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NUTRITIONAL STATUS ASSESSMENT BASED ON BMI-AGE AND METABOLIC SYNDROME STATUS AMONG ADOLESCENTS

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ABSTRACT
Adolescents are in a transitional phase that often involves changes in dietary habits and lifestyle, which can significantly affect their nutritional status and increase the risk of metabolic syndrome. This study aimed to identify the nutritional status based on Body Mass Index-for-Age (BMI/A) and metabolic syndrome status among adolescents in Semarang Regency. A quantitative descriptive survey with a cross-sectional approach was conducted at SMA Negeri 1 Pabelan, Semarang Regency, from March to July 2024. A total of 86 students aged 16–18 years were selected using random sampling. Data collection included anthropometric measurements (height, weight, waist circumference) to assess nutritional status and blood tests for glucose, uric acid, and cholesterol levels to identify potential metabolic syndrome. Data analysis was conducted using quantitative descriptions. The results showed that 11.6% of respondents were undernourished and 8.1% were obese. The prevalence of pre-metabolic syndrome was higher among female students (33.7%) compared to male students (16.3%), while metabolic syndrome was more common among males (27.9%) than females (18.6%). In conclusion, most adolescents had a good nutritional status; however, the presence of undernutrition and obesity indicates a risk of metabolic syndrome. Continuous health monitoring and education regarding balanced nutrition and healthy lifestyles are essential to prevent adolescent metabolic disturbances.

Keywords: adolescents; nutritional statu; metabolic syndrome

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INTRODUCTION

Malnutrition remains one of the most prevalent causes of morbidity and mortality among children and adolescents. In conjunction with an imbalanced diet, it is now recognized as the leading risk factor contributing to the global burden of disease. Adolescence represents a critical developmental stage, characterized by substantial changes in health status, and the determinants influence well-being later in life. Ensuring adequate nutritional intake is essential to facilitate a healthy transition from adolescence to adulthood, as the consequences of malnutrition in this population include growth retardation, impaired cognitive development, reduced intelligence quotient (IQ), behavioral issues, and an elevated susceptibility to infectious diseases (Salam et al., 2020) The Southeast Asia and Pacific regions account for nearly half of the global cases of the triple burden of malnutrition-undernutrition, overweight, and micronutrient deficiencies. This is primarily driven by dietary transitions marked by increased intake of processed foods and decreased physical activity due to industrialization and urbanization (Rah et al., 2021).

The problem of undernutrition among adolescents is influenced by a range of complex factors, including individual characteristics, household environments, and community-level determinants. According to the World Health Organization (WHO), the main causes of this condition comprise inadequate dietary intake, illnesses, physical injuries, infections, and early

pregnancy. Thinness in adolescents is frequently linked to a higher risk of infectious diseases, delayed sexual maturation, diminished muscle strength, and reduced work capacity and bone density in later life. In particular, thinness in adolescent girls may adversely affect pregnancy outcomes and impede fetal growth. This condition is typically assessed by body mass index-for-age (BMI-for-age) values falling two standard deviations below the WHO growth reference median. Micronutrient deficiencies reflect insufficient intake of essential vitamins and minerals required in small amounts to support optimal growth and development (Estecha Querol et al., 2022).

The prevalence of overweight and obesity among children and adolescents has significantly increased, leading to a global health crisis. There is strong evidence linking childhood obesity with serious medical conditions that diminish quality of life and elevate morbidity rates from an early age. Concurrently, the occurrence of metabolic syndrome (MetS) has risen alongside childhood obesity. MetS has been identified as a key predictor of cardiovascular disease (CVD) development (Pinhas-Hamiel et al., 2015). Based on the background, the objective of this study is to identify the nutritional status based on Body Mass Index-for-Age (BMI/A) and the metabolic syndrome status among adolescents in Semarang Regency

METHOD

This research is a quantitative descriptive design and was conducted at SMA Negeri 1 Pabelan, Semarang Regency, Central Java, from March to July 2024. This research has passed ethics number REC.2024043001/03.10/2025 from the Research Ethics Commission of the Faculty of Health Sciences, Satya Wacana Christian University. The population of the study was students aged 16-18 years. The research sample was determined using simple random sampling with the Slovin formula, 86 students were involved in this study. Nutritional status was assessed using anthropometric measurements, including body weight (digital scale) and height (stadiometer), with BMI-for-age (BMI/A) classification based on the Indonesian Ministry of Health Regulation No. 2 of 2020. Nutritional categories included: severely thinness (< -3 SD), thinness (-3 to < -2 SD), normal (-2 to +1 SD), overweight (+1 to +2 SD), and obese (> +2 SD). Metabolic syndrome risk was evaluated through blood glucose, uric acid, and cholesterol levels using the Easy Touch GCU meter. A blood glucose level >100 mg/dL was considered high. According to WHO (2016), normal uric acid levels are 3.6–5.5 mg/dL for males and 3.6–4.0 mg/dL for females aged 10–18. Normal cholesterol levels were defined as <100 mg/dL. According to the WHO Asia-Pacific guidelines (2020), central obesity is defined as a waist circumference of ≥90 cm for males and ≥80 cm for females. The normal blood pressure for adolescents is 122/77 mmHg. Metabolic syndrome was identified based on the NCEP/ATP III criteria, adapted to Indonesian guidelines, with a minimum of three criteria required for diagnosis. Data analysis was performed using descriptive quantitative methods.

RESULT

Table 1.
Respondent characteristics (n= 86)

Respondent characteristics	f	%
Age		
16 years old	12	14
17 years old	51	59
18 years old	23	27
Gender		
Female	47	55
Male	39	45

Table 2.
Nutritional Status Based on Body Mass Index-for-Age (BMI/A)

Category	Male		Female		Total	
	f	%	f	%	f	%
Severely thinness	3	3,5	7	8,1	10	11,6
Thinness	11	12,8	2	2,3	13	15,1
Normal	22	25,6	29	33,7	51	59,3
Overweight	1	1,2	4	4,7	5	5,8
Obese	2	2,3	5	4,8	7	8,1
Total	39	45,3	47	54,7	86	100,0

Table 3.
Distribution of Metabolic Syndrome Risk

Variable	Male		Female		Total	
	f	%	f	%	f	%
Uric acid						
Normal	31	36	25	29	56	65
High	8	9	22	26	30	35
Blood Glucose						
Normal	39	45	47	55	86	100
High	0		0		0	0
Cholesterol						
Normal	38	44	46	54	84	98
High	1	1	1	1	2	2
Blood Pressure						
Diastolic						
Pre-hypotension	7	8	7	8	14	16
Normal	20	23	32	38	52	61
Hypertension	12	14	8	9	20	23
Systolic						
Pre-hypotension	10	12	19	22	29	34
Normal	18	21	23	26	41	47
Hypertension	11	13	5	6	16	19
Waist circumference						
Normal	33	38	43	50	76	88
High	6	7	4	5	10	12

Table 4.
The Risk of Metabolic Syndrome Among Adolescents

Respondent characteristics	Normal		Pra-Metabolic Syndrome		Metabolic Syndrom		Total
	f	%	f	%	f	%	
Age							
16 years old	0	0	3	3	9	11	12
17 years old	3	3	29	34	19	22	51
18 years old	0	0	11	13	12	14	23
Gender							
Female	2	2	29	34	16	19	47
Male	1	1	14	16	24	28	39

DISCUSSION

Respondent characteristics

Table 1 indicates that most of the respondents (59%) are 17 years old, 14% of the respondents are aged 16, and 27% are aged 18. The majority of respondents in this study were female (55%), and 45% were male. Adolescence is a phase marked by physical, biological,

psychological, and social development as part of the transition to adulthood. According to data from the World Health Organization (WHO), adolescents are categorized within the age range of 10 to 19 years. This age group accounts for approximately 20% of the global population, with about 84% residing in developing countries. WHO states that attention to adolescent health and nutrition is still relatively recent. In fact, adolescence represents the second fastest period of growth after the first 1,000 days of life, indicating the need for targeted nutritional interventions for this age group (Gezaw et al., 2023).

Nutritional Status Based on Body Mass Index-for-Age (BMI/A)

Table 2 indicates that the majority of male respondents have a normal nutritional status (25.6%). Among male respondents, 16.3% are classified as undernourished or malnourished, and 3.5% are overweight. Similarly, most female respondents have a normal nutritional status (33.7%), with 10.4% categorized as undernourished and malnourished, and 9.5% as overweight. Overweight and extreme underweight are associated with an increased risk of health problems (Cuntz et al., 2023). Obesity in children and adolescents has been associated with a wide range of health complications, including menstrual irregularities, sleep disorders such as obstructive sleep apnea (OSA) and early onset of puberty. It significantly increases the risk of metabolic conditions such as prediabetes, type 2 diabetes, hypertension, non-alcoholic fatty liver disease (NAFLD), hypercholesterolemia, and metabolic syndrome. Moreover, obesity may adversely affect psychological well-being, low self-esteem, contributing to depression, negative body image, anxiety,eating disorders, and impaired peer relationships (Kansra et al., 2021).

Underweight is widely recognized as one of the major public health issues, as it can affect physical condition, cognitive function, and educational achievement. In addition, poor health and inadequate nutritional intake among adolescent girls have the potential to cause long-term, intergenerational impacts, including malnutrition, reduced productivity, and economic losses (J. K. Singh et al., 2021). The research conducted by Verbecque et al revealed that underweight children typically demonstrate higher agility but possess lower muscle strength compared to their age-matched peers with normal weight. Given its correlation with motor competence and physical activity, it is essential to provide targeted interventions to address muscle strength deficiencies in these children, enabling them to fulfill the fundamental requirements for maintaining a healthy lifestyle in later life (Verbecque et al., 2022).

Distribution of Metabolic Syndrome Risk Among Adolescents

Table 3 shows that 35% of respondents had high uric acid levels. This needs further attention. Monitoring and education related to a healthy diet and lifestyle are important to prevent increased uric acid levels that have the potential to cause health problems such as gout or other metabolic disorders (A. Singh et al., 2025). Blood glucose measurements indicated that 100% of respondents had normal levels. A total of 2% had high cholesterol levels. Total cholesterol levels in adolescents should be below 170 mg/dL. The majority of adolescents had normal cholesterol levels, indicating good lipid health status (Suciawati et al., 2025). Blood pressure measurements revealed that 23% had elevated diastolic pressure, while 19% had elevated systolic pressure, mostly in male respondents. These results are similar to the results of a study by (Andajani, 2021) which found that male adolescent students were at a risk of developing pre-hypertension to grade 1 systolic and diastolic hypertension by 5,36 and 1,95 times higher than female students, respectively. These blood pressure variables indicate the need for routine monitoring and healthy lifestyle education to maintain blood pressure within the normal range to prevent the risk of cardiovascular disease in the future. In addition, waist circumference measurements showed that 12% of respondents exceeded the standard threshold. A large waist circumference reflects visceral fat congestion, which is closely related to a high risk of metabolic syndrome, such as hypertension, type 2 diabetes, dyslipidemia, and heart disease (Mulyasari et al., 2023). Table 4 indicates that the majority of

respondents aged 17 years were categorized as having pre-metabolic syndrome (34%) and metabolic syndrome (22%). Based on gender characteristics, most female respondents fell into the pre-metabolic syndrome category, whereas the majority of male respondents were categorized as having metabolic syndrome (28%). These findings are of particular concern in order to reduce the risk of metabolic syndrome in adolescents, so routine health assessments are needed for early detection, nutrition education, and structured physical activity programs, as well as handling central obesity through lifestyle modification.

Metabolic syndrome (MetS) is a multifactorial disorder that involves central obesity, dyslipidemia, elevated blood pressure, and increased fasting blood glucose levels (Codazzi et al., 2024). A study reported that the prevalence of metabolic syndrome (MetS) ranges from 0.2% to 38.9%, with a median value of approximately 3.3% (ranging from 0–19.2%) in the general population. The rates tend to be higher among overweight (11.9%) and obese (29.2%) children. These findings indicate that MetS in children and adolescents is increasingly becoming a significant public health concern (Bitew et al., 2020). Several studies indicate that children with obesity have the potential to develop into adults with obesity, and even morbid obesity, which significantly increases the likelihood of experiencing various chronic health problems over time. Furthermore, early exposure to obesogenic factors can also raise the risk of developing metabolic syndrome (MetS) in adulthood (Podeanu et al., 2024).

CONCLUSION

The conclusion of this research is that the majority of adolescents at SMA Negeri 1 Pabelan, Semarang Regency, had a normal nutritional status. However, cases of undernutrition and obesity were still found, which may increase the risk of metabolic syndrome. Several factors, such as uric acid and cholesterol levels, central obesity, and unstable blood pressure, also contributed to the emergence of metabolic syndrome among adolescents.

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