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Association of chronotype, breakfast habits, and sleep quality with BMI-for-Age in adolescents

Hubungan chronotype, kebiasaan sarapan, dan kualitas tidur dengan IMT/U pada remaja

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Abstract

Adolescence is prone to nutritional imbalances. Research in SMPN 18 Surakarta showed that 50% of adolescents were thinned, 10% were overweight, and 3,3% were obese. This study aimed to analyze whether chronotype, breakfast habits, and sleep quality contribute to malnutrition among adolescents. This research was conducted in Surakarta City between November 2024-January 2025 and used a cross-sectional as the design with multistage sampling. The Lemeshow Formula showed that the minimum sample size was 106. The instruments used were MEQ, Breakfast Habits, and PSQI questionnaires as well as body weight and height measurements. Kolmogorov-Smirnov test showed that the data is normally distributed. Pearson used as the bivariate test and multiple linear regression as the multivariate test. There was no correlation between chronotype (p = 0,900; r = 0,011), breakfast habits (p = 0,298; r = 0,087), and sleep quality (p = 0,420; r = 0,067) and BMI-for-age. There was no correlation between all independent variables and the dependent variable (F = 0,585). This research concluded that there is no correlation between chronotype, breakfast habits, and sleep quality with BMI-for-age in adolescents. However, further research with more diverse subjects and lifestyle variables is required to confirm these findings.

Keywords: Chronotype, breakfast habits, sleep quality, BMI-for-age, adolescent

Abstrak

Remaja rentan terhadap ketidakseimbangan status gizi. Penelitian di SMPN 18 Surakarta menunjukkan 50% remaja kurus, 10% gizi lebih, dan 3,3% obesitas. Penelitian ini bertujuan menganalisis apakah *chronotype,* kebiasaan sarapan, dan kualitas tidur berkontribusi terhadap malnutrisi remaja. Penelitian dilaksanakan di Kota Surakarta antara November 2024-Januari 2025 dengan desain *cross-sectional* dan *multistage sampling*. Rumus *Lemeshow* menunjukkan sampel minimal sebanyak 106 remaja. Instrumen yang digunakan adalah kuesioner MEQ, kebiasaan sarapan, dan PSQI, serta pengukuran tinggi dan berat badan. Uji Kolmogorov-Smirnov menunjukkan data terdistribusi normal. Uji Pearson digunakan sebagai uji bivariat dan regresi linear berganda sebagai uji multivariat. Hasil menunjukkan tidak terdapat hubungan *chronotype* (p = 0,900; r = 0,011), kebiasaan sarapan (p =0,298; r = 0,087), dan kualitas tidur (p = 0,420; r = 0,067) dengan IMT/U. Tidak terdapat hubungan seluruh variabel bebas terhadap variabel terikat secara simultan (F = 0,585). Penelitian ini menyimpulkan tidak terdapat hubungan antara *chronotype*, kebiasaan sarapan, dan kualitas tidur pada remaja. Namun, penelitian lebih lanjut dengan variasi subjek dan variabel pola hidup diperlukan untuk mengkonfirmasi hasil ini.

Kata Kunci: *Chronotype,* kebiasaan sarapan, kualitas tidur, IMT/U, remaja

Introduction

Adolescence is a critical transition period in the life cycle, followed by changes in some aspects including social, behavioral, physiological, and cognitive functions. This condition causes health problems in adolescents (Chan et al., 2020). One of the problems that often arises is nutritional status.

Nutritional status shows the balance between daily nutritional intake and nutritional needs. Adolescents' nutritional status could be evaluated using body mass index-for-age as an indicator that classifies adolescents as severely thinned, thinned, normal, overweight, and obese. Indonesian Health Survey (2023) showed that in Indonesian adolescents there were 1,9% severely thinned, 5,7% thinned, 76,1 % normal, 12,1% overweight, and 4,1% obese. The prevalence in adolescents in Central Java was 1,5% severely thinned, 5,7% thinned, 77,6% normal, 11,5% overweight, and 3,7% obese. Both undernutrition and overnutrition can lead to serious health problems in the future.

Breakfast is defined as the first meal of the day before any activities start or two hours after waking up. People eat breakfast before 10.00 A.M. (Suja'I et al. 2022). Sleep is defined as a condition in which motoric activity also responds, interactions with the environment are decreased, eyes are closed, lie down, and easy to wake up (Wahyuningrum, 2021). Sleep is defined as good quality if there are no insufficient sleep duration symptoms or sleep disruptions (Tristianingsih and Handayani 2021). Previous research has shown that breakfast habits and sleep quality affect BMI-for-age. Individuals who do not eat breakfast and have poor sleep quality tend to be overweight or obese.

Individuals' breakfast habits and sleep quality could be affected by chronotype. The chronotype is an individual's preference for daily sleep and awake times based on the circadian rhythm. Circadian rhythm is an internal biological clock in the human body (Tussey et al., 2024). Chronotypes were classified as morningness, eveningness, and intermediate. Adolescents tend to have eveningness chronotypes caused by the puberty phase, in which their circadian time is delayed based on the onset of dim-light melatonin.

Eveningness is identical to breakfast-skipping routine, delayed mealtime, and night eating behavior (Bazzani et al., 2022). This behavior has an impact on shorter and poorer sleep quality (Gülseven et al., 2024). A combination of poor dietary and sleep patterns is associated with metabolic syndrome, weight gain, and higher body mass index. This occurs because there is a decrease in melatonin, an increase in cortisol, an increase in ghrelin, and a decrease in leptin production that makes individuals feel hungry and eat more foods (Yeo et al., 2024). However, another study showed that school-age individuals tend to have *morningness* according to their school time (Saepulloh et al., 2023).

Previous research in SMPN 16 Surakarta showed that 25,5% of participants skipped breakfast before going to school (Awianti, 2016). Meanwhile, previous research on SMPN 1 Juwiring showed that 83,3% of subjects had poor sleep quality (Permatasari et al., 2023). Based on this theory, these conditions indicate that the prevalence of overweight or obesity must be higher. However, previous research in SMPN 18 Surakarta showed that 50% of subjects were thin, 10% were overweight, and 3,3% were obese (Astrika Yunita et al., 2020). This shows the possibility of adolescents being undernourished even in the puberty phase or not having an eveningness chronotype. In addition, in this previous study, the prevalence of thinned adolescents was much higher than the prevalence in Central Java and Indonesia.

Several researchers have studied chronotypes, breakfast habits, sleep quality, and nutritional status over time. However, research combining these four variables using cross-sectional methods, especially among adolescents, is still limited (Ferrante et al., 2022). This study aimed to analyze whether chronotype, breakfast habits, and sleep quality contribute to malnutrition in adolescents in Surakarta City. The relationship between these variables is important for optimizing adolescent growth and productivity. It is also important to minimize the risk of future health problems.

Methods

This study had a cross-sectional design. Data collection began in November 2024, and continued until January 2025. The study population included adolescents registered in public and private junior high schools in Surakarta City. Based on basic data on Indonesian education, the total number of

students in the Junior High School in Surakarta City academic year 2024/2025 is 18.932 (Kemdikbudristek, 2024).

In this study, multistage sampling was performed. The first technique is cluster sampling to separate the population into public and private school clusters. Schools were randomly chosen from each cluster as samples. The second technique was a simple random sampling to obtain participants from each chosen school. The sample size was calculated using the Lemeshow Formula, as explained below.

$$n = \frac{z^2 p(1-p)N}{d^2(N-1) + z^2 p(1-p)}$$

Description:
z = *confidence interval* = 95%
p = proportion of unknown cases = 50%
N = population = 30778
d = degrees of deviation = 10%
n = number of samples

This formula was used because the proportion of cases is unknown. From these calculations, 96 adolescents were included in the study. Samples (10%) were added as a backup for loss to follow-up. Subsequently, 106 adolescents were included in the study. This number was distributed to two public junior high schools and three private junior high schools in Surakarta. This is because the proportion of private junior high schools is higher than that of public junior high schools. The minimum number of participants was distributed to each school based on the following calculation:

$$n = \frac{X}{N}\ x\ N1$$

Description:

n = number of subjects in each school
X = number of population in each school
N = number of population = 30778
N1 = number of total minimum subjects = 106

The inclusion criteria were 7th grade students, registered as students in the chosen schools, and school time in the morning. The exclusion criteria were special school and diet programs, inability to stand, and genetic, metabolic, or infectious diseases.

Data were collected using self-report questionnaires completed during the data collection schedule at each school under the supervision of the research team. The first was the Reduced Morningness Eveningness Questionnaire (MEQ) by Horne and Östberg (1975), which was translated into Indonesian. The validity test scored 0,344 with r count > r table and Cronbach's Alpha is 0,87 (Yula, 2021). The second questionnaire was about breakfast habits and was developed by Nabila (2023). From the validity test, eight out of the ten questions were valid, and Cronbach's Alpha was 0,841. The last questionnaire was *the Pittsburgh Sleep Quality* Index (PSQI) by Buysse (1989), which was translated into Indonesian. The validity test showed lower PSQI score on normal population compared with risk population and the Cronbach's Alpha is 0,72 (Setyowati and Chung, 2021). This showed that all the questionnaires were valid and reliable. Identity data were also added to the participants' characteristic data.

After completing the questionnaire, the participants' body weights were measured using a digital body scale with an accuracy of 0,1 kg and a maximum weight of 100 kg. Body height was measured using a microtoise with an accuracy of 0,1 cm and maximum height of 200 cm. Each measurement was performed twice and the mean of the results was used. BMI-for-age was calculated using WHO Anthro Plus and interpreted according to Minister of Health Regulation number 2 of 2020.

All data were analyzed using IBM SPSS version 25. All the variables have a ratio scale. Univariate tests were used to show the frequency, percentage, mean, and standard deviation of data such as sex, age, chronotype, breakfast habits, sleep quality, and BMI-for-age categories. Before the bivariate test, a normality test was performed using the Kolmogorov-Smirnov test. The data were normally distributed if the p-value > 0,05. The bivariate Pearson Correlation Test was used because the data were normally distributed. The relationship was considered significant if the p-value < 0,05. Multiple linear regression was used for multivariate analysis. All tests used the total score of each questionnaire and the z-score of BMI-for-age.

All procedures performed were in accordance with ethical standards, and the

authors have no affiliations with any entities. This study was approved by The Health Research Ethics Committee Dr. Moewardi General Hospital (ethical clearance number: 2.622/XI/HREC/2024). Before the day of data collection, all participants were asked to provide informed consent to their parents. Informed consent required signatures from parents and participants as proof of approval. This research was self-funded by the researchers, and any supporting data were communicated through the corresponding author.

Result and Discussion

The participants' characteristics based on the research results are presented in Table 1.

Table 1. Subjects' characteristics

Characteristics	Public School		Private School		Mean ± SD
	n	%	n	%	
Gender					
Female	35	59,3	49	56,3	
Male	24	40,7	38	43,7	
Age (years)					12,55 ± 0,6
11			1	1,1	
12	24	40,7	45	51,7	
13	33	55,9	40	46	
14			1	1,1	
15	2	3,4			
Chronotype					55,28 ± 6,76
Definitely morning type			1	1,1	
Moderately morning type	19	32,2	29	33,3	
Intermediate	40	67,8	55	63,2	
Moderately evening type			1	1,1	
Definitely evening type			1	1,1	
Breakfast Habits					5,6 ± 2,19
Good	39	66,1	67	77	
Poor	20	33,9	20	23	
Sleep Quality					7,36 ± 2,18
Good	14	23,7	14	16,1	
Poor	45	76,3	73	83,9	
BMI-for-Age					0,23 ± 1,53
Severely thinnes	2	3,4	1	1,1	
Thinnes	3	5,1	7	8	
Normal	33	55,9	53	60,9	
Overweight	12	20,3	13	14,9	
Obese	9	15,3	13	14,9	

A total of 146 adolescents were included in this study. The study included 84 females (57,5%) and 62 males (42,5%). The participants were aged 11-15 years old. Most of the participants (73 adolescents) were 13 years old (50%).

All chronotypes were identified. The mean MEQ score was 55, with the majority being intermediate among the 95 adolescents (65,1%). The mean breakfast habit score was 7, with the majority (106 adolescents (72,6%) having good breakfast habits). The mean sleep quality score was 7, with the majority of 119 adolescents (81,5%) having poor sleep quality. This study also identified all the nutritional status categories. The mean *z-score* BMI-for-age was 0,23 with the majority or 86 adolescents (58,9%) having normal BMI-for-age.

The relationship between chronotype and BMI-for-age is presented in Table 2.

Table 2. Bivariate test of chronotype and BMI-for-Age

	BMI-for-Age	
Chronotype	r	0,011
	p	0,900
	n	146

Table 2 shows the bivariate test results, in which there was no significant correlation between chronotype and BMI-for-age (p = 0,900). The chronotype only explained 0,01% of the variance in BMI-for-age (r = 0,011). This result is in line with previous research in Lebanon, which showed no correlation between chronotype and BMI (p = 0,632) (Eid et al., 2020). However, this result differs from previous research in Turkey, which showed that obese adolescents tend to have eveningness. The BMI z-score was positively correlated with the chronotype (p < 0,001) (Karadag & Yilmaz, 2021).

A previous study used a wider educational level to affect heterogeneity. In addition, a previous study also used a case-control research design that specifically compared obesity and non-obesity groups. BMI measurement was also supported by waist circumference measurements as another indicator of nutritional status.

Chronotype is a factor related to dietary patterns (Karadag & Yilmaz, 2021). The heterogeneity of methodology and subject characteristics would affect dietary and sleep patterns related to obesity (Cardoso et al., 2024). The chronotype has simple stability, so it is responsive to any intervention. Newest conceptualization shows that chronotype is a condition that is influenced by many environmental factors (Karan et al., 2021). These conditions indicate that individuals can adjust their lifestyle according to their needs. This was supported by the finding that most of the participants were intermediate. They are more tolerant to changes in their daily activity schedules. It does not significantly affect sleep quality or other factors (Rosa et al. 2021).

The relationship between breakfast habits and BMI-for-age is presented in Table 3.

Table 3. Bivariate test of breakfast habits and BMI-for-Age

		BMI-for-Age
Breakfast Habits	r	0,087
	p	0,298
	n	146

Table 3 shows the bivariate test results, in which there was no significant correlation between breakfast habits and BMI-for-age (p = 0,298). Breakfast habits only explained 0,76% of the variance in BMI-for-age (r = 0,087).

This result is in line with previous research in Ghana, which showed no correlation between breakfast consumption and BMI (p = 0,865 ; x^2 = -0,362) (Annan et al., 2020). However, previous research in Malaysia has shown that breakfast consumption is related to body weight and a lower BMI (p < 0,001) (Yeo et al., 2024). Research in Yogyakarta also showed a correlation between breakfast habits and nutritional status (p = 0,047 ; RP = 2,1) (Halawa et al., 2022).

A previous study used a wider age range of subjects. For younger participants, there was potential parental participation in answering the questions. This could have affected the difference in the accuracy of each subject. A previous study also conducted interviews on intake and dietary quality. BMI measurements were also supported by waist circumference and body fat.

Proportion domination of subjects who have breakfast or have normal BMI-for-age contributes to the significance of the result (Wikanti et al., 2024). Breakfast frequency is not the only factor that increases the body weight. Overall eating pattern is the main factor that defines an individual's nutritional status (Utami et al., 2023). Previous research has found that individuals who tend to skip breakfast but have a good overall diet quality would have better health quality than those who eat poor quality breakfast (Ria Wijayanti et al., 2021).

The relationship between sleep quality and BMI according to age is shown in Table 4.

Table 4. Bivariate test of sleep quality and BMI-for-Age

		BMI-for-Age
Sleep Quality	r	0,067
	p	0,420
	n	146

Table 4 shows the bivariate test results, in which there was no significant correlation between sleep quality and BMI for age (p = 0,420). Sleep quality only explained 0,45% of the variance in BMI for age (r = 0,067).

This result is in line with previous research in Denpasar, which showed no significant correlation between sleep quality and nutritional status (p = 0,108; r = -0,131) (Hasan et al., 2021). Previous research in South Jakarta also showed no correlation between sleep quality and being overweight among adolescents (Wardoyo & Medise, 2020).

Previous research has shown that only 20% of adolescents have optimal sleep duration. About 57,7% of adolescents have at least one sleep problem (Depboylu & Şimşek, 2025). These findings are related to the results of this study, in where 80,82% of adolescents had poor sleep quality with many sleep problems. Many factors can lead to poorer sleep quality, such as feeling like going to the bathroom at night and nightmares. Another factor is an increase in screen time at night. This could lead to increased food intake, poor dietary quality, and increased body weight. However, this is modifiable (Gale et al., 2024).

The relationship between chronotype, breakfast habits, sleep quality, and BMI-for-age was tested using multiple linear regression. Before the test, classical assumption tests were performed to fulfill the requirements of multiple linear regressions. The classical assumption tests include multicollinearity, autocorrelation, heteroscedasticity, and normality. The results showed that all multiple linear regression requirements were fulfilled. The results of the multiple linear regression tests are presented in Table 5.

Table 5. Multivariate test

Independent Variables	Regression Coefficient	t	p-value
Constant	-0,668	-0,477	0,634
Chronotype	0,002	0,098	0,922
Breakfast habits	0,064	1,028	0,306
Sleep quality	0,057	0,890	0,375

F = 0,585; Adj. R Square = -0,007

The results showed F > 0,05, which means there was no correlation between all independent variables and the dependent variable simultaneously. The adjusted R square value explained that the effect proportion of independent variables to the dependent variable was -0,7%. This means that, if there is an increase in the independent variables, there will be a decrease in the dependent variable.

This result is consistent with previous research in Jakarta, which showed no significant correlation between breakfast routine and nutritional status (p = 1,000; OR = 1,000) and no significant correlation between sleep quality and nutritional status (p = 0,441; OR = 0,725) (Wikanti et al., 2024). However, a different result was reported in a study conducted in China. This study found that the morning chronotype was significantly correlated with lower BMI (p = 0,002), good breakfast routine (p = 0,012), and good sleep patterns (p < 0,001) (Yang et al., 2023). This was caused by the sampling technique used, which was purposive sampling that affected the participants' characteristics.

The BMI for age is not only defined based on food intake and sleep quality. Factors that were not studied in this research might influence nutritional status, such as physical activity, family background, health knowledge, and screen time (Wikanti et al., 2024). High-intensity physical activity can help break down energy storage. Low-intensity physical activity can lead to fat accumulation and increased body weight (Wijayanti et al., 2021). This study mostly used self-report questionnaires as instruments. The accuracy of the answers depends on the individual's ability to memorize and answer honestly (Martinez Lozano et. al., 2020).

Conclusion

This study concluded that there was no relationship between chronotype, breakfast habits, sleep quality, and BMI-for-age among adolescents in Surakarta City. Although there was a difference from the theory, this result is in line with that of previous research. This difference could be caused by the different research designs, heterogeneity of subjects' characteristics, and other confounding factors.

In addition, this research could bring new knowledge and impact on adolescents' nutritional status optimization. Future research could improve these topics by using a more diverse proportion of characteristics. The analysis could include some confounding factors, such as screen time duration, physical activity, overall eating patterns, health knowledge, and parenting. BMI-for-age could also be combined with body composition indicators such as fat mass and waist-hip ratio.

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