JPPIPA 9(5) (2023)

Jurnal Penelitian Pendidikan IPA

*Journal of Research in Science Education*

http://jppipa.unram.ac.id/index.php/jppipa/index

# Fat and Carbohydrates as Causative Factors of Obesity of Youths at Bulukumba City, South Sulawesi

Muriyati[1], Hamdana[1], Asri[2], Safruddin[2], Asnidar[3*]

[1] Departemen Surgical and Medical Nursing, Stikes Panrita Husada Bulukumba, Indonesia
[2] Departemen Community and Family Nursing, Stikes Panrita Husada Bulukumba, Indonesia
[3] Departement of Pediatric and Maternity Nursing, Stikes Panrita Husada Bulukumba, Indonesia

Received: March 20, 2023
Revised: May 25, 2023
Accepted: May 28, 2023
Published: May 31, 2023

Corresponding Author:
Asnidar
asnidarnidar16@yahoo.co.id

DOI: 10.29303/jppipa.v9i5.3467



**Abstract:** Globally, obesity has entered the epidemic proportion, with at least 2.8 million people dying every year due to obesity, for Indonesia itself the incidence of obesity has also increased significantly in every region with Jakarta's first ranking of 11.4%. The purpose of this study was to determine with certainty that fat and carbohydrates are factors that influence the incidence of obesity in the youth of Bulukumba community. adolescents. Method: Case control study with a total of 155 subjects, cases are people with obesity (IMT/U > +2SD) and controls are people with non-obesity. Independent variables are carbohydrates and fats that they consume. While the dependent variable is the incidence of obesity. Data analysis using Chi-Square test and logistic regression. Results: Factors that are significantly associated ($p<0.05$) and become causal factors the risk of obesity cases in the community is that fat (OR = 2.34; CI: 1.19-4.57) and carbohydrates (OR = 2.64; CI: 1.34) which were significantly influenced. Conclusion: the youth who have excessive intake of macro foods with high carbohydrate and fat content are more at risk of obesity.

**Keywords:** Fat and farbohydrates; Life experience; Obesity

## Introduction

Globally obesity has reached epidemic proportions, with at least 2.8 million people dying each year as a result of being overweight or obese. Once associated with high - income countries , obesity is now also prevalent in low- and middle-income countries . Obesity is a collection of abnormal or excessive fat that can cause health complications. Obesity is a major factor causing chronic diseases, such as diabetes mellitus, cardiovascular disease, and cancer (Waddell & Orfila, 2022).

Obesity in some high-income countries is a global problem because it goes hand in hand with the emergence of the main complication of obesity, namely type II diabetes mellitus Edward W. Gregg, 2017 . an increase in the prevalence of obesity in the child and adolescent population, the risk of developing diabetes mellitus increase (Paul et al., 2018).

Based on previous research by (Wei et al., 2019) , the results of this study are body mass index (BMI) as a risk factor for diabetes. population of this study were middle-aged and elderly people with an average age of 63 years. the average person with diabetes mellitus is a person who has an abnormal body mass index (BMI).

Data presented by the World Health Organization (WHO) In 2016 more than 1.9 billion adults, namely over the age of 18 years, were overweight, of these more than 650 million people were obese. Overall, around 13% of the world's population is obese (11% of men and 15% of women) and the prevalence of obesity has tripled from 1975 to 2016.

The prevalence of obesity in Indonesia is also increasing, where 1 in 4 Indonesians are obese and Indonesians who are obese are aged over 18 years. Based on the results of monitoring the Nutrition Status (PSG) of the Ministry of Health in 2017 around 25.8% of Indonesia's population classified as adults are obese and this number has increased from the previous year which was 10.6%. From the results of research conducted by Cut novianti Rachmi and Alison Baur, women who live in urban areas have a higher chance of experiencing obesity, which is equal to 1.26 times compared to women who live in rural areas. This is in line with the results of

**How to Cite:**
Muriyati, M., Hamdana, H., Asri, A., & Safruddin, S. (2023). Fat and Carbohydrates as Causative Factors of Obesity of Youths at Bulukumba City, South Sulawesi. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2726–2731. https://doi.org/10.29303/jppipa.v9i5.3467

a survey conducted by the Ministry of Health which stated that around 29.7 % of women in Indonesia are classified as obese. While in men the number is only 11.4 % . And the province of Jakarta has the most obese adult population, followed by Aceh, East Java and Riau.

Based on health profile data for the province of South Sulawesi in 2014 the incidence of obesity in South Sulawesi was 6.2 % for men and 12.7% for women. In 2017 the incidence of obesity increased, male as much as 13.85 % and female as much as 27.07%. Based on initial data collection by researchers at the Bulukumba Health Office in 2018 there were 35 people. From the results of observations made by researchers, currently there are very many obese people in Bulukumba district, but the community considers that obesity is not a health problem, plus the public perception that obesity is a symbol of prosperity. At the Puskesmas itself obesity is also considered not a health problem unless obese people have experienced several problems due to obesity.

People with obesity usually face many negative images by society and a number of pathological symptoms in health (Fastenau et al., 2019; D.-Y. Lu et al., 2019; D. Lu et al., 2018). Physical and emotional health suffers when obesity is driven by the influence of body image. Negative body image can reduce one's mood, self-esteem, and self-confidence (Loue & Sajatovic, 2004). People with obesity experience negative stigma and find that stigmatization affects almost every aspect of their lives. people with obesity report job discrimination, social exclusion, exploitation by the fitness industry, denial of health facilities, difficulty finding clothes, abuse by doctors, and ridicule by community (Billinger et al., 2014; Hutchison, 1994).

Obesity is also a risk factor for several non-communicable diseases, for example, people with obesity have a double risk of heart disease, stroke, diabetes and high blood pressure. Obesity is also susceptible to cancer, men are susceptible to colon cancer and prostate cancer, while women are susceptible to breast and cervical cancer.

## Method

This study included observational research with a case control research design. Cases were adolescents with obesity and controls were non-obese adolescents. The study was conducted in public high schools (SMAN) in Bulukumba, South Sulawesi. This study is all students in the high school X and XI classes in the research period at Bulukumba.

Based on the results of the calculation research sample was 160 samples consisting of 80 case samples and 80 control samples. In this study, pairwise matching was carried out between case and control groups based on age, gender, and school origin or peer group. The inclusion criteria for the case group were students who had obese nutritional status (> +2SD) based on body mass index based on age (IMT/U); age 15-18 years; and willing to become respondents (informed consent). While the control group inclusion criteria are students who have an obese nutritional status (> +2SD) based on IMT / U; age 15-18 years; and willing to become respondents (informed consent).

Exclusion criteria were students who were not present at the time of the study. The independent variables were macronutrient intake, sugary food/drink consumption patterns, while the dependent variable was the incidence of obesity. Obesity status is a nutritional status based on body weight and height as seen using the IMT/U index based on the z-score according to the World Health Organization (WHO) 2005 for the age group 15-18 years (obese > 2 SD and not obese ≤ 2 SD).

Macronutrient intake (energy, protein, and fat) is the amount of energy, protein, and fat consumed by the subject during a certain time in units of g/day which is categorized as more (> 100% RDA) and sufficient (≤ 100% RDA). Macronutrient intake, fiber, was obtained from a food consumption survey using the semi-quantitative food frequency questionare (SQ-FFQ).

Meanwhile, the self-esteem scale used a Likert format with 4 categories (score 1 to 4). The response categories were strongly-agree; agree; disagree; and strongly disagree. Data were analyzed using univariate analysis; bivariate using Chi-Square test with 95% confidence level ($\alpha = 0.05$) and Odds Ratio (OR); and multivariate using logistic regression test.

## Result and Discussion

*Fat and Carbohydrate in Adolescent Obesity*

The results of the analysis showed that the factors that were significantly associated ($p<0.05$) and became risk factors for obesity in adolescents were fat (OR=2.34; CI: 1.19-4.57); carbohydrates (OR=2.64). Obese adolescents had higher mean energy intake than non-obese adolescents (3627.8 kcal vs 3368.5 kcal). The mean energy intake of both groups exceeded the recommended RDA (2150-2650 kcal). Adolescents with higher energy intake had a 4.69 times greater risk of obesity compared to adolescents with adequate energy intake ($p=0.000$). Similarly, fat and carbohydrate intake showed that most obese adolescents had higher mean intake (fat 106.3 g vs 88.0 g and carbohydrate 356.2 g vs 307.1 g). Adolescents with higher fat and carbohydrate intake were at twice the risk of obesity compared to adolescents with adequate fat and carbohydrate intake who had adequate fat and carbohydrate intake ($p=0.012$ and $p=0.004$).

**Table 1.** Risk of Fat and Carbohydrate affecting the incidence of obesity

| Intake | Obesity Status | | OR (95% CI) | P |
|---|---|---|---|---|
| | Obesity | Non-Obesity | | |
| | n | n | | |
| Fat | | | | |
| More | 41 | 26 | 2.34 | 0.012 |
| Enough | 31 | 46 | (1.19-4.57) | |
| Carbohydrate | | | | |
| More | 48 | 31 | 2.64 | 0.004 |
| Enough | 24 | 41 | (1.34-5.20) | |

*Fat intake*

More of fat intake was found in the obese group compared to the non-obese group (Moussavi et al., 2020). The results of the study on fat intake showed that the high consumption of fat in most of the study samples consumed high-fat foods such as fried foods, namely tempe mendoan, fried tofu, spring rolls, risoles, martabak, omelet and usually fried foods are high in protein. Thus, fried foods have a large contribution to daily fat intake.

Nearly one-third of American children aged 4-19 years consume fat every day, resulting in a weight gain of 3 kg per year (Moore et al., 2023). However, the real problem of obesity lies not in overeating, but in choosing the wrong type of food. In teenagers, snacks contribute 30% or more of an adolescent's total daily calorie intake. These snacks are often high in fat, sugar and sodium, which can increase the risk of obesity and dental caries.

*Carbohydrate intake*

Excess carbohydrate intake in the obese group was found to be higher than the non-obese group (Polak et al., 2020). The high carbohydrate consumption was due to some of the research samples consuming high-carbohydrate foods during breaks (snacks) such as fried rice, cilok, batagor, chicken noodles, meatballs, and siomay. In addition, snacks such as chitato, cassava chips, and potato chips were also consumed. Excess carbohydrates in the body will be converted into fat. This change occurs in the liver. This fat is then carried to fat cells which can store an unlimited amount of fat. The size or portion of a meal that is too excessive can also have many calories in large quantities compared to what is recommended for normal people to consume daily.

The results of this study are in line with research that says that there is a significant difference between carbohydrate intake in obese and non-obese children. Adolescent age is vulnerable to the risk of obesity because at this age adolescents experience decreased physical activity, increased consumption of high fat, and high carbohydrates.

*Uncontrolled eating patterns*

Wrong dietary factors can cause an abnormal BMI body mass index, especially foods that contain lots of fat, sugar and fast food. Consuming excess calories results in fat accumulation in the body due to an imbalance between the amount of energy consumed and expended (Bertoncini-Silva et al., 2022).

An unhealthy lifestyle will lead a person to eating patterns that are not good and eventually obesity, eating patterns that are not controlled, consuming foods that contain fat, sugar and fast food (Hajivandi et al., 2020). Not balanced with sufficient energy expenditure, it can lead to obesity. In obese people, the pancreas is forced to work hard to produce insulin because the energy requirement is large. The fatter the higher the insulin requirement. If this is allowed to continue, the pancreas will become exhausted and start to decrease its excessive performance resulting in insulin resistance.

People's lifestyles are currently undergoing many changes. This has resulted in changes in people's eating patterns referring to high-calorie, high-fat diets. Consumption of fatty and sweet foods has a significant relationship with diabetes mellitus rates. The addition of oil and coconut milk is a parameter in fatty foods and cholesterol, especially in fast food which has an impact on increasing the risk of obesity (Susilowati & Waskita, 2019).

The results of Dafriani (2017), said that the incidence of obesity was higher in respondents with bad eating patterns (51.9%) compared to those who had better eating patterns, namely (29.3%) a lifestyle with unhealthy eating patterns resulted in People tend to consume food excessively resulting in various diseases.

According to Nuraini & Supriatna (2016)), in their research it was stated that there was a relationship between diet and the incidence of obesity . Large portions of food cause an increase in body fat and if repeated in the long term this condition can lead to obesity.

Results of research conducted by Ardhany & Lamsiyah (2018), argued that consuming too much cooking oil repeatedly will affect the smell and color of cooking oil. When oil is heated to high temperatures, the fat in it will break down into free fatty acids, calorie content and free fat in the oil jelanta turned out to be higher, eating food that is fried with used cooking oil continuously will cause obesity.

According to Sudargo et al. (2018), in his book states that the diet that is the trigger for obesity is consuming large portions of food (more than needed), eating high energy, high fat, high simple carbohydrates, and low fiber. Meanwhile, wrong eating behavior is the act of consuming excessive amounts of food without being balanced with balanced energy expenditure, one of which is physical activity (exercise).

*Physical activity*

Lack of physical activity is one of the main causes of obesity, lack of movement can cause fat accumulation so that body weight can increase (Carbone et al., 2019; Magkos et al., 2020). The large number of calorie troops that enter, but sufferers tend to have less physical activity. Physical activity in the form of sports is useful for controlling blood sugar and weight loss in type II diabetes mellitus. The great benefits of physical activity or exercise in diabetes mellitus include lowering blood glucose levels, preventing obesity, playing a role in overcoming complications, blood lipid disorders and increased blood pressure. The recommended physical activity for people with type II diabetes mellitus is regular physical activity. (3-4 times a week) for approximately 30 minutes (Sari & Purnama, 2019).

According to the results of (Setiawati et al., 2019), physical activity carried out by a person can increase the sensitivity of insulin receptors so that glucose can be converted into energy through metabolism. One of the benefits of physical activity is that it can lower blood sugar levels in diabetics and prevent obesity.

Research conducted by Dafriani (2017), the incidence of DM was higher in respondents with light physical activity, namely 26 respondents (53.1%) compared to those with heavy physical activity, namely 13 respondents (29.5%), Physical activity is very important for DM sufferers because the effect can lower blood glucose levels Physical activity will lower blood glucose levels by increasing glucose uptake by muscles and improving insulin. Based on the results of the study, the researchers concluded that lack of physical activity is one of the causes of obesity . When active, the body will use glucose in the muscles to be converted into energy. in the blood will decrease.

After conducting the interview, the participants said they lacked activity, lack of activity, then used to consuming sweet and fatty foods resulted in an imbalance in the body. Food intake was not completely processed into energy and unused food scraps would eventually be stored as a pile of fat. This resulted in obesity. Physical activity greatly influences the incidence of obesity where the average hard worker tends not to be obese, this is due to the large number of activities carried out in a day.

According to Setiawan et al. (2020) the principle of obesity is losing weight by creating an energy deficit by reducing energy consumption or increasing energy use through regular exercise. Active exercise is one way to lose weight besides managing your diet by reducing consumption of foods that contain lots of fat and sugar. But some fat people feel embarrassed to participate in sports, and of course this kind of attitude will make the body stay or even gain weight.

In research conducted by (Kurdanti et al., 2015; Purwanto et al., 2020), that someone who is obese on average has less activity where a decrease in physical activity will result in a decrease in energy expenditure in the body. The food consumed in a day is one of its functions is to produce energy and this energy is used for daily activities. When a person experiences an increase in food intake in a day and does not have an increase in activity, there will be an imbalance between the intake of nutrients that enter the body and the energy used so that this will trigger the accumulation of fat in the body and cause obesity.

## Conclusion

The adolescents who have excess fat and carbohydrates are at greater risk of obesity. Adolescents vulnerable to the risk of obesity should be educated with media to improve food intake, especially energy intake by paying attention to the balance of fat and carbohydrate nutrient intake. The level of knowledge is one of the causes of obesity. Unhealthy eating patterns are one of the causes of obesity. An unhealthy lifestyle will lead a person to eating patterns that are not good and eventually obesity, eating patterns that are not controlled, consuming foods that contain fat, sugar and fast food. Not balanced with sufficient energy expenditure, it can lead to obesity. In obese people, the pancreas is forced to work hard to produce insulin because the energy requirement is large. The fatter the higher the insulin requirement. If this is allowed to continue, the pancreas will become exhausted and start to decrease its excessive performance resulting in insulin resistance. Lack of physical activity is one of the causes of obesity. The perspective or mindset of people who still consider obesity is a sign of happiness and prosperity.

**Acknowledgments**

The author would like to thank the parties who have played a role in this research activity, so that the research entitled Fat and Carbohydrates as Causative Factors of Obesity of Youths at Bulukumba City, South Sulawesi, can be carried out well. Thank you to the informants, and the local government for giving permission to researchers to complete this academic task.

**Author Contributions**

In this study, all researchers contributed actively with the tasks that were carried out together. In other words, this research was supported by equal distribution of roles and contributions of all authors, because each stage was always discussed together.

**Funding**

This research is an empirical research funded by the researchers themselves or independent research. So on this happy occasion, I as the first author express my highest appreciation and gratitude to my colleagues who are members of this research team for their financial participation.

**Conflicts of Interest**

In this research, there is no tug of interest and or hidden interests among the researchers. In addition, this research is also not an order from any funder because it is independent research, or in other words, the research team itself plays a role in preparing proposals, selecting topics, conceptualizing problems, collecting data, analyzing problems, drawing conclusions until the publication stage in this journal.

## References


Ardhany, S. D., & Lamsiyah. (2018). Knowledge level of tent stall traders on Jalan Yos Sudarsopalangkaraya about the dangers of using used cooking oil for health. *Journal of Surya Medika (JSM), 3*(2), 62-68. https://doi.org/10.33084/jsm.v3i2.99

Bertoncini-Silva, C., Zingg, J.-M., Fassini, P. G., & Suen, V. M. M. (2022). Bioactive dietary components—Anti-obesity effects related to energy metabolism and inflammation. *BioFactors*. https://doi.org/10.1002/biof.1921

Billinger, S. A., Arena, R., Bernhardt, J., Eng, J. J., Franklin, B. A., Johnson, C. M., Mackay-Lyons, M., Macko, R. F., Mead, G. E., Roth, E. J., Shaughnessy, M., & Tang, A. (2014). Physical activity and exercise recommendations for stroke survivors: A statement for healthcare professionals from the American Heart Association/American Stroke Association. *Strokes*, *45*(8), 2532–2553. https://doi.org/10.1161/STR.0000000000000022

Carbone, S., Del Buono, M. G., Ozemek, C., & Lavie, C. J. (2019). Obesity, risk of diabetes and role of physical activity, exercise training and cardiorespiratory fitness. *Progress in Cardiovascular Diseases*, *62*(4), 327–333. https://doi.org/10.1016/j.pcad.2019.08.004

Dafriani, P. (2017). Hubungan Pola Makan dan Aktifitas Fisik Terhadap Kejadian Diabetes Melitus di Poliklinik Penyakit Dalam RSUD dr. Rasidin Padang. *NERS Jurnal Keperawatan*, *13*(2), 70–77. https://doi.org/10.25077/njk.13.2.70-77.2017

Fastenau, J., Kolotkin, R. L., Fujioka, K., Alba, M., Canovatchel, W., & Traina, S. (2019). A call to action to inform patient-centred approaches to obesity management: development of a disease-illness model. *Clinical Obesity*, *9*(3), e12309. https://doi.org/10.1111/cob.12309

Hajivandi, L., Noroozi, M., Mostafavi, F., & Ekramzadeh, M. (2020). Food habits in overweight and obese adolescent girls with polycystic ovary syndrome (PCOS): a qualitative study in Iran. *BMC Pediatrics*, *20*(1), 1–7. https://doi.org/10.1186/s12887-020-02173-y

Hutchison, M. G. (1994). Imagining ourselves whole: A feminist approach to treating body image disorders. *Feminist Perspectives on Eating Disorders*, 152–168.

Kurdanti, W., Suryani, I., Syamsiatun, N. H., Siwi, L. P., Adityanti, M. M., Mustikaningsih, D., & Sholihah, K. I. (2015). Factors that influence the incidence of obesity in adolescents. *Indonesian Journal of Clinical Nutrition*, *11*(4), 179. https://doi.org/10.22146/ijcn.22900

Loue, S., & Sajatovic, M. (2004). *Encyclopedia of women's health*. Springer Science & Business Media. https://doi.org/10.1007/978-0-306-48113-0

Lu, D.-Y., Che, J. Y., Yarla, N. S., Putta, S., Lin, L. P., & Shen, Y. (2019). Human obesity, pathological and therapeutic advances. *EC Pharmacology & Toxicology*, *7*(4), 231–238. Retrieved from https://www.researchgate.net/profile/Da-Lu/publication/332111259_Human_Obesity_Pathological_and_Therapeutic_Advances/links/5ca1c598a6fdccd46047fac2/Human-Obesity-Pathological-and-Therapeutic-Advances.pdf

Lu, D., JY, C., Y, L., HY, W., NS, Y., TR, L., B, X., YK, H., & DF, L. (2018). An Overview of Obesity. *Journal of Postgenomics Drug & Biomarker Development*, *8*(2), 8–11. https://doi.org/10.4172/2153-0769.1000200

Magkos, F., Hjorth, M. F., & Astrup, A. (2020). Diet and exercise in the prevention and treatment of type 2 diabetes mellitus. *Nature Reviews Endocrinology*, *16*(10), 545–555. Retrieved from https://www.nature.com/articles/s41574-020-0381-5

Moore, L. L., Zhou, X., Wan, L., Singer, M. R., Bradlee, M. L., & Daniels, S. R. (2023). Fruit Juice Consumption, Body Mass Index, and Adolescent Diet Quality in a Biracial Cohort. *Beverages*, *9*(2), 42. https://doi.org/10.3390/beverages9020042

Moussavi, J. M. S., Madani, Z., Movahedi, A., Karandish, M., & Abbasi, B. (2020). The correlation between dietary fat quality indices and lipid profile with Atherogenic index of plasma in obese and non-obese volunteers: a cross-sectional descriptive-analytic case-control study. *Lipids in Health and Disease*, *19*, 1–9. https://doi.org/10.1186/s12944-020-01387-4

Nuraini, H. Y., & Supriatna, R. (2016). Hubungan Pola Makan, Aktivitas Fisik dan Riwayat Penyakit Keluarga Terhadap Diabetes Melitus Tipe 2. *Jurnal Ilmu Kesehatan Masyarakat, 5*(1), 5-14. https://doi.org/10.33221/jikm.v5i1.14

Paul, K. C., Jerrett, M., & Ritz, B. (2018). Type 2 diabetes mellitus and Alzheimer's disease: overlapping biologic mechanisms and environmental risk factors. *Current Environmental Health Reports*, *5*, 44–58. https://doi.org/10.1007/s40572-018-0176-1

Polak, A. M., Krentowska, A., Łebkowska, A., Buczyńska, A., Adamski, M., Adamska-Patruno, E., Fiedorczuk, J., Krketowski, A. J., Kowalska, I., & Adamska, A. (2020). The association of serum levels of leptin and ghrelin with the dietary fat content in

non-obese women with polycystic ovary syndrome. *Nutrients*, *12*(9), 2753. https://doi.org/10.3390/nu12092753

Purwanto, A., Pramono, R., Asbari, M., Hyun, C. C., Wijayanti, L. M., & Putri, R. S. (2020). Studi eksploratif dampak pandemi COVID-19 terhadap proses pembelajaran online di sekolah dasar. *EduPsyCouns: Journal of Education, Psychology and Counseling*, *2*(1), 1–12. Retrieved from https://ummaspul.e-journal.id/Edupsycouns/article/view/397

Sari, N., & Purnama, A. (2019). Aktivitas Fisik dan Hubungannya dengan Kejadian Diabetes Melitus. *Window of Health: Jurnal Kesehatan,* 368-381. Retrieved from https://jurnal.fkmumi.ac.id/index.php/woh/article/download/621/138

Setiawan, I., Putri, Y., Damayanti, A., Herawati, D. M. D., Sufiawati, I., & Widyaputra, S. (2020). The Comparison of the Salivary Flow Rate and the DMF-T Index in Obese and Normal-Weight Individuals. *Journal of International Dental and Medical Research*, *13*(4), 1488–1493. Retrieved from Retrieved from http://www.jidmr.com/journal/wp-content/uploads/2020/12/40-XD20_1275_Ignatius_Setiawan_Indonesia.pdf

Setiawati, D., Nuhriawangsa, A., & Wasita, B. (2019). Relationship between serum magnesium and blood glucose levels in overweight and obese adults. *Amerta Nutrition*, *3*(4), 239. https://doi.org/10.20473/amnt.v3i4.2019.239-246

Sudargo, T., Freitag, H., Kusmayanti, N. A., & Rosiyani, F. (2018). *Pola makan dan obesitas*. UGM press.

Susilowati, A. A., & Waskita, K. N. (2019). Pengaruh pola makan terhadap potensi resiko penyakit diabetes melitus. *Jurnal Mandala Pharmacon Indonesia*, *5*(1), 43–47. https://doi.org/10.35311/jmpi.v5i01.43

Waddell, I. S., & Orfila, C. (2022). Dietary fiber in the prevention of obesity and obesity-related chronic diseases: From epidemiological evidence to potential molecular mechanisms. *Critical Reviews in Food Science and Nutrition*, 1–16. https://doi.org/10.1080/10408398.2022.2061909

Wei, J., Liu, X., Xue, H., Wang, Y., & Shi, Z. (2019). Comparisons of visceral adiposity index, body shape index, body mass index and waist circumference and their associations with diabetes mellitus in adults. *Nutrients*, *11*(7), 1580. https://doi.org/10.3390/nu11071580