

The Relationship Between Nutritional Status and Sexual Maturity of Students at Al-Irsyad Al-Islamiyyah II Elementary School, Bekasi

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Abstract

Puberty is a transitional period to adulthood characterized by physical, cognitive, and psychosocial changes. One of the indicators is sexual maturity and reproductive ability, which are influenced by various factors, including nutritional status. Nutritional imbalances can accelerate or delay sexual maturity. This study aims to determine the relationship between nutritional status and sexual maturity in students of *SD Al-Irsyad Al-Islamiyyah II Bekasi*. The design of this study is quantitative, with an analytical descriptive approach using a cross-sectional method. The sample consisted of 60 students in grades 4, 5, and 6, obtained using a total sampling technique. Nutritional status was measured using the Body Mass Index (BMI) based on the *CDC 2000 growth chart*, while sexual maturity was assessed using the *Tanner staging* questionnaire. The data were analyzed using the Chi-square test and Fisher's exact test. The results showed a significant relationship between nutritional status and sexual maturity in male students, with a p-value = 0.023, and a p-value = 0.036 in the female group. Both results indicate that there is a significant relationship between nutritional status and sexual maturity in boys and girls.

INTRODUCTION

Adolescence is a transitional period in human life from childhood to adulthood, typically occurring between the ages of 10 and 19 years. During this period, significant physical, cognitive, and psychosocial changes occur (WHO, 2024). One of the physical changes in adolescents is sexual maturation and the development of reproductive capability, commonly referred to as puberty. The average age of puberty onset in females is between 8 and 13 years, while in males it is between 9 and 14 years. Signs of puberty in females include breast development (thelarche), the growth of pubic hair (pubarche), menarche, and maturation of the ovaries, uterus, and vagina. Puberty in males is characterized by increased testicular size, pubarche, and growth of the penis (Breehl & Caban, 2023). Several factors can influence the timing of puberty, including ethnic, social, psychological, physical, chronic disease, and nutritional factors (Widiastini et al., 2024).

Nutrition is an important factor affecting the timing and tempo of puberty (Cheng et al., 2022; Fantuz et al., 2024; Leite, 2025). The need for calories, protein, iron, calcium, zinc, and folate increases during this period to support optimal physical and cognitive growth and development (Soliman et al., 2022). The balance between nutrient requirements and food intake is referred to as nutritional status (Putri et al., 2022). According to the Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020 concerning Child Anthropometric

Standards, nutritional status can be categorized using Body Mass Index (BMI) for Age (BMI/U).

The most common nutritional problems among adolescents in Indonesia include protein-energy malnutrition (PEM), chronic energy deficiency (CED), anemia, iodine deficiency, vitamin A deficiency, and obesity. Data from Riset Kesehatan Dasar (Riskesdas) in 2018 reported that 25.7% of adolescents aged 13–15 years had short stature and 26.9% of adolescents aged 16–18 years had very short stature. In addition, 8.7% of adolescents aged 13–15 years and 8.1% of adolescents aged 16–18 years were recorded as thin or severely thin. The prevalence of obesity in adolescents was 16% in the age range of 13–15 years and 13.5% in the age range of 16–18 years (Sabiah et al., 2023).

Several endocrine factors can be affected by malnutrition, which may delay the signaling required to initiate puberty (Akram et al., 2023; Fedorcak et al., 2023). This delay is associated with alterations in the pulsatile amplitude of gonadotropin-releasing hormone (GnRH), which stimulates the secretion of luteinizing hormone (LH) and follicle-stimulating hormone (FSH). These hormones play key roles in the production of sex steroid hormones in the ovaries and testes. Other endocrine factors, such as the hormones leptin and ghrelin—both regulators of energy balance and appetite—also play important roles in puberty. Low concentrations of leptin are associated with delayed onset of menstruation. Meanwhile, ghrelin, which is produced in large quantities during states of energy deficiency, can inhibit the release of GnRH. In males, the hormone testosterone plays a role in spermatogenesis, the development of secondary sexual characteristics, changes in body composition, muscle formation, and brain development in gender-dimorphic areas. In females, the hormone estrogen plays an important role in reproductive maturation, mammary gland development, changes in body composition, and the mineralization and closure of epiphyseal bone plates (Christian & Smith, 2018).

According to research by Arsyad et al. (2018) involving adolescent girls aged 11–13 years, there is a relationship between nutritional status and secondary sexual characteristics. Adolescent girls with higher BMI tend to experience earlier menarche. On the other hand, research conducted by Wijayati (2021) on adolescent girls in Kediri showed different results, indicating that there was no relationship between nutritional status and the incidence of menarche. The differences in these findings indicate that inconsistencies still exist, highlighting the need for further research.

Although several studies have explored the impact of nutrition on puberty, there is limited research specifically targeting adolescent students in the Bekasi area. Additionally, most studies focus on either nutritional status or puberty independently, without examining the combined influence of both factors on sexual maturity. This study addresses this gap by examining the relationship between nutritional status and sexual maturity, providing a more holistic understanding of how these factors interact.

This study aims to analyze the relationship between nutritional status and sexual maturity among students at SD Al-Irsyad Al-Islamiyyah II Bekasi by assessing BMI and Tanner stages in both male and female students. The findings of this study are expected to contribute to the existing body of knowledge on adolescent health, particularly regarding the role of nutrition in sexual development. The results may inform parents, educators, and healthcare professionals about the importance of maintaining balanced nutrition for optimal physical and hormonal development during adolescence. Furthermore, this research may serve as a reference for future

studies on adolescent health and support the development of interventions aimed at improving adolescent well-being.

METHOD

This study is quantitative research with a cross sectional design that aims to analyze the relationship between nutritional status and sexual maturity. The study population was all students in grades 4, 5, and 6 of SD Al-Irsyad Al-Islamiyyah II Bekasi, with samples determined using total sampling according to the inclusion criteria (age 8–14 years, have entered puberty, and willing to be respondents) and exclusion criteria (not present at the time of data collection, incomplete questionnaire, or having diseases that can inhibit puberty). Primary data were obtained through weight, height, and Tanner Stage questionnaire measurements, then nutritional status was determined based on body mass index by age (BMI/U) based on the CDC 2000 curve. The number of samples analyzed was 60 students. The data was processed using Microsoft Excel 2021 and IBM SPSS Statistics 29.0, with a descriptive and correlational approach. The data were analyzed using the Chi-Square test and Fisher's Exact Test.

RESULTS AND DISCUSSIONS

The number of respondents in this study was 60 respondents who met the inclusion and exclusion criteria. Respondent characteristics based on gender were found that the most respondents were male with a total of 37 people (61.7%).

Table 1. Respondents' gender characteristics

Gender	Frequency (n)	Percentage
Male	37	61,7%
Women	23	38,3%
Total	60	100%

Source: Adapted from WHO, 2024

In this study, the age of the respondents ranged from 10 to 12 years. The majority of respondents in this study were in the age group of 11 years, which was 25 students (41.7%). The most male students are in the 12-year-old age group of 15 students. Meanwhile, female students are dominated by the 11-year-old age group, which is 13 students.

Table 2. Age characteristics of respondents

Age (years)	Male (n)	Female (n)	Total (N)	Percentage
10	10	3	13	21,7%
11	12	13	25	41,7%
12	15	7	22	36,7%
Total	37	23	60	100%

Source: Adapted from Kliegman et al., 2020

Nutritional status in this study was determined based on Body Mass Index (BMI) which was classified according to the CDC 2000 curve based on age and sex. The nutritional status categories used are:

1. Underweight: BMI < 5th percentile
2. Healthy weight: BMI ≥ 5th percentile and < 85th percentile
3. Overweight: BMI ≥ 85th percentile and 95th < percentile
4. Obesity (obese): BMI ≥ 95th percentile
5. Severe obesity if 120% of the 95th percentile or more, or 35 kg/m² or more

The distribution of nutritional status in 60 respondents after height and weight measurements are presented in Table 3 below.

Table 3. Characteristics of the nutritional status of the respondents

Gender	Underweight	Normal Weight	More Weight	Obesity	Total
Male	3 (8,1%)	18 (48,6%)	9 (24,3%)	7 (18,9%)	37
Women	2 (8,7%)	11 (47,8%)	6 (26,1%)	4 (17,4%)	23
Total	5 (8,3%)	29 (48,3%)	15 (25%)	11 (18,3%)	60

Source: Adapted from CDC 2000 Guidelines for Body Mass Index (BMI) Assessment

Most of the respondents had a healthy *weight* nutritional status, which was 48.3% of the total 60 children analyzed. The normal weight group consisted of 18 boys (48.6%) and 11 girls (47.8%). This shows that almost half of all respondents are at normal nutritional status according to the CDC 2000 curve. Respondents with overweight, obesity, and underweight categories reached 31 children (51.6%) who were abnormal nutritional status.

Sexual maturity in this study was measured using the Tanner stage, which is a scale for assessing the development of sexual characteristics which includes 5 levels. The results of the observation of the Tanner stage are categorized into 3 groups, namely early, normal, and late sexual maturity, based on the suitability between the child's age and the level of sexual maturity experienced. Based on the results of the questionnaire, 60 respondent data were obtained with the distribution of sexual maturity classification by gender as follows.

Table 4. Tanner Stage male student respondents

Tanner Stage	Number of Children (n)	Percentage (%)
1	16	43,2%
2	9	24,3%
3	11	29,7%
4	1	2,7%
Total	37	100%

Source: Adapted from Tanner, 1962 (Standard Puberty Classification)

Table 4 shows that male respondents totaling 37 children, as many as 16 children (43.2%) were at level 1 of the Tanner stage, 9 children (24.3%) were at level 2, 11 children (29.7%) were at level 3, and 1 child (2.7%) reached level 4. Most of the boys are in the 1st and 3rd levels of the Tanner stage.

Table 5. Tanner Stage female student respondents

Tanner Stage	Number of Children (n)	Percentage (%)
1	8	34,8%
2	11	47,8%
3	4	17,4%
Total	23	100%

Source: Adapted from Tanner, 1962 (Standard Puberty Classification)

In Table 5, the number of female respondents was recorded as 23 children, as many as 8 children (34.8%) were at level 1 Tanner stage, 11 children (47.8%) were at level 2, and 4 children (17.4%) were at level 3. Most girls are at level 2 (47.8%). Level classification Tanner stage It plays an important role in identifying early, normal, or late sexual maturity categories based on age.

Table 6. Distribution of sexual maturity by sex

Gender	Sexual Maturity			Total
	Early	Normal	Late	
Male	11 (29,7%)	16 (43,2%)	10 (27%)	37
Women	0 (0%)	14 (60,9%)	9 (39,1%)	23
Total	11 (18,3%)	30 (50%)	19 (31,7%)	60

Source: Based on study data

Table 6 above shows that the two groups of respondents were mostly in the category of normal sexual maturity (50%), consisting of 16 boys (43.2%) and 14 girls (60.9%). Meanwhile, in the category of abnormal sexual maturity, 30 children (50%) were found, namely 11 children (18.3%) with early sexual maturity and 19 children (31.7%) with late sexual maturity.

Table 7. Cross-tabulation of nutritional status by sexual maturity in male students

Nutritional status		Sexual Maturity			Total
		Dini	Normal	Late	
Abnormal	Count	10	6	3	19
	Expected count	6,2	7,7	5,1	19
Normal	Count	2	9	7	18
	Expected count	5,8	7,3	4,9	18
Total	Count	12	15	10	37
	Expected count	12	15	10	37

Source: Chi-square analysis results from this study

Table 8. Chi-Square test results in male students

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7,512a	2	,023
Likelihood Ratio	8,045	2	,018
Linear-by-Linear Association	6,347	1	,012
N of Valid Cases	37		

a. 1 cells (16,7%) have expected count less than 5. The minimum expected count is 4,86.

Source: IBM SPSS Statistics 29.0 Analysis

Most of the respondents were in the normal sexual maturity category, namely 15 children (40.5%). The majority of boys with normal nutritional status are of normal sexual maturity, with a total of 9 children (50%). Meanwhile, children with abnormal nutritional status categories experienced the most early sexual maturity, namely 10 children (52.6%). Based on the Chi-Square test in Table 8, it was found that the significance value (p-value) was 0.023, which means that the p-value < 0.05, so it can be concluded that there is a significant relationship between nutritional status and sexual maturity in boys at SD Al-Irsyad Al-Islamiyyah II Bekasi. The results of the validation of the Chi-Square test requirements showed that there was only 1 cell (16.7%) that had an expected count of < 5, with the smallest value of 4.86. This value is still within reasonable limits (<20%), so the Chi-Square test is still considered valid and can be used to draw conclusions.

Table 9. Cross-tabulation of nutritional status with sexual maturity in female students

		Sexual Maturity		Total	
		Normal	Late		
Nutritional status	Abnormal	Count	10	2	12
		Expected count	7,3	4,7	12
	Normal	Count	4	7	11
		Expected count	6,7	4,3	11
Total	Count	14	9	23	
	Expected count	14	9	23	

Source: Chi-square analysis results from this study

Table 10. Chi-Square and Fisher's Exact Test test results for female students

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5,316a	1	,021		
Continuity Correction ^b	3,527	1	,060		
Likelihood Ratio	5,555	1	,018		
Fisher's Exact Test				,036	,029
Linear-by-Linear Association	5,085	1	,024		
N of Valid Cases	23				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 4,30.

b. Computed only for a 2x2 table

Source: IBM SPSS Statistics 29.0 Analysis.

Overall, the respondents were most in the category of normal sexual maturity with a total of 14 children (60.9%), compared to 9 children (39.1%) who experienced late sexual maturity. Most girls with abnormal nutritional status have normal sexual maturity, which is 10 children (83.3%). However, the majority of children with normal nutritional status actually experience late sexual maturity, namely 7 children (63.6%).

Based on the Chi-Square test in Table 10, a significance value (p-value) was obtained which is 0.021, which means a p-value < 0.05, so it can be concluded that there is a significant relationship between nutritional status and sexual maturity in girls at SD Al-Irsyad Al-Islamiyyah II Bekasi. In the results of this Chi-Square test, there are 2 cells (50.0%) that have an expected count of <5, with a minimum value of 4.30, which means that it exceeds the ideal

limit (20%), so the Chi-Square test is considered less than ideal. Therefore, the Fisher's Exact Text test was performed, which is more accurate for tables with small frequencies.

The Fisher's Exact Text test showed a significance result of $p=0.036$, which means a p -value < 0.05 , so it can be concluded that there is a significant relationship between nutritional status and sexual maturity in girls at SD Al-Irsyad Al-Islamiyyah II Bekasi.

Discussion

Based on the Chi-Square statistical test, it was found that there was a significant relationship between nutritional status and sexual maturity in boys ($p = 0.023$) and girls ($p = 0.021$; Fisher's exact $p = 0.036$). This shows that nutritional status is one of the important factors that affect the incidence of puberty.

In 37 male respondents, the nutritional status of the abnormal category was more related to early sexual maturity (52.6%), which reached Tanner stage 3 and there was even 1 child who reached Tanner stage 4 who was not in accordance with his age. This shows that nutritional imbalances, both undernutrition and overnutrition, can cause disturbances in the regulation of sexual development hormones, especially in overnutrition conditions and obesity.

Excess body fat is related to increased production of the hormone leptin. Leptin signals to the hypothalamus which is the regulatory organ of various hormones, including the production of gonadotropin releasing hormone (GnRH). GnRH hormone stimulates the pituitary gland to produce luteinizing hormone (LH) and follicle stimulating hormone (FSH). Furthermore, LH and FSH stimulate the gonadal glands to produce testosterone in males and estrogen in females, thereby accelerating puberty (Kliegman et al., 2020). These results are in line with the research of Rumayauw et al. (2024) entitled Physical Growth and Sexual Maturity of Subsistence Populations in the Padaido Islands, Papua, on 130 boys and 153 girls aged 7-16 years. The study showed that children with faster physical growth tend to experience earlier sexual maturity, due to the accumulation of body fat used before or before puberty.

Some male respondents with abnormal nutritional status categories continued to experience normal sexual development and some were late. In addition, in the category of normal nutritional status it was related to normal (50%) and late sexual maturity (38.9%).

In the category of abnormal nutritional status, there were 3 underweight children who experienced normal sexual maturity. In a study conducted by Campisi et al. (2021) on the timing of puberty in Pakistan, it was found that malnourished children tend to experience puberty later in the early stages, but the time of completion of puberty remains at a relatively similar age to that of well-nourished children, suggesting that there is a time compensation in the development of puberty. In another study by Durda-Masny et al. (2022), it was found that children born with a lower-than-normal baby weight or Small for Gestation Age (SGA) experienced rapid growth because they caught up or also called catch-up growth. Although anthropometrically underweight, children with SGA experience early puberty, but the growth period may be shorter and end up with lower final height. This involves an increase in leptin levels due to a heavy rebound, which then activates the hypothalamic-pituitary-gonad axis (HPG-axis) via the kisspeptin pathway. In other words, even though the child's weight is still relatively low, this minimal increase in weight is enough to trigger the activation of the hormones that regulate puberty, so that sexual maturity can still take place normally.

In the category of abnormal nutritional status, there were 2 overweight children and 1 obese child who experienced late sexual maturity. These findings are in line with the explanation of Kythreotis et al. (2025), that obesity in boys can cause late puberty because excess leptin will increase gamma-aminobutyric acid (GABA) in the hypothalamus which inhibits the release of the hormone GnRH. In addition, leptin also increases the activity of aromatases that convert testosterone into estrogen, thereby lowering the levels of free testosterone needed for puberty and sexual maturation (Kythreotis et al., 2025).

There were 7 children with normal nutritional status who experienced late sexual maturity. In line with the explanation of Howard & Dunkel (2019), delayed puberty is not always caused by nutritional disorders or chronic diseases, but can be a form of self-limited delayed puberty (SLDP). SLDP is a developmental variation that is physiological and generally genetic, especially in children with normal nutritional status. In most cases, children with SLDP will experience puberty spontaneously before the age of 18 without the need for hormone therapy. In addition to genetics, other factors also affect the delay of puberty, such as excessive exercise, anorexia nervosa, psychological stress, chronic diseases, radiation exposure, as well as tumors that affect the hypothalamic-pituitary-gonad pathway (Howard & Dunkel, 2019).

This shows that the relationship between nutritional status and sexual maturity can be influenced by various other factors, such as genetics, physical activity, stress, and body health conditions. This occurrence is also supported by the theory in the 21st edition of the Nelson Textbook of Pediatrics, which states that puberty is a complex series of processes that are not only influenced by nutrition, but also depend on neuroendocrine and environmental factors (Kliegman et al., 2020).

In 23 female respondents, no cases of early sexual maturity were found. Children with normal nutritional status categories were associated with normal (36.4%) and late (63.6%) sexual maturity, and even more were recorded to experience late sexual maturity (63.6%). Meanwhile, children with abnormal nutritional status categories mostly experienced normal sexual maturity (83.3%). This seems to contradict the common theory that children with high body fat tend to experience earlier sexual maturation. However, according to the 21st edition of the Nelson Textbook of Pediatrics, puberty is not only influenced by nutritional status but also by genetic factors, excessive physical activity, psychosocial stress, body health, and environmental factors, which were not studied in this study. These factors can delay the activation of the hypothalamic-pituitary-gonadal pathway (HPG-axis), so that puberty and sexual maturity occur more slowly.

Similar things were also found in Wijayati's (2021) research on the relationship between menarche incidence and nutritional status in adolescent girls at MI Nururrisallah, Sumberbendo Village, Pare District, Kediri Regency using a cross sectional method using a questionnaire, results were obtained from 70 respondents, there were 19 respondents with abnormal nutritional status who had not menarched, 7 respondents with abnormal nutritional status had menarche, 38 respondents with normal nutritional status have not menarched, and 6 respondents with normal nutritional status have menarche. This study reinforces the understanding that nutritional status is one of the important factors that affect girls' sexual maturity, but the power of influence can vary depending on individual conditions and environmental factors.

In the normal nutritional status category, there were 7 girls of normal weight who experienced late sexual maturity. It can also be caused by self-limited delayed puberty (SLDP),

which is a normal physiological development with slower activation of the hypothalamic–pituitary–gonadal pathway than peers without nutritional disorders or chronic diseases. In addition, other factors can also play a role such as high physical activity, low energy intake, hypothyroidism, and suboptimal macro or micronutrient deficiencies (Howard & Dunkel, 2019).

In this study, 7 girls with normal nutritional status experienced late sexual maturity according to Tanner Stage's assessment. However, 6 of them have not experienced menarche. According to the Nelson Textbook of Pediatrics, menarche generally occurs between the ages of 9–15, with an average age of about 12.5 years. This means that girls who have not experienced menarche but are still in that age range are part of the normal variation of the puberty process, not an indication of late puberty. The sequence of occurrence of puberty features such as thelarche, pubarche, and then menarche is relatively consistent, but the timing of their onset can vary between populations and individuals (Kliegman et al., 2020).

CONCLUSION

There was a significant relationship between nutritional status and sexual maturity among students in grades 4, 5, and 6 at SD Al-Irsyad Al-Islamiyyah II Bekasi, observed in both male and female students. These findings highlight the importance of adequate nutrition in supporting normal sexual maturation during late childhood and early adolescence. Therefore, parents and schools are encouraged to routinely monitor students' growth and development, including nutritional status and pubertal progression, through regular health checkups and health education programs to help detect potential growth or developmental disorders early. For future research, studies with larger sample sizes are recommended, along with the inclusion of additional variables such as physical activity, dietary intake, hormonal indicators of puberty, and psychosocial conditions to provide a more comprehensive understanding of the factors influencing sexual maturity.

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