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ASSOCIATION BETWEEN DETERMINANT FACTORS AND OBESITY AMONG ADOLESCENTS

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ABSTRACT
The prevalence of obesity has continued to increase every year. The WHO reports that in 2022, more than 160 million children and adolescents aged 5-19 years will be obese. Obesity has become a growing public health concern in low- and middle-income countries such as Indonesia due to changes in diet, sedentary lifestyles, and weak food control policies. This study aims to analyze the factors that contribute to obesity in adolescents, including genetic factors, gender, dietary Advanced Glycation End products intake (dAGE intake), eating frequency, water consumption, physical activity, and sleep duration. This study employed a quantitative approach with a cross-sectional design. The sample consisted of 50 students selected using a total population sampling technique. The research instruments included a 24-hour food recall, the International Physical Activity Questionnaire (IPAQ), and the Pittsburgh Sleep Quality Index (PSQI). All instruments demonstrated acceptable psychometric properties, with significance values below 0.05 and Cronbach's alpha coefficients exceeding 0.70. Statistical analysis showed that physical activity ($p = 0.027$) and sleep duration ($p = 0.006$) were significantly associated with obesity. Other factors, including genetics, gender, dAGE intake, eating frequency, and water consumption, were not significantly associated with obesity. Sleep duration was identified as the most influential factor (Exp(B) = 0.103). Factors such as physical activity and sleep duration were associated with obesity. Adolescents need to focus on increasing physical activity, adopting healthy eating habits, and regulating optimal sleep duration as early obesity prevention measures.

Keywords: adolescents; obesity; physical activity; sleep duration

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INTRODUCTION

The prevalence of obesity has continued to increase every year. According to the World Health Organization (WHO), in 2022 over 390 million children and adolescents aged 5-19 were overweight including 160 million who were living with obesity (World Health Organization, 2025). In addition, the World Obesity Federation estimates that the prevalence of obesity will continue to increase to 24% of the total population in the same period in 2035. In the past, obesity was more common in high-income countries, but now obesity is also a problem in low- and middle-income countries (Hsieh et al., 2023). This increase is mainly due to changes in diet, sedentary lifestyles, and weak food regulation policies in middle-income countries such as Indonesia, India, and Nigeria (World Obesity Federation, 2023).

Obesity is a multi-factorial disease caused by various factors, in which excessive body fat accumulation has negative effects on health. The primary cause of obesity is a long-term energy imbalance between calories consumed and calories burned (Lin & Li, 2021). Obesity has many negative effects on public health, such as accelerating the aging process, impairing intelligence due to free radicals and peripheral blood vessel disorders caused by high fat and sugar levels, insulin resistance, osteoarthritis as a mechanical effect of obesity on the joints, varicose veins, breathing difficulties, cholelithiasis, and premature death. In addition, obesity also has a broad impact on various chronic degenerative diseases such as hypertension, coronary heart disease, stroke, cancer, type 2 diabetes, and bone disorders (Budyono et al., 2022).

Nowadays, obesity in adolescents has become an increasingly common health problem. One of the causes is lifestyle changes, such as in physical activity levels and dietary patterns. A study conducted in the United States reported a 39% decrease in physical activity among boys and a 56% decrease among girls, as well as a 38% decrease among adolescents aged 11-15 years (Wiardani & Kusumajaya, 2023). In Indonesia, 57.3% of children are inactive and 39.4% of children do not exercise regularly (Afifah et al., 2023). Furthermore, the Indonesian Ministry of Health found that Indonesians over the age of 10 have a tendency to consume fatty, high-cholesterol, and fried foods (40.7%), salty foods (26.2%), and sweet foods (53.1%), while 93.6% do not consume enough vegetables and fruits (Saraswati & Lubis, 2025). Obesity that occurs at a young age can continue into adulthood if not treated. Therefore, understanding the factors that cause obesity is very important so that preventive measures can be taken effectively. Therefore, this study aims to analyze various factors that contribute to obesity in adolescents, including genetic factors, gender, advanced glycation end products (AGEs) intake, eating frequency, water consumption, physical activity, and sleep duration.

METHOD

This study used a quantitative method with a cross-sectional design. The research subjects included 10th and 11th grade students with a Body Mass Index (BMI) > 25 from three high schools, which are SMA Negeri 1, SMA Negeri 2, and SMA Negeri 3 in Gorontalo City. Sampling was conducted using a total population sampling method, with a total of 50 respondents. Data collection was conducted from March to April 2025. Data were collected using valid instruments, including 24-hour food recall forms to assess data on dAGE intake and daily water consumption, International Physical Activity Questionnaire (IPAQ) to collect data on physical activity, and the Pittsburgh Sleep Quality Index (PSQI) to assess data on sleep duration. All instruments demonstrated acceptable psychometric properties, with significance values below 0.05 and Cronbach's alpha coefficients exceeding 0.70. Data were analyzed using univariate analysis to describe the distribution of each variable, bivariate analysis to test the relationship between variables using the Chi-square test, and multivariate analysis to determine the most influential variables using logistic regression. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Sports and Health, Gorontalo State University, with approval number 010C/UN47.B7/KE/2025.

RESULT

Table 1.
Distribution of Respondents Based on Genetics, Gender, AGEs Intake, Eating Frequency, Water Intake, Physical Activity, Sleep Duration, and Obesity (n=50)

Variable		f	%
Genetics	Yes	18	36
	No	32	64
Gender	Male	28	56
	Female	22	44
AGE intake	Low	27	54
	High	23	46
Meal Frequency	Regular	24	48
	Irregular	26	52
Water Consumption	sufficient	23	46
	Insufficient	27	54
Physical Activity	Low	22	44
	Moderate	13	26
	High	15	30
Sleep Duration	Short	19	38
	Optimal	22	44
	Long	9	18
Obesity Status	Overweight	20	40
	Obesity	30	60

Table 1 shows that most respondents did not have a genetic history of obesity (64%), were male (56%), had low dAGE intake (54%), irregular eating frequency (52%), and insufficient water consumption (54%). In addition, some respondents had low level of physical activity (44%), short sleep duration (38%), and obesity status of (60%).

Table 2.
Analysis of the relationship between obesity and genetics, gender, age intake, eating frequency, water consumption, physical activity, and sleep duration

Variable		Obesity				Total (n=50)		P Value
		Overweight (n=20)		Obesity (n=30)				
		f	%	f	%	f	%	
Genetic	Yes	4	8	14	28	18	36	0.054
	No	16	32	16	32	32	64	
Gender	Male	13	26	15	30	28	56	0.295
	Female	7	14	15	30	22	44	
dAGE intake	Low	10	20	17	34	27	54	0.643
	Height	10	20	13	26	23	46	
Meal Frequency	Regular	11	22	13	26	24	48	0.419
	Irregular	9	18	17	34	26	52	
Water Consumption	Sufficient	12	24	11	22	23	46	0.105
	Insufficient	8	16	19	38	27	54	
Physical Activity	Low	5	10	17	34	22	44	0.027*
	Moderate	5	10	8	16	13	26	
	High	10	20	5	10	15	30	
Sleep Duration	Short	3	6	16	32	19	38	0.006*
	Optimal	10	20	12	24	22	44	
	Long	7	14	2	4	9	18	

*significant at $p < 0.05$

Table 2 shows the results of bivariate analysis using the Chi-square test. Physical activity ($p = 0.027$) and sleep duration (0.006) showed a significant relationship, while other variables such as genetics, gender, dAGE intake, eating frequency, and water consumption showed no significant relationship.

Table 3.
Logistic regression analysis

Variable	B	S.E	Wald	Df	Sig.	Exp(B)
Physical Activity	-1.711	0.599	8.171	1	0.004	0.181
Sleep Duration	-2.276	0.723	9.909	1	0.002	0.103
Constant	7.988	2.362	11.438	1	0.001	2,945.001

Table 3 shows that physical activity ($p = 0.027$) and sleep duration ($p = 0.006$) are variables that influence obesity. Among the two, sleep duration is the most influential variable with an exp(B) value of 0.015.

DISCUSSION

The Relationship Between Genetics and Obesity

The results showed that most students did not have a genetic history of obesity (64%). Contrary to theory, students who did not have a genetic history of obesity had the highest risk of obesity (32%). The Chi-square test showed no statistically significant difference ($p > 0.05$), indicating that genetic history was not a factor associated with obesity. Obesity is generally a hereditary disease (Khera et al., 2019). However, many recent studies, such as gene-environment interaction (G×E) studies, show that certain lifestyle factors, such as physical activity, can weaken the influence of certain genes on obesity (Kim et al., 2024). For example, the influence of the FTO gene on obesity risk can be reduced by 30–40% with increased physical activity or a healthy diet (Loos & Yeo, 2022). A meta-analysis of more than 110,000 individuals also showed that physical activity can balance the genetic influence on the development of obesity (Flores-Dorantes et al., 2020).

The Relationship Between Gender and Obesity

The results of the study show that the obesity among male and female students was the same (30%). The results of the Chi-square test show that there is no significant relationship between gender and obesity ($p > 0.05$). According to Maharani et al. the absence of a relationship between gender and obesity is due to the fact that both women and men are at risk of obesity depending on other factors such as physical activity and diet (Maharani & Hernanda, 2020). Although men and women have similar BMIs, women tend to have 10% more adipose tissue than men, and men have higher visceral adipose tissue (VAT) than women. Furthermore, women tend to store free fatty acids derived from food in subcutaneous adipose tissue (SAT), whereas men, tend to store them in VAT (Koceva et al., 2024). Adolescent girls tend to store excess energy as body fat, while adolescent boys use excess energy for protein synthesis (Ramadhany et al., 2023).

The Relationship Between Dietary Advanced Glycation End Products (dAGE) Intake Obesity

The results showed that the majority of obese students had low AGEs intake (34%). Statistical tests showed a p-value of 0.643 ($p > 0.05$), which means that there was no significant relationship between dAGE intake and obesity. AGEs or Advanced Glycation End Products, are heterogeneous compounds resulting from the reaction of glucose and fructose in sugar and amino acids in protein, also known as the Maillard reaction (Perrone et al., 2020). Research conducted by Uribarri reported that AGEs as a whole are not associated with an increase in body fat mass in individuals with obesity. However, high AGEs levels in obese people are a signal of the transition from obesity to metabolic syndrome (Liman et al., 2022). A study conducted on adults in Iran reported that high AGEs intake can increase the risk of two metabolic syndromes, which are abdominal obesity and hypertriglyceridemia (Angoorani et al., 2016).

The Relationship Between Eating Frequency and Obesity

The majority of students with obesity had irregular eating frequencies (34%). Meanwhile, overweight students mostly had regular eating frequencies (22%). Statistical test results showed that there was no significant relationship between eating frequency and the incidence of obesity among adolescent students in Gorontalo City ($p > 0.05$). In previous studies, many have reported an inverse relationship between eating frequency and energy intake, but overall, the results of the study are still ambiguous. Based on the available evidence, eating frequency appears to influence obesity, but eating frequency is only a symptom or by-product of the relationship between nutritional knowledge, sociodemographic factors, lifestyle, and obesity (Zhang et al., 2018).

The Relationship Between Water Consumption and Obesity

Most students had insufficient water intake (54%), and among them, 38% were obese. The results of the Chi-square test analysis showed that there was no statistically significant difference ($p > 0.05$). Water consumption intervention had no significant effect on adiposity, possibly due to calorie compensation, which is the body's mechanism of adjusting calorie intake in response to changes in consumption. If the feeling of fullness from water does not last long, individuals tend to eat again before the next meal time, thus offsetting the expected calorie reduction (Q. Y. Chen et al., 2024).

The Relationship Between Physical Activity and Obesity

Most students who are obese have low levels of physical activity (34%), while students who are overweight mostly have high levels of physical activity (20%). Telisa et al. (2020) revealed that most adolescents believe that participating in school sports alone is enough for physical activity. In addition, adolescents are also less motivated to engage in physical activity in the form of sports because they do not master a particular sport (Telisa et al., 2020). According to Khomsan's theory, lack of physical activity results in decreased calorie use, so that the calories used are smaller than those consumed, resulting in excess calories. Over time, these excess calories will accumulate in the body and can cause weight gain and are said to be at risk of obesity (Saputri & Samsudi, 2024). Obesity is characterized by chronic inflammation that reduces muscle mass and protein synthesis. Physical activity can improve this condition by lowering IL-6 and TNF-α levels, thereby improving

metabolic function and reducing the risk of obesity. Moreover, moderate to high-intensity physical activity can lower leptin levels and increase adiponectin levels, which are known to be hormones that play a role in regulating appetite and fat metabolism (Becic et al., 2018; Sirico et al., 2018; Wang et al., 2025).

The Relationship between Sleep Duration and Obesity

Most students with short sleep duration had a higher proportion of obesity (32%) compared to those with optimal sleep (24%) or long sleep duration (4%). Statistical test results showed a significant relationship between sleep duration and obesity among adolescent students in Gorontalo City ($p < 0.05$). Sleep plays an important role in maintaining physical and mental health, including cardiovascular, cognitive, immune, and hormonal functions. Sleep also influences changes in appetite hormones and the activation of brain areas related to food selection (Xu et al., 2025). Sleeping less than 7 hours increases the risk of obesity due to circadian rhythm disturbances that affect metabolic, inflammatory, neuroendocrine, and antioxidant changes (Keramat et al., 2023). Sleep duration in adolescents has decreased over the past decade due to increased use of electronic devices and exposure to light before bedtime (Martínez-Gómez et al., 2023). Approximately 90% of studies report that screen media use before bedtime causes delayed sleep onset and reduced total sleep duration (Krishnan et al., 2020).

CONCLUSION

Physical activity and sleep duration are factors significantly associated with obesity. However, among the two, sleep duration is the most closely related. Adolescents need to focus on increasing physical activity, adopting healthy eating habits, and regulating optimal sleep duration as early obesity prevention measures.

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