Early menarche has been linked to an increased risk of health issues such as cardiovascular disease, obesity, breast cancer, metabolic disorders, and psychological conditions (Karim et al., 2021). Conversely, delayed menarche is associated with a higher risk of osteoporosis. Global trends also indicate a decline in the age of menarche over time. In Northern Europe, the average age has decreased from 16–17 years to around 13 years, while in the United States, it has decreased from 17 years to approximately 14 years. In Indonesia, data from the 2018 Basic Health Research (Riskesmas) show that about 20% of adolescent girls experience menarche before the age of 12, with the overall age range spanning from 9 to 17 years. These findings underline the importance of monitoring menarche age as a key indicator of reproductive health in adolescent girls, particularly regarding nutritional status and changing lifestyle factors in the modern era.

#### 3.1.4. Nutritional Status in Adolescent Girls

Nutritional status is the condition of the body's health that reflects the balance between the intake of nutrients from food and the needs for metabolism and physiological function (Thamaria, 2017). Nutritional status assessment can be conducted directly through anthropometric methods (measuring weight, height, upper arm circumference, etc.), clinical examinations, biochemical analysis, and indirectly through food consumption surveys and environmental factors. In the ten articles analyzed, the Body Mass Index (BMI) by Age (BMI/A) indicator was used to determine the nutritional status of adolescent girls. The nutritional status categories for adolescent girls can be seen in Table 4 below.

**Table 4. Nutritional Status Category (BMI/A)**

| Reference                       | Nutritional Status Category (BMI/A) (%) |              |        |             |         |
|---------------------------------|-----------------------------------------|--------------|--------|-------------|---------|
|                                 | Mal nutrition                           | Under weight | Normal | Over weight | Obesity |
| (Makarimah & Muniroh, 2018)     | 0                                       | 0            | 51,4   | 48,6        | 0       |
| (Enggar et al., 2022)           | 0                                       | 66,7         | 28,9   | 4,4         | 0       |
| (T. S. P. Hartati et al., 2022) | 3,4                                     | 10,4         | 57,5   | 19,5        | 9,2     |
| (Asfahani et al., 2019)         | 0                                       | 23,5         | 48,8   | 27,7        | 0       |
| (Alam et al., 2021)             | 0                                       | 35,1         | 64,9   | 0           | 0       |
| (Amiruddin et al., 2023)        | 0                                       | 33           | 61,8   | 2,6         | 2,6     |
| (Niu & Rahmatia, 2019)          | 0                                       | 28,8         | 35,6   | 35,6        | 0       |

| Reference                     | Nutritional Status Category (BMI/A) (%) |              |           |             |            |
|-------------------------------|-----------------------------------------|--------------|-----------|-------------|------------|
|                               | Mal nutrition                           | Under weight | Normal    | Over weight | Obesity    |
| (Taufiqurrahman et al., 2018) | 0                                       | 2,6          | 60,8      | 23,5        | 13,1       |
| (Mutasya et al., 2016)        | 0                                       | 22,2         | 61,1      | 16,7        | 0          |
| (Br Napitupulu et al., 2018)  | 0                                       | 7,7          | 41,5      | 50,8        | 0          |
| <b>Average</b>                | <b>0,34</b>                             | <b>23</b>    | <b>51</b> | <b>23</b>   | <b>2,5</b> |

Nutritional status in adolescent girls is important in determining health and reproductive maturity. Based on Table 4, a review of ten articles shows that many adolescent girls have a nutritional status in the normal category (51%), followed by overweight and underweight. Assessment of nutritional status is generally conducted using the Body Mass Index according to Age (BMI/A) indicator. Normal nutritional status supports optimal reproductive hormone function, while inadequate or excessive nutritional status can influence the menarche process, either accelerating or delaying it. Factors affecting nutritional status include diet, family economics, parental education, and fast-food consumption. Therefore, a balanced nutritional status is vital for the growth and development of adolescent girls.

### 3.2. Discussion

Nutritional status has a role in determining the age of menarche. Adequate and balanced nutritional intake is necessary to support the optimal growth and development of adolescent girls, as well as to prevent early or delayed menarche, which can impact physical and reproductive health in the future. Based on the study of 10 articles, it can be determined that the type of analysis used in all articles is bivariate analysis. Bivariate analysis analyzes two variables, namely one independent variable and one dependent variable. Out of ten articles, eight showed a significant relationship between nutritional status and the age of menarche in adolescent girls. In comparison, the other two articles indicated no relationship between nutritional status and the age of menarche. Two produced R values based on eight articles with a significant relationship between nutritional status and menarche age. This research was conducted by Amiruddin et al. (2023) with a value of R equal to -0,319, This means that the nutrition status and age of menarche have a moderate inverse relationship, indicating that the lower the nutrition status of adolescent girls, the slower the age of menarche becomes. This R value is smaller than the research by Makarimah (2017), which has an R value of -0,360, meaning there is a relationship, but it is weak between nutrition status and age of menarche. Articles with P values <0,05 indicate a relationship between nutritional status and menarche age. Menarche is the first menstruation.

The onset of menarche also indicates that the vital organs of adolescent girls are ready for fertilization (Ratnaningsih, 2017). The age of menarche varies among women. Generally, menarche occurs between 12 and 14, but can happen earlier or later. This can be influenced by health status, body weight, and nutritional status (Rodiyah, 2023). The research from (T. S. P. Hartati et al., 2022) explained that menarche in adolescent girls is associated with improved nutritional status. Better nutritional status can be caused by an increase in the amount and mass of body fat, which leads to an increase in serum leptin levels. Leptin will trigger the release of FSH (Follicle Stimulating Hormone) and LH (Luteinizing Hormone) levels in the ovaries. This will result in the maturation of follicles and the formation of estrogen hormones. Estrogen hormones cause negative feedback on FSH. If there is an increase in FSH, then estrogen levels will decrease. The decrease in estrogen levels causes the proliferation of blood vessels in the endometrium to stop. This results in the shedding of the endometrial layer and causes bleeding, which is known as the first menstruation or menarche. Articles that are not related or  $P > 0,05$  are found in the article by Enggar (2022) with  $P = 5,42$  and the article by Asfahani (2019) with  $P = 0,376$ , which indicate no relationship between nutritional status and age of menarche. In the articles by Enggar (2022), there is no relationship because in that study, the majority of the



samples that experienced menarche at the normal age of 96,7% had an underweight nutritional status. In addition, the age of menarche is influenced not only by nutritional status but also by several factors, including genetics, dietary status, body fat, physical activity, environment, and socio-economic conditions.

This research is in line with Wulandari's (2018) study, which stated that there is no relationship between nutritional status and age of menarche because many of the respondents studied had poor nutritional status due to their dieting. Meanwhile, Asfahani et al.'s (2019) article shows that there is no relationship between nutritional status and age of menarche, as adolescent girls with poor, good, or excessive nutritional status can still experience early or late menarche because many factors influence the age of menarche. This study aims to evaluate the relationship between nutritional status and menarche age in adolescent girls through a systematic review of 10 scientific articles that meet the inclusion criteria. Most studies used a cross-sectional design, and only one used a retrospective design. Data analysis in the article generally uses bivariate statistical tests such as Chi-square and Spearman correlation, which show variations in correlation and statistical significance between the studied variables. Eight of the 10 articles reviewed indicate a significant relationship between nutritional status and menarche age, marked by a p-value <0,05. For example, Amiruddin et al. (2023) study showed a correlation value of  $r = -0,319$ , indicating a moderate and inverse relationship that the lower the nutritional status, the later the menarche age. Similarly, Makarimah (2017) showed a value of  $r = 0,360$ , although this correlation is weaker. These two findings are consistent with the theory that energy deficit can delay the maturation of reproductive organs due to decreased reproductive hormone levels, such as FSH and LH. On the other hand, two other articles show no significant relationship between nutritional status and age of menarche, namely the articles by Enggar et al. (2022) and Asfahani et al. (2019). This is due to the characteristics of the sample, where most respondents in both studies experienced normal menarche despite having poor nutritional status. For example, Enggar's research noted that 96,7% of the thin respondents still experienced menarche within the normal age range.

This emphasizes that factors other than nutrition, such as genetics, dietary patterns, physical activity, and socioeconomic status, can also influence the age of menarche. This finding reinforces the understanding that nutritional status is an important factor, but not the only one, in determining the age of menarche. A comprehensive review of these articles also indicates that higher nutritional status (overweight or obesity) is often associated with early menarche. At the same time, undernutrition has the potential to delay the menarche process. This is in line with hormonal mechanisms, where excess adipose tissue increases leptin production, which then affects the secretion of GnRH, FSH, and LH, as well as stimulates estrogen production that accelerates the maturation of ovarian follicles. The findings of this research emphasize that the fulfillment of balanced nutrition during adolescence is a crucial aspect in preventive efforts against reproductive system disorders, including delays or advances in menarche age. Therefore, the active role of parents, healthcare providers, and educational institutions is essential in ensuring adequate nutritional intake for adolescents while providing education on the importance of maintaining reproductive health from an early age. This study's uniqueness and main contribution lie in using a comprehensive literature review approach to research conducted in the local context of Indonesia. Previously, related studies were still separate and limited in scope. This research not only compiles various findings but also critically analyzes the inconsistencies in data and highlights the interaction between nutritional status and external factors such as diet, physical activity, and social environmental conditions.

Thus, this study provides new insights in the form of relevant empirical and theoretical synthesis that can serve as a foundation for developing adolescent health policies and as a reference for further in-depth research. Nevertheless, this study has several limitations that need to be acknowledged. First, because it uses a literature review method, the data depend entirely on the quality, depth, and completeness of the information from the analyzed articles. Second, most of the articles reviewed used a cross-sectional research design, limiting the ability to assess cause-and-effect relationships thoroughly. Third, there is variability in the characteristics of the samples, such as geographical location, socioeconomic background, and different population sizes, which limits the generalization of the findings. Fourth, because all the articles analyzed come from Indonesian language sources obtained through Google Scholar and accredited journals SINTA 1-4, the

potential for publication bias needs to be considered when interpreting the results more broadly. Considering these strengths and limitations, this study is expected to serve as a preliminary basis for a broader literature review, which includes international sources and more varied methodologies to enrich the understanding of factors influencing menarche age in adolescent girls.

#### IV. Conclusion

Based on the findings from the analysis of ten research articles reviewed in this literature review, it can be concluded that nutritional status significantly influences the age of menarche in adolescent girls. Adolescents with good nutritional status tend to experience menarche at a normal age, which is between 11 and 13 years. Otherwise, adolescents with higher nutritional status or obesity tend to experience earlier menarche, while those with undernutrition status are at risk of experiencing delayed menarche. Eight of the ten articles reviewed show a statistically significant relationship between nutritional status and age at menarche. This relationship is generally explained through hormonal mechanisms, where excess fat tissue increases the secretion of the hormone leptin, which stimulates the production of reproductive hormones (GnRH, FSH, and LH) that affect sexual maturity and the timing of menarche. In addition to nutritional status, other factors such as genetics, socioeconomic status, physical activity, dietary patterns, and lifestyle also play a role in determining the timing of menarche. Therefore, optimal nutritional fulfillment during adolescence is essential to maintain reproductive health, prevent early or late menarche, and support healthy and balanced growth and development in adolescent girls.

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