

# The Relationship between BMI-for-age and Other Factors with Body Fat Percentage among Students in Jakarta, Indonesia

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**Abstract-** This study using the secondary data aims to determine the relationship between the independent variables that included gender, body mass index for age (BMI-for-age), breakfast habits, physical activity, and nutrients intake (energy, carbohydrates, proteins, and fats) with the dependent variable that included body fat percentage (body fat percentage) in adolescents. This is a cross-sectional study that conducted on 131 students of SMAN 39 Jakarta in 2019. The results showed that 53,4% respondents had excess body fat percentage with the average on females  $28,59 \pm 5,02\%$  were classified excessive and males  $20,8 \pm 5,94\%$  were classified not excessive. There was a significant relationship ( $p$ -value  $< 0,05$ ) on gender and BMI-for-age with body fat percentage in student, while there was no significant relationship ( $p$ -value  $> 0,05$ ) on breakfast habits, physical activity, and nutrients intake (energy, carbohydrates, proteins, and fats) with body fat percentage in adolescents.. This study suggested that BMI and body fat percentage to stay in normal range by monitoring the body weight and height regularly, conduct sports activities once a week, students should join sports extracurricular, and providing education related to diet and exercise as a prevention of obesity.

Keywords: BMI-for-age, obesity, body fat percentage.

## I. INTRODUCTION

Besides facing the undernutrition, overweight or obesity is also a nutritional problem globally and nationally. Obesity is the root cause of various non-communicable diseases, such as cardiovascular disease, diabetes, and cancer [1]. According to World Health Organization (WHO), obesity in the adolescent group is one of the causes of non-communicable diseases in young adults which has caused 71% of global deaths where cardiovascular disease is the largest cause of death in 2016 with a total death toll of 15.2 million. Apart from health, obesity also has an impact on reducing the quality of life of sufferers, individual and state productivity, and high health costs [2].

According to the WHO, overweight and obesity are defined as abnormal conditions or having excess body fat accumulation which can be indicated in various ways, one of which is by measuring the percent of body fat (body fat percentage). body fat percentage is often used in determining the status of overweight and obesity because it can describe the total

fat in the body against a person's body weight, gender, age, and height [3]. Having excess body fat as a teenager is a serious global public health problem in the 21st century. Based on a study in the United States, the median of the body fat percentage in adolescents aged 18 years was 17% in boys and 27.8% in women [4]. The national average of body fat percentage in Indonesia youth is not known. However, a previous study on 267 high school students showed body fat percentage mean of 30.1% in males and 17.7% in females [5]. Globally, obesity at school age and adolescence has increased more than 10-fold over the past 40 years from 11 million to 124 million in 2016 [6].

The high prevalence of obesity and obesity is caused by lifestyle changes that occur in the community, including changes in diet and low physical activity [2]. Changes in people's diet occur due to easy access and variety of foods that are high in energy, high in fat, and high in sugar, which can cause an energy imbalance to occur which increases the risk of excess fat accumulation in adolescents [3]. In addition, having a habit of skipping breakfast can lead to changes in appetite and decreased satiety, resulting in excessive food consumption and a risk of overweight and obesity [7]. In addition to diet, technological advances along with changes in sedentary lifestyle also cause energy imbalances, which can increase the risk of obesity or accumulation of fat in the body [8]. A sedentary lifestyle can lead to decreased muscle mass, persistent accumulation of fat, and an increased the risk of cardiovascular disease [9]. In addition, a high body mass index (BMI) of a person tends to have a high body fat percentage as well [10], [11].

Seeing the high prevalence of obesity, especially among adolescents in Jakarta, the study was conducted with the aim of knowing the factors that associated with the high body fat percentage in adolescence. The high body fat percentage at an early age can increase the risk of chronic disease, including cardiovascular disease, diabetes, and cancer. Therefore, prevention of excessive body fat percentage needs to be addressed from an early age because it is considered easier than when it is adults [12].

## II. MATERIAL AND METHOD

This research is a quantitative study using a cross-sectional study design. The independent variables of the study included breakfast habits, nutrient intake (energy, carbohydrates,

protein and fat), physical activity, and BMI-for-age status. The dependent variable to be studied is body fat percentage. This study uses secondary data from last research by Mailani in 2019 entitled "Differences in Cardiorespiratory Fitness Status based on Nutritional Status, Physical Activity, and Other Factors in Students of SMAN 39 Jakarta in 2019 [13].

The number of samples of 131 respondents was obtained using total sampling from secondary data. The data included 10<sup>th</sup> and 11<sup>th</sup> grade students who were selected by non-random sampling through an agreement on class selection determined by the school. The inclusion and exclusion criteria of this study were adjusted to the primary study. The primary research inclusion criteria were all students from 10<sup>th</sup> to 11<sup>th</sup> grade of SMAN 39 Jakarta who were suggested by the school and students who were physically fit. The exclusion criteria in the primary study were students who had a history of cardiovascular disease and students who were athletes.

The research instruments used in the primary researcher include: research questionnaires (respondent identity, informed consent, physical activity with PAQ-A, breakfast habits, anthropometric data, 24 hours food recall), Kris brand digital weight scales that have been calibrated with accuracy 0.1 kg, GEA brand height scale with 0.1 cm accuracy, Omron brand BIA with 0.1 body fat percentage accuracy, food model, and stationery. In data processing, body fat percentage was categorized as excessive if it had a value of >22% in men and >27% in women. A person is categorized as having a breakfast habit if they have a frequency of breakfast ≥5 times a week. Physical activity is categorized as active if PAQ-A score of ≥3. Based on BMI-for-age, a person is categorized as overweight if they have a score of >1 z-score. In addition, nutritional intake (energy, carbohydrates, protein, and fat) can be categorized as excessive if the intake is >110% Indonesia Recommended Dietary Allowance (RDA). Univariate analysis is presented in the form of frequency distribution tables and proportions and bivariate analysis using the chi-square test to see differences in body fat percentage categories according to independent variables. This research has gone through an ethical review procedure through the Ethics Commission for Research and Community Health Service, Faculty of Public Health, University of Indonesia with letter number Ket-204 / UN2.F10.D11 / PPM.00.02 / 2020.

### III. FINDINGS

Below table contained the result of univariate analysis of dependent and independent variables.

Table I: Result of Univariate Analysis

Variable	Amount (n)	Percentage (%)
<b>Body Fat Percentage</b>		
Excess	70	53.4
Not excess	61	46.3
<b>Gender</b>		
Male	52	39.7
Female	79	60.3
<b>BMI-for-age</b>		
Overnutrition	36	27.5
Not-overnutrition	95	72.5

<b>Breakfast Habits</b>		
Not Always	72	55
Always	59	45
<b>Physical Activity</b>		
Less Active	110	84
Active	21	16
<b>Energy Intake</b>		
High	2	1.5
Not High	129	98.5
<b>Carbohydrate Intake</b>		
High	2	1.5
Not High	129	98.5
<b>Protein Intake</b>		
High	20	15.3
Not High	111	84.7
<b>Fat Intake</b>		
High	24	18.3
Not High	107	81.7

Based on the results of univariate analysis, most of the students (53.4%) had excess body fat percentage, with an average body fat percentage in women of 28.59 ± 5.02% which was classified as excessive and body fat percentage in men 20.8 ± 5.94% which is classified as not excessive. Based on the BMI-for-age of the samples, 72.5% of the respondents were overweight. The average BMI for students in 2019 is 22.1±4.13 kg/m<sup>2</sup> with an average 0.17±1.26 z-score. The average BMI for men was 22.72±4.92 kg/m<sup>2</sup> and for women was 21.7 ± 3.48 kg / m<sup>2</sup>. There are as many as 55% of respondents have the habit of not having breakfast. As many as 84% of respondents have a low level of physical activity.

The result of bivariate analysis between dependent variable (body fat percentage) and independent variables can be seen in below table.

Table II: Result of Bivariate Analysis

Variable	Not excess Body Fat Percentage		Excess Body Fat Percentage		p-value
	N	%	N	%	
<b>Gender</b>					
Male	33	63.5	19	36.5	0,003
Female	28	25.4	51	64.6	
<b>BMI-for-age</b>					
Overnutrition	59	62.1	36	37.9	0.0001
Not overnutrition	2	5.6	34	94.4	
<b>Breakfast Habit</b>					
Not Always	31	43.1	41	56.9	0.476
Always	30	50.8	29	49.2	
<b>Physical Activity</b>					
Less Active	50	45.5	60	54.5	0.119
Active	11	52.4	10	47.6	
<b>Energy Intake</b>					
Not High	60	46.5	69	53.5	1
High	1	50	1	50	
<b>Carbohydrate Intake</b>					
Not High	59	45.7	70	54.3	0.215
High	2	100	0	0	

Protein Intake					
Not High	50	45	61	55	0,563
High	11	55	9	45	
Fat Intake					
Not High	52	48.6	55	51.4	0.448
High	9	37.5	15	62.5	

Based on the result of bivariate analysis, there is a significant relationship (p-value <0.05) between gender and BMI-for-age with body fat percentage among students. There is no significant relationship (p-value >0.05) between the variables of breakfast habits, physical activity, nutritional intake (energy, carbohydrates, protein, fat) with body fat percentage among students.

#### IV. DISCUSSION

Based on the result of univariate analysis, the average body fat percentage in this study was higher than the research conducted on adolescents in rural area in Serbia, with an average on body fat percentage  $17.9 \pm 7\%$  in boys and  $25.1 \pm 5.4\%$  in girls [14]. The difference in the results of this study can be caused by the higher consumption of fast food in urban than in rural areas. Urban areas have easier accessibility to fast food restaurants, especially in shopping center areas that provide a wide variety of fast-food foods, compared to district areas [15]. Fast food has the characteristics of high energy and fat content which are risk factors for obesity and obesity. In addition, excessive consumption of fast food is also triggered by parental work and pocket money for adolescents. Most of the jobs of parents in urban areas are private employees and civil servants, while in district areas are laborers and self-employed. The type of work affects the income of parents, where the income per capita in cities is higher than in districts so that it can increase the purchasing power of consumption and giving pocket money to children in urban areas which is higher [16]. The higher the allowance can increase the frequency of fast-food food in adolescents [17].

The results of this study indicate a significant relationship between gender and body fat percentage in adolescents, where women have more body fat percentage than men. The results of this study are in line with research in Africa which shows that there is a significant difference between body fat percentage according to sex in the children, adolescents, and adults groups [18]. The OR in the results of this study showed that female adolescents had a 3,164 times higher risk of obesity and obesity than boys. The results of this study are supported by a cross-sectional study conducted in Saudi Arabia on adolescents aged 11-19 years, which shows that female adolescents are more at risk of obesity than men [19]. In general, women have higher body fat percentage than men. With the same BMI, a woman tends to have body fat percentage about 10% higher than a man [20]. This could be influenced by the difference in sex hormones and rapid muscle growth in the male group during adolescence which has an impact on increasing lean body mass and reducing body fat percentage in men. In contrast, body fat percentage in women continues to increase significantly [21]. During puberty, the concentration of the hormone testosterone in men increases,

triggering muscle mass growth and fat breakdown or lipolysis, while changes in endocrine hormones in women neutralize the lipolytic effect of growth hormone resulting in an increase in body fat percentage [5]. In this study, there were no significant differences between energy intake, macronutrient intake and physical activity according to gender. However, excessive intake of energy and macronutrients, as well as less physical activity, tended to be dominated by female respondents. Excessive intake of energy and macronutrients with less physical activity will result in excess energy which can be metabolized into body fat [9].

The results of the bivariate analysis in this study showed that there was a significant relationship between BMI-for-age and body fat percentage among students. These results indicate that students who have high BMI-for-age are at risk of having a high body fat percentage. Previous research conducted in Serbia showed similar results, namely that there was a very strong relationship between BMI and body fat percentage in adolescents aged 15-19 years [22]. Another cross-sectional study done in Denpasar, Indonesia also shows a significant positive relationship between BMI and body fat percentage based on BIA measurements in SMA 2 Denpasar students [23]. In addition, the results of a study in Germany in 2015 conducted on 3327 children to adolescents with a median BMI of  $29 \text{ kg/m}^2$  found a significant positive relationship between BMI and body fat percentage, and there was no significant difference between BMI and body fat percentage in predicting the risk of cardiovascular disease [24]. However, BMI measurement has a disadvantage in assessing body composition because it is only based on height and weight. Basically, each individual has different fat-free mass and body fat mass [25]. During growth, weight gain and height can affect a person's BMI. Changes in body composition can occur in both women and men. body fat percentage in women tends to increase, while body fat percentage in men tends to decrease during its growth. Moreover, adolescents in Asia tend to have high body fat percentage, but with lower BMI [26]. With the results of this study, it can be concluded that the nutritional status assessment based on BMI-for-age can be used as a simple and inexpensive way to estimate body fat percentage, especially if the measurement does not have BIA tools or competent human resources in measuring body fat percentage with the skinfold method.

Based on the results of the bivariate analysis of this study, it was found that there was no significant relationship between breakfast habits and body fat percentage in adolescents. However, there was a tendency that excessive body fat percentage was higher in subjects who did not always have breakfast (56.9%) compared to subjects who always had breakfast (49.2%). Another study conducted on female adolescents in Surabaya, Indonesia also showed that there was no significant relationship between breakfast habits and nutritional status [27]. There was a study that showed an association between rarely having breakfast (less or equal to 2 times a week) with higher BMI, BMI z-score, and body fat percentage in children and adolescents in Hong Kong [28]. The difference in these results is assumed because the number of samples used in the results that are not significant is less, namely 131 respondents in this study and 80 respondents in Surabaya research, while in the research in Hong Kong have total sample of 11,570

respondents. Thus, the number of samples used in this study could not show a significant relationship between breakfast habits and body fat percentage in adolescents. In addition, it is suspected that there are factors of physical activity, energy intake, and food quality that can affect body fat percentage. According to the results of this study, most or as much as 84% of students have a low level of physical activity. It was found that more active students were higher in the group who always ate breakfast (25.4%) than in the group who did not always eat breakfast (8.3%). This is in line with other research that shows adolescents who have a habit of not having breakfast tend to do sedentary activities, such as spending time sitting, watching television, and playing gadgets [29]. It also added that the habit of not having breakfast can increase food and energy intake throughout the day.

The results in this study showed that respondents with low physical activity were more likely to be found excess body fat percentage (54.5%) than not excess body fat percentage (47.6%). The  $p$ -value  $>0.05$ , which means that there is no significant relationship between physical activity and body fat percentage in adolescents. However, there is a tendency that most of the students with excess body fat percentage have less physical activity levels. This research result is in line with other studies conducted on 11,570 adolescent boys and girls aged 9-18 years in Hong Kong which showed a relationship between low exercise frequency and higher body fat percentage [28]. In addition, research conducted on 267 high school students in Depok also showed a significant relationship between physical activity and body fat percentage [5]. This insignificant result in this study is thought to be due to the relatively small sample. As many as 83.97% of respondents have a low level of physical activity, which causes homogeneity in the research respondents and causes an insignificant relationship in the results of this study.

Based on the results of the bivariate analysis, it was found that there was no significant relationship between energy intake and body fat percentage in adolescents. The results of this study are in line with research in Bogor which states that there is no significant relationship between the energy adequacy level and body fat percentage [16]. Contrary to these results, research on 120 adolescents aged 16-18 years in Jakarta showed a relationship between energy intake and overweight status, where the more someone consumed excess energy intake, the more risk of overweight [30]. This difference in results is thought to be influenced by the factor of the sample appearance method used. Stratified random sampling was used as the subject collection method on the research with 50.8% of the subjects having excess nutritional status and 60% of the subjects having more energy intake [30], while the sample collection method in this study was carried out with total sampling of data secondary so as to allow the homogeneity of the research variables. It can be seen that as many as 98.5% of respondents have a level of intake that is not excessive. The food recall that has been carried out allows the occurrence of flat slope syndrome where the reporting of nutritional intake is less than the reality, especially for respondents with excess body fat percentage.

Based on the results of the bivariate analysis, it was found that there was no relationship between carbohydrate intake

and body fat percentage among students. The results are in line with another research in Bogor, Indonesia which found no association between carbohydrate intake and body fat percentage in adolescents [16]. In contrast to these results, research conducted on high school students in Depok, Indonesia shows a relationship between carbohydrate intake and body fat percentage [5]. The relationship that is not related to the results of this study is assumed to be due to the flat slope syndrome when food recalling students of SMAN 39 Jakarta. As many as 98.5% of the research respondents had carbohydrate intake which was classified as not excessive and the average carbohydrate intake still did not meet the 80% Indonesia RDA. This can also be caused by the method of total sampling from secondary data. In fact, consuming excess carbohydrates can increase the total daily energy intake and increase the risk of overweight. In addition, it is suspected that the development of the food or beverage industry has increased the refined carbohydrates and sugar intake [31]. Based on data from Baseline Health Research in 2018, 57.1% of adolescents aged 15-19 years have habits of consuming sweetened drinks at least once per day. An increase in high sugar intake causes rapid blood absorption which cause the increasing of insulin and also followed by a rapid decrease in blood glucose. This increase in insulin results in excess glucose for body fat, causes hunger, and decrease in the metabolic rate, thereby increasing the risk of obesity to insulin resistance [32].

The relationship between protein intake and body fat percentage in adolescents in this study showed that there was no significant relationship statistically ( $p$ -value  $>0.05$ ). These results are in line with a case control study which found that more protein intake in non-obese adolescents was higher than obese adolescents, where the relationship between protein intake and body fat percentage also showed statistical significance [33]. However, the absence of the relationship in this study could be caused by the sample collection method in this study was carried out with total sampling of the secondary data. These allow the homogeneity of the research variables as it shows 84.7% respondents have been categorized as excess protein intake.

The relationship between fat intake and body fat percentage in this study was not statistically significant ( $p$ -value  $>0.05$ ). Similar results were found in a case control study, which stated that fat intake was found to be higher in obese adolescents than non-obese adolescents. In addition, the results of the study also stated that adolescents with excessive fat intake had a 2 times greater risk of being obese than adolescents with sufficient fat intake [33]. The insignificant results in this study were assumed because the sample collection method was the total sampling method from secondary data, which allowed for bias in the study. This can be seen from the number of samples with not excess fat intake that is much higher than excess fat intake, which is as much as 81.7% of all respondents. This can also be caused by the occurrence of flat slope syndrome during the food recall.

## V. CONCLUSION AND RECOMMENDATIONS

Most of the students of have excess body fat percentage, with an average body fat percentage in women  $28.59 \pm 5.02\%$  which is classified as excessive and body fat percentage in men

20.8 ± 5.94% which is classified as not excessive. There is a significant relationship (p-value <0.05) between gender and BMI-for-age with body fat percentage among students. There is no significant relationship (p-value >0.05) between variables of breakfast habits, physical activity, nutritional intake (energy, carbohydrates, protein, fat) with body fat percentage among students.

It is suggested that the school can routinely organize sports activities, oblige all students to take part in sports extracurricular activities, and provide education related to balanced nutrition for adolescents. In addition, the local public health center together with the school conduct regular and periodic measurement to monitor adolescent nutritional status.

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#### REFERENCES

- [1] C. L. Ogden, "Prevalence of High Body Mass Index in US Children and Adolescents, 2007-2008," *JAMA*, vol. 303, no. 3, p. 242, Jan. 2010, doi: 10.1001/jama.2009.2012.
- [2] M. Masrul, "Epidemi obesitas dan dampaknya terhadap status kesehatan masyarakat serta sosial ekonomi bangsa," *Maj Kedokt Andalas*, vol. 41, no. 3, p. 152, Oct. 2018, doi: 10.25077/mka.v41.i3.p152-162.2018.
- [3] Nadiyah and N. Adriani, "Asupan Karbohidrat dan Serat Berhubungan dengan Lemak Tubuh Remaja SMPN 16 Jakarta," *Nutrire Diaita*, vol. 9, no. 2, pp. 67–72, 2017.
- [4] K. R. Laurson, J. C. Eisenmann, and G. J. Welk, "Body Fat Percentile Curves for U.S. Children and Adolescents," *American Journal of Preventive Medicine*, vol. 41, no. 4, pp. S87–S92, Oct. 2011, doi: 10.1016/j.amepre.2011.06.044.
- [5] F. Badzlina and T. Triyanti, "BMI for Age (BAZ) as the Dominant Factor of Body Fat Percentage among Students in Depok, Indonesia," *Proceedings of The 3rd Faculty of Public Health UI Science Festival 2019*, pp. 417–425, 2019.
- [6] L. Abarca-Gómez *et al.*, "Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults," *The Lancet*, vol. 390, no. 10113, pp. 2627–2642, Dec. 2017, doi: 10.1016/S0140-6736(17)32129-3.
- [7] J. K. Zakrzewski *et al.*, "Associations between breakfast frequency and adiposity indicators in children from 12 countries," *Int J Obes Supp*, vol. 5, no. S2, pp. S80–S88, Dec. 2015, doi: 10.1038/ijosup.2015.24.
- [8] M. Ezzati and E. Riboli, "Behavioral and Dietary Risk Factors for Noncommunicable Diseases," *N Engl J Med*, vol. 369, no. 10, pp. 954–964, Sep. 2013, doi: 10.1056/NEJMr1203528.
- [9] J. Thompson, M. Manore, and L. A. Vaughan, *The science of nutrition*, 2nd ed., Student ed. San Francisco, CA: Pearson Benjamin Cummings, 2011.
- [10] M. H. Heriyanto, "Hubungan Asupan Gizi dan Faktor Lain dengan Persen Lemak Tubuh pada Mahasiswi Prodi Gizi dan Ilmu Komunikasi UI Angkatan 2009 Tahun 2012," 2012.
- [11] M. Ilman, Y. Zuhairini, and A. Siddiq, "Correlation between Body Mass Index and Body Fat Percentage," *amj*, vol. 2, no. 4, Dec. 2015, doi: 10.15850/amj.v2n4.642.
- [12] D. Simbolon, W. Tafriani, and D. Dahrizal, "Edukasi Gizi dan Perubahan Berat Badan Remaja Overweight dan Obesitas," *JK*, vol. 9, no. 2, p. 289, Sep. 2018, doi: 10.26630/jk.v9i2.841.
- [13] W. Mailani, "Perbedaan Status Kesehatan Kardiorespiratori berdasarkan Status Gizi, Aktivitas Fisik dan Faktor Lainnya pada Siswa SMAN 39 Jakarta 2019."
- [14] F. Tishukaj *et al.*, "Physical fitness and anthropometric characteristics among adolescents living in urban or rural areas of Kosovo," *BMC Public Health*, vol. 17, no. 1, p. 711, Dec. 2017, doi: 10.1186/s12889-017-4727-4.
- [15] D. Dwiningasih and A. Pramono, "Perbedaan Asupan Energi, Protein, Lemak, Karbohidrat, dan Status Gizi Pada Remaja yang Tinggal di Wilayah Perkotaan dan Pedesaan," *J. NutriColl*, vol. 2, no. 2, pp. 232–241, May 2013, doi: 10.14710/jnc.v2i2.2748.
- [16] H. P. Panjaitan, "Pola Konsumsi Western Fast Food dan Soft Drink serta Persen Lemak Tubuh pada Siswa SMAN 10 dan SMA Kornita di Kota dan Kabupaten Bogor," *Institut Pertanian Bogor*, 2015.
- [17] T. R. Imtihani and E. R. Noer, "Hubungan Pengetahuan, Uang Saku, dan Peer Group dengan Frekuensi Konsumsi Makanan Cepat Saji pada Remaja Putri," *J. NutriColl*, vol. 2, no. 1, pp. 162–169, Jan. 2013, doi: 10.14710/jnc.v2i1.2112.
- [18] S. Amoo-Tella, B. Danborn, S. Akuyam, and S. Adebisi, "Gender-and age-related differences in anthropometric and body composition parameters in Nigerians, Zaria, Nigeria," *J Exp Clin Anat*, vol. 16, no. 2, p. 137, 2017, doi: 10.4103/jeca.jeca\_4\_17.
- [19] A. Mahfouz, M. Khan, O. Mostafa, A. Shatoor, A. Daffalla, and M. Hassanein, "Nutrition, physical activity, and gender risks for adolescent obesity in Southwestern Saudi Arabia," *Saudi J Gastroenterol*, vol. 17, no. 5, p. 318, 2011, doi: 10.4103/1319-3767.84486.
- [20] K. Karastergiou, S. R. Smith, A. S. Greenberg, and S. K. Fried, "Sex differences in human adipose tissues – the biology of pear shape," *Biol sex dif*, vol. 3, no. 1, p. 13, 2012, doi: 10.1186/2042-6410-3-13.
- [21] F. He, P. Guan, Q. Liu, D. Crabtree, L. Peng, and H. Wang, "The relationship between obesity and body compositions with respect to the timing of puberty in Chongqing adolescents: a cross-sectional study," *BMC Public Health*, vol. 17, no. 1, p. 664, Dec. 2017, doi: 10.1186/s12889-017-4681-1.
- [22] J. Jelena *et al.*, "Relationship between Body Mass Index and Body Fat Percentage among Adolescents from Serbian Republic," *J Child Obes*, vol. 01, no. 02, 2016, doi: 10.21767/2572-5394.100009.
- [23] K. D. P. Lestari and N. Wahyuni, "Hubungan Indeks Massa Tubuh, Persentase Lemak Total Tubuh, dan Aktivitas Fisik terhadap Tingkat Volume Oksigen

- Maksimal pada Remaja Putri di Denpasar Selatan,” *Majalah Ilmiah Fisioterapi Indonesia*, vol. 8, no. 2, pp. 49–56, 2020.
- [24] B. Bohn *et al.*, “BMI or BIA: Is Body Mass Index or Body Fat Mass a Better Predictor of Cardiovascular Risk in Overweight or Obese Children and Adolescents?,” *Obes Facts*, vol. 8, no. 2, pp. 156–165, 2015, doi: 10.1159/000381227.
- [25] S. N. Fatimah *et al.*, “Hubungan Pengukuran Lemak Subkutan dengan Indeks Massa Tubuh pada Laki-Laki Usia Lanjut,” *Penelitian Gizi dan Makanan (The Journal of Nutrition and Food Research)*, vol. 40, no. 1, pp. 29–34, Oct. 2017, doi: 10.22435/pgm.v40i1.6295.29-34.
- [26] S. Chung, “Body mass index and body composition scaling to height in children and adolescent,” *Ann Pediatr Endocrinol Metab*, vol. 20, no. 3, p. 125, 2015, doi: 10.6065/apem.2015.20.3.125.
- [27] W. Irdiana and T. S. Nindya, “Hubungan Kebiasaan Sarapan dan Asupan Zat Gizi dengan Status Gizi Siswi SMAN 3 Surabaya,” *Amerta Nutrition*, pp. 227–235, 2017.
- [28] H. K. So *et al.*, “Breakfast frequency inversely associated with BMI and body fatness in Hong Kong Chinese children aged 9–18 years,” *Br J Nutr*, vol. 106, no. 5, pp. 742–751, Sep. 2011, doi: 10.1017/S0007114511000754.
- [29] L. Wadolowska *et al.*, “Skipping Breakfast and a Meal at School: Its Correlates in Adiposity Context. Report from the ABC of Healthy Eating Study of Polish Teenagers,” *Nutrients*, vol. 11, no. 7, p. 1563, Jul. 2019, doi: 10.3390/nu11071563.
- [30] W. N. I. Mukhlisa, L. S. Rahayu, and M. Furqan, “Asupan Energi dan Konsumsi Makanan Ringan Berhubungan dengan Kejadian Gizi Lebih pada Remaja,” *ARGIPA*, vol. 3, no. 2, pp. 59–66, 2018.
- [31] K. Sartorius, B. Sartorius, T. E. Madiba, and C. Stefan, “Does high-carbohydrate intake lead to increased risk of obesity? A systematic review and meta-analysis,” *BMJ Open*, vol. 8, no. 2, p. e018449, Feb. 2018, doi: 10.1136/bmjopen-2017-018449.
- [32] D. S. Ludwig and C. B. Ebbeling, “The Carbohydrate-Insulin Model of Obesity: Beyond ‘Calories In, Calories Out,’” *JAMA Intern Med*, vol. 178, no. 8, p. 1098, Aug. 2018, doi: 10.1001/jamainternmed.2018.2933.
- [33] W. Kurdanti *et al.*, “Faktor-faktor yang mempengaruhi kejadian obesitas pada remaja,” *Jurnal Gizi Klinik Indonesia*, vol. 11, no. 4, p. 179, Apr. 2015, doi: 10.22146/ijcn.22900.

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