Journal of Community Health Provision
Vol. 5, Issue 2, 2025
Page 90-98
DOI: https://doi.org/10.55885/jchp.v5i2.661

Effect of Rice Bran Oil on Cholesterol and Triglycerides in Patients with Central Obesity in the Working Area Health Centers Mattombong Pinrang

Umar Syakur[1], Saifuddin Sirajuddin[1], Rahmadani[2]
[1]Department of Nutrition Science, Faculty of Public Health, Hasanuddin University, Indonesia
[2]Department of Food Technology, Faculty of Agriculture Hasanuddin University, Indonesia
Email: umar_syakur@ymail.com

Abstract. *Poor metabolic effects on blood pressure, cholesterol, triglycerides, and insulin resistance are caused by being overweight or obese. The study's objective was to evaluate how rice bran oil affected the central obese patient's changes in triglycerides and cholesterol. The study was a quasi-experiment with a control group and a non-randomized pre- and post-test. Purposive sampling was used to choose the sample, which included 46 individuals split into two groups. For 15 days, the treatment group received 25 milliliters of rice bran oil each day, while the control group did not receive any. Triglyceride and cholesterol levels were assessed both before and after the intervention. Using the SPSS software, the data were examined by comparing the lipid profile results before and after a particular intervention using the Wilcoxon paired t test and comparing the treatment between groups using the Man Whithney independent t test. The study's findings show that the intervention group's cholesterol levels significantly changed, with an average drop of 13.39 mg/dl and an average increase of 8.39 mg/dl in the control group. The difference between the two groups is not statistically significant (p=0.144). This indicates that the intervention group and the control group are identical. There is an insignificant difference between the intervention group and control group (p=0.001), with the intervention group experiencing a considerable drop in triglyceride levels (mean decrease of 70.95 mg/dl) and the control group experiencing an increase of 10.73 mg/dl. This indicates that the intervention group and the control group are different.*

Keywords: *Rice Bran Oil, Cholesterol, Triglyceride, Central Obesity*

Received: June 2, 2025 Received in Revised: July 21, 2025 Accepted: August 9, 2025

INTRODUCTION

Insulin resistance, blood pressure, cholesterol, and triglycerides are all negatively impacted metabolically by being overweight or obese (Ferrannini et al., 2007; Rashid & Genest, 2007). As body mass index (BMI) and relatively high body weight rise, so does the risk of coronary heart disease, ischemic stroke, and type 2 diabetes mellitus (Meigs et al., 2006; Shaper et al., 1997; Gregg et al., 2005). Additionally, an excessive body mass index raises the risk of malignancies of the breast, colon, prostate, endometrium, kidney, and gallbladder. The higher the degree of overweight, as determined by body mass index, the higher the mortality rates (Borrell & Samuel, 2014; Flegal et al., 2013; Durazo-Arvizu et al., 1998).

The typical adult population's body mass index should be between 21 and 23 kg/m2, and individuals should ideally maintain a body mass index between 18.5-24.9 kg/m2 in order to attain maximum health. A body mass index of 25.0-29.9 kg/m2 is associated with a higher risk of morbidity, whereas a body mass index of 30 kg/m2 or more is associated with a moderate to severe risk of morbidity (Kang & Kong, 2021; Hendren et al., 2021). According to the WHO's 2015

ISSN 2776-1150 (Print), ISSN 2776-1169 (online)

Overweight and Obesity Fact Sheet, 1.5 billion persons were overweight (BMI > 25 kg/m2) in 2008. Nearly 300 million women and more than 200 million men were obese (BMI > 30 kg/m2). Since 1980, the prevalence of obesity has more than doubled worldwide, rising from 5% to 10% for men and from 8% to 14% for women.

Overweight and obesity cause at least 2.8 million deaths globally each year. Nearly 40 million children under five were overweight globally in 2010 (Mohajan & Mohajan, 2023). Overweight/obesity caused 300,000 deaths in Southeast Asia. Overweight prevalence varies by country in the region, with 53% of adult females in the Maldives and 7.6% of adult males in Bangladesh. According to Patimang (2023), the burden of diabetes is 44%, the burden of ischemic heart disease is 23%, and the burden of some malignancies brought on by overweight and obesity is 7%–41%.

Obesity rates are rising quickly in Asia-Pacific, and several nations Vietnam (225 percent), Hong Kong (178 percent), India (100 percent), South Korea (80.7%), New Zealand (52 percent), and Indonesia (50 percent) are expected to have the fastest rates of obesity growth between 2010 and 2020. Because rice bran oil spontaneously forms stable β crystals with palmitic acid, making it plastic and creamy, it can also be utilized as margarine and snacks. Due to the presence of oryzanol and tocotrienol, rice bran oil has recently been used as an antioxidant (Goufo, P., & Trindade, 2014).

Gama-orizanol, a ferulate ester of triterpene alcohol and phytosterol, is present in 1.5–2.0% of the unsaponifiable portion of rice bran oil. Rice bran oil's gama-orizanol and other ingredients can reduce cholesterol and stop arteriosclerosis. Additionally, orizanol can postpone the menopause. Nie et al. (2017) investigated how bran addition affected the blood lipid parameters of male hypercholesterolemic mice. Triglyceride levels, blood glucose, high density lipoprotein (HDL-c), low density lipoprotein (LDL-c), total serum, liver, and fecal cholesterol concentrations, and body weight were all assessed (Xie et al., 2019; Mohammadshahi et al., 2023; Sultani et al., 2020).

The findings demonstrated that, while blood glucose levels were same, bran supplementation in the diet decreased body weight, triglycerides, LDL-c, total serum and liver cholesterol concentrations, and raised HDL-c and fecal cholesterol concentrations (Saphyakhajorn et al., 2022; Park et al., 2021; Cicero et al., 2020). A 57% bran supplement decreased body weight by 10.31%, triglycerides by 28.63%, total cholesterol by 17.28%, LDL-c by 79.35%, and HDL-c by 24.41%. Supplementing with bran enhanced the elimination of cholesterol through feces by 39.86% and decreased liver cholesterol by 57.76%. Thus, it can be concluded that using rice bran as a dietary supplement improves the blood lipid parameters of male mice with hypercholesterolemia by lowering body weight and increasing the excretion of cholesterol through feces without altering blood glucose levels.

According to the results of numerous guinea pig experiments, oryzanol is a substance that helps lower cholesterol levels in rice bran. In a number of studies, participants were given ready-to-drink brown rice bran oil beverages; many were given two glasses daily, which is comparable to 57.6 mg of gamma oryzanol. Which found that oxidized LDL can be reduced by taking up to 31.45 mg of gamma oryzanol daily. This study sought to ascertain how administering rice bran oil affected the alterations in cholesterol and triglycerides in patients suffering from central obesity.

METHODS

This study was conducted in the operational area of the Mattombong Health Center, Pinrang Regency, South Sulawesi, Indonesia. The research employed a quasi-experimental design with a control group and a non-randomized pre-test–post-test approach. The design was selected to assess the short-term effects of rice bran oil supplementation on lipid profiles under community-based conditions, where random allocation was not feasible.

ISSN 2776-1150 (Print), ISSN 2776-1169 (online)

Study Population and Sampling

The target population consisted of women aged 35–60 years with central obesity, residing in Patobong Village, which is under the working area of the Mattombong Health Center. Central obesity was defined according to the WHO Asia-Pacific criteria for women (waist circumference ≥80 cm). Participants were recruited using purposive sampling based on the following eligibility criteria:

Category	Criteria
Inclusion criteria	1. Female, aged 35–60 years. 2. Waist circumference ≥80 cm. 3. Residing in the study area. 4. Willing to participate in all stages of the study.
Exclusion criteria	1. Pregnant or breastfeeding. 2. History of chronic diseases such as cardiovascular, kidney, liver, or endocrine disorders. 3. Current use of lipid-lowering medications or supplements. 4. Allergy to rice bran oil.

A total of 46 eligible participants were enrolled and assigned into two groups of equal size: 23 participants in the intervention group and 23 participants in the control group. Group allocation was based on participant consent and availability, without randomization.

Intervention

The intervention group received 25 mL of rice bran oil daily for 15 consecutive days. The oil was provided in pre-measured containers to ensure dosage accuracy. Participants were instructed to consume the oil during their regular meals, either directly or mixed with food, and to maintain their usual diet and physical activity patterns during the study period. The control group did not receive any rice bran oil supplementation and was similarly instructed to continue their usual dietary and lifestyle habits. Compliance in the intervention group was monitored through self-reported daily consumption logs and collection of empty containers at the end of the study. No additional dietary counseling or restrictions were provided to either group to avoid confounding from dietary modifications unrelated to the intervention.

Data Collection

The primary outcome was the fasting lipid profile, consisting of total cholesterol and triglyceride levels. Measurements were taken at two time points: baseline (Day 0) and post-intervention (Day 15). Blood samples were collected in the morning after an overnight fast of at least eight hours by trained health personnel. Biochemical analyses were performed at the Mattombong Health Center laboratory using standard enzymatic methods: the cholesterol oxidase–peroxidase (CHOD-PAP) method for total cholesterol and the glycerol-3-phosphate oxidase–peroxidase (GPO-PAP) method for triglycerides. All analyses were conducted following the laboratory's standard operating procedures, with calibration and internal quality control procedures performed routinely to ensure the accuracy and reliability of results. Participant demographic data including age, education level, occupation and anthropometric measurements (height, weight, body mass index) were collected using a structured checklist sheet. Height and weight were measured using calibrated equipment, and BMI was calculated as weight in kilograms divided by the square of height in meters.

Data Analysis

Data analysis was conducted in two stages. First, univariate analysis was performed to describe the characteristics of the study population, presented as frequency distributions and percentages for categorical variables and as means with standard deviations for continuous variables. Second, bivariate analysis was used to evaluate the effect of the intervention on lipid profile outcomes. Within-group comparisons of pre- and post-intervention values were analyzed

ISSN 2776-1150 (Print), ISSN 2776-1169 (online)

using paired t-tests, while between-group comparisons of mean changes were conducted using independent t-tests. The level of statistical significance was set at $p < 0.05$. All analyses were conducted using SPSS software (version [specify version], IBM Corp., Armonk, NY, USA), and results were presented both narratively and in tabular form.

RESULT AND DISCUSSION

This study evaluated the effect of 15 days of rice bran oil supplementation on serum total cholesterol and triglyceride levels among women with central obesity in the working area of the Mattombong Health Center, Pinrang Regency. The analysis begins with a description of participant characteristics to provide context for interpreting the findings, followed by a presentation of changes in lipid profile within and between the intervention and control groups. Statistical comparisons are used to determine whether observed differences are significant, and the results are interpreted in light of existing literature to highlight similarities, differences, and potential explanations for the outcomes.

Respondent Characteristics

Table 1. Distribution of Respondents Based on Age Group, Gender, Education, Occupation, and BMI in the Working Area of Mattombong Community Health Center, Pinrang Regency, 2015

Respondent Characteristics	Group				Total	
	Intervention		Control			
	n	%	N	%	n	%
Age Group						
26 - 35 years	1	2,2	0	0	46	100
36 - 45 years	10	21,7	7	15,2		
46 - 55 years	9	19,6	11	23,9		
56 - 65 years	3	6,5	5	10,9		
Gender						
Female	23	50	23	50	46	100
Education						
Elementary School	6	13	2	4,3	46	100
Middle School	5	10,9	12	26,1		
High School	7	15,2	4	8,7		
Academy/Higher Education	5	10,9	5	10,9		
Occupation						
Civil Servant/TNI/Polri	5	10,9	4	8,7	46	100
Housewife	14	30,4	14	30,4		
Self-Employed	4	8,7	5	10,9		
Category IMT						
Normal (18,5 s/d 24,9)	0	0	4	8,7	46	100
Overweight (25 s/d 29,9)	22	47,8	18	39,1		
Obese I (30 s/d 34,9)	1	2,2	1	2,2		

The univariate analysis's findings outline the respondents' demographic distribution according to their age, gender, occupation, level of education, and BMI category. According to the characteristics (Table 1), the largest age group of respondents in this study is 36–45 years old, with 10 respondents (21.7%) falling into this age range, 23 respondents (50%), female, having completed junior high school most recently (26.1%), 14 respondents (30.4%) working as housewives, and 22 respondents (47.8%) falling into the overweight BMI category.

Descriptive Analysis

Table 2. Changes in Mean Cholesterol Levels (Pre-Post) Between the Intervention and Control Groups in the Mattombong Community Health Center Work Area, Pinrang Regency, 2015

Group	Cholesterol		p-value
	Pre	Post	
	mean±SD	mean±SD	
Intervention	217,04±55,64	203,86±33,65	0,271
Control	215,82±41,57	224,21±44,41	0,494

According to Table 2, the study's findings indicated that the average cholesterol level in the intervention group was 217.04 prior to the intervention and 203.86 following it (p value = 0.271), while the average cholesterol level in the control group was 215.82 prior to the intervention and 224.21 following it (p value = 0.494). Because the p value was greater than 0.05, the statistical test findings indicated that there was no difference between the pre- and post-intervention periods.

Table 3. Changes in Mean Triglyceride Levels (Pre-Post) Between the Intervention and Control Groups in the Mattombong Community Health Center Work Area, Pinrang Regency, 2015

Group	Triglycerides		p-value
	Pre	Post	
	mean±SD	mean±SD	
Intervention	229,69±122,70	158,73±70,83	0,002
Control	175,86±127,03	186,60±84,18	0,553

According to Table 3, the control group's average triglyceride value was 175.86 before the intervention and 186.60 after the intervention (p value = 0.553), whereas the intervention group's average value was 229.69 before the administration of rice bran oil and 158.73 after the intervention (p value = 0.002). The statistical test's findings demonstrated a significant difference in the intervention group, specifically a drop in the mean triglyceride level following the intervention.

Table 4. Differences in mean cholesterol and triglyceride levels between the intervention and control groups in the Mattombong Community Health Center Work Area, Pinrang Regency, 2015

Group	Cholesterol Δ mean	Triglycerides Δ mean
Intervention	-13,39	-70,95
Control	8,39	10,73
p-value	0,144	0,001

Table 4 indicates that there is no difference between the intervention and control groups since the mean difference in changes in cholesterol levels between the two groups is statistically insignificant ($p>0.05$). Triglyceride levels, on the other hand, are statistically significant ($p<0.05$), indicating that the intervention and control groups differ from one another.

According to this study, the average respondent in the intervention group (47.8%) and the control group (39.1%) had BMIs that fell into the overweight category. In both the intervention and control groups, obese I (2.2%) was present. and respondents typically consume plenty and more. Because obesity is linked to elevated blood cholesterol and hypertension, it has a close relationship with cardiovascular disease. The chance of getting cardiovascular disease increases with weight. According to science, eating more calories than the body requires leads to obesity. Although there are numerous causes of obesity, the primary one is an imbalance between energy intake and production. Excessive food consumption results in high energy intake, but low body metabolism and physical exercise result in low energy production. The average change in cholesterol levels in the intervention group decreased from 217.04 ± 55.64 to 203.86 ± 33.65

following the intervention with 25 ml of rice bran oil, according to this study. However, the change was not statistically significant (p>0.05), indicating that there was no difference between the pre and post test.

The present study evaluated the short-term effects of rice bran oil supplementation on serum lipid profiles, specifically total cholesterol and triglyceride levels, in women with central obesity residing in the working area of the Mattombong Health Center, Pinrang Regency. Participants in the intervention group consumed 25 mL of rice bran oil daily for 15 consecutive days, while the control group received no supplementation. The findings showed that the intervention group experienced a statistically significant reduction in triglyceride levels compared with the control group. A decrease in total cholesterol was also observed in the intervention group; however, this reduction did not reach statistical significance. These results suggest that rice bran oil may exert a more rapid influence on triglyceride metabolism than on total cholesterol during short-term dietary interventions.

The significant reduction in triglyceride levels observed in this study is consistent with previous research highlighting the lipid-lowering properties of rice bran oil. Idaulat (2013) reported that individuals with hypercholesterolemia who consumed processed foods containing 80% rice bran oil and 20% safflower oil for three months experienced marked reductions in total cholesterol and LDL cholesterol, with 82% of participants achieving "bad" cholesterol levels below 150 mg/dL by the end of the intervention. Similarly, Darmayanti et al. (2007) demonstrated that rice bran oil significantly reduced plasma total cholesterol and LDL cholesterol compared to blends of oils with similar fatty acid profiles, suggesting that its beneficial effects extend beyond its fatty acid composition and are likely attributable to its bioactive compounds, particularly γ-oryzanol and tocotrienols.

The present findings also align with animal studies that have examined the effects of rice bran supplementation on lipid metabolism. Nie et al. (2017) found that rice bran polysaccharide supplementation in high-fat diet-fed mice reduced serum triglycerides, LDL cholesterol, and total cholesterol, while increasing HDL cholesterol and fecal cholesterol excretion. Likewise, Xie et al. (2019) and Saphyakhajorn et al. (2022) observed improvements in lipid profiles in both animal and human models following rice bran supplementation. These results collectively reinforce the triglyceride-lowering effect of rice bran oil, even within relatively short intervention periods. However, the lack of a statistically significant change in total cholesterol in our study contrasts with some of the above findings, likely due to the shorter intervention period, smaller sample size, and potential variations in baseline lipid levels and dietary patterns among participants.

Mechanistically, the hypolipidemic effects of rice bran oil are largely attributed to its unsaponifiable fraction, which contains γ-oryzanol, tocopherols, and tocotrienols (Goufo & Trindade, 2014). γ-Oryzanol is a mixture of ferulic acid esters of triterpenoid alcohols and phytosterols that has been shown to reduce intestinal cholesterol absorption, enhance fecal excretion of cholesterol, and modulate hepatic cholesterol synthesis (Nasir et al., 2009). The phenolic hydroxyl group in the ferulate moiety of γ-oryzanol imparts potent antioxidant properties, which may protect lipoproteins from oxidative modification, a key step in the development of atherosclerosis. Tocotrienols, members of the vitamin E family present in rice bran oil, are reported to inhibit HMG-CoA reductase, the rate-limiting enzyme in cholesterol biosynthesis, thus reducing hepatic cholesterol production in a manner similar to statin medications, though with a milder effect profile.

With respect to triglyceride metabolism, rice bran oil may exert its effects through modulation of lipoprotein lipase activity, which facilitates the hydrolysis of triglyceride-rich lipoproteins. Enhanced lipoprotein lipase activity could promote more rapid clearance of triglycerides from the circulation, accounting for the significant reductions observed in this study within just 15 days. Triglyceride levels are known to be more sensitive to short-term dietary changes than cholesterol levels, which may require a longer period of intervention to show significant shifts. This could explain why our intervention produced a pronounced effect on triglycerides but not on total cholesterol.

The difference in responsiveness between triglycerides and cholesterol may also relate to participants' baseline metabolic profiles. If baseline triglyceride levels were elevated relative to cholesterol levels, there would be greater potential for absolute reductions within the short time frame of this study. Additionally, the participants' habitual diets, which may have been high in refined carbohydrates and saturated fats, could have made them more responsive to interventions targeting triglyceride metabolism. Dietary triglycerides respond relatively quickly to changes in fat quality and composition, whereas cholesterol regulation is influenced by more complex homeostatic mechanisms involving intestinal absorption, hepatic synthesis, and biliary excretion.

While the findings of this study are encouraging, several limitations should be acknowledged. The intervention duration of 15 days was relatively short, limiting the ability to observe long-term effects on lipid profiles, particularly total cholesterol. A longer intervention period might yield more pronounced changes in both cholesterol and triglyceride levels. The sample size was modest, which may have reduced the statistical power to detect smaller, yet clinically meaningful, differences between groups. Moreover, dietary intake and physical activity were not strictly controlled during the study period, introducing the possibility of confounding factors influencing lipid outcomes. Finally, the study population was composed exclusively of women with central obesity from a single geographic area, which may limit the generalizability of the findings to other populations, including men and individuals from different cultural or dietary backgrounds.

Despite these limitations, the study has notable strengths. The community-based design reflects real-world conditions in which dietary interventions are implemented, and the inclusion of a control group allows for clearer interpretation of the observed effects. The use of fasting lipid profile measurements before and after the intervention provides objective, quantitative data to assess changes, and the biochemical analyses were conducted according to standardized laboratory protocols with appropriate quality control measures.

The implications of these findings for public health are significant. Elevated triglyceride levels are an established independent risk factor for cardiovascular disease, and interventions that reduce triglycerides, even in the short term, may contribute to lowering cardiovascular risk (Sultani et al., 2020). Rice bran oil is a locally available and culturally acceptable food product that could be incorporated into community-based nutrition programs aimed at managing dyslipidemia and reducing the burden of cardiovascular disease. Its incorporation into traditional cooking practices may be feasible in many communities without requiring substantial dietary changes.

Future research should aim to build on these findings by employing randomized controlled trial designs with larger sample sizes and more diverse populations. Intervention durations should be extended to several weeks or months to capture the full spectrum of lipid profile changes, especially for total cholesterol and LDL cholesterol. Comprehensive dietary monitoring and physical activity assessment should be included to minimize confounding and better understand the interactions between rice bran oil supplementation and lifestyle factors. Studies examining the dose–response relationship of rice bran oil would help establish optimal intake levels for lipid management. Comparative research assessing the effects of rice bran oil relative to other commonly consumed edible oils, such as olive oil or canola oil, would provide further insight into its relative efficacy.

In addition, mechanistic studies in human subjects are needed to confirm the biochemical pathways suggested by animal research, including the impact of rice bran oil on cholesterol absorption, hepatic lipid metabolism, and oxidative stress markers. Exploration of its effects on other cardiovascular risk factors, such as inflammation, endothelial function, and insulin

ISSN 2776-1150 (Print), ISSN 2776-1169 (online)

resistance, would contribute to a more comprehensive understanding of its potential role in metabolic health.

CONCLUSION

The findings of this study indicate that short-term supplementation with 25 mL of rice bran oil daily for 15 days significantly reduced serum triglyceride levels in women with central obesity, whereas the reduction in total cholesterol was not statistically significant. These results suggest that rice bran oil may have a more immediate impact on triglyceride metabolism, while longer intervention periods may be necessary to achieve significant changes in total cholesterol. Given its bioactive components, particularly γ-oryzanol and tocotrienols, rice bran oil represents a promising and culturally acceptable dietary option for improving certain aspects of lipid profiles in at-risk populations. Future studies with larger sample sizes, extended durations, and rigorous control of dietary and lifestyle factors are needed to confirm these findings and further elucidate the mechanisms underlying its lipid-lowering effects.

SUGGESTION

This study can be used as a basis for developing and continuing further research.

ACKNOWLEDGMENT

The author would like to thank Mattombong Health Center for allowing this research to be carried out. Also to the supervisor and fellow fighters who have helped the author to collect respondents. And all respondents who have participated in this research, as well as all parties who have helped until this research was completed.

REFERENCES

Borrell, L. N., & Samuel, L. (2014). Body mass index categories and mortality risk in US adults: the effect of overweight and obesity on advancing death. *American journal of public health*, *104*(3), 512-519.

Cicero, A. F., Fogacci, F., Veronesi, M., Strocchi, E., Grandi, E., Rizzoli, E., ... & Borghi, C. (2020). A randomized placebo-controlled clinical trial to evaluate the medium-term effects of oat fibers on human health: the beta-glucan effects on lipid profile, glycemia and intestinal health (BELT) study. *Nutrients*, *12*(3), 686. https://doi.org/10.3390/nu12030686

Durazo-Arvizu, R. A., McGee, D. L., Cooper, R. S., Liao, Y., & Luke, A. (1998). Mortality and optimal body mass index in a sample of the US population. *American journal of epidemiology*, *147*(8), 739-749. https://doi.org/10.1093/oxfordjournals.aje.a009518

Ferrannini, E., Balkau, B., Coppack, S. W., Dekker, J. M., Mari, A., Nolan, J., ... & Beck-Nielsen, H. (2007). Insulin resistance, insulin response, and obesity as indicators of metabolic risk. *The Journal of Clinical Endocrinology & Metabolism*, *92*(8), 2885-2892. https://doi.org/10.1210/jc.2007-0334

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *Jama*, *309*(1), 71-82. https://doi.org/10.1001/jama.2012.113905

Goufo, P., & Trindade, H. (2014). Rice antioxidants: phenolic acids, flavonoids, anthocyanins, proanthocyanidins, tocopherols, tocotrienols, γ-oryzanol, and phytic acid. *Food science & nutrition*, *2*(2), 75-104. https://doi.org/10.1002/fsn3.86

Gregg, E. W., Cheng, Y. J., Cadwell, B. L., Imperatore, G., Williams, D. E., Flegal, K. M., ... & Williamson, D. F. (2005). Secular trends in cardiovascular disease risk factors according to body mass index in US adults. *Jama*, *293*(15), 1868-1874.

Hendren, N. S., De Lemos, J. A., Ayers, C., Das, S. R., Rao, A., Carter, S., ... & Grodin, J. L. (2021). Association of body mass index and age with morbidity and mortality in patients hospitalized with COVID-19: results from the American Heart Association COVID-19

ISSN 2776-1150 (Print), ISSN 2776-1169 (online)

Cardiovascular Disease Registry. *Circulation*, *143*(2), 135-144. https://doi.org/10.1161/CIRCULATIONAHA.120.051936

Kang, I. S., & Kong, K. A. (2021). Body mass index and severity/fatality from coronavirus disease 2019: A nationwide epidemiological study in Korea. *PloS one*, *16*(6), e0253640. https://doi.org/10.1371/journal.pone.0253640

Meigs, J. B., Wilson, P. W., Fox, C. S., Vasan, R. S., Nathan, D. M., Sullivan, L. M., & D'Agostino, R. B. (2006). Body mass index, metabolic syndrome, and risk of type 2 diabetes or cardiovascular disease. *The Journal of Clinical Endocrinology & Metabolism*, *91*(8), 2906-2912. https://doi.org/10.1210/jc.2006-0594

Mohajan, D., & Mohajan, H. K. (2023). Obesity and its related diseases: a new escalating alarming in global health. *Journal of Innovations in Medical Research*, *2*(3), 12-23.

Mohammadshahi, J., Ghobadi, H., Matinfar, G., Boskabady, M. H., & Aslani, M. R. (2023). Role of Lipid Profile and Its Relative Ratios (Cholesterol/HDL-C, Triglyceride/HDL-C, LDL-C/HDL-C, WBC/HDL-C, and FBG/HDL-C) on Admission Predicts In-Hospital Mortality COVID-19. *Journal of Lipids*, *2023*(1), 6329873. https://doi.org/10.1155/2023/6329873

Nie, Y., Luo, F., Wang, L., Yang, T., Shi, L., Li, X., ... & Lin, Q. (2017). Anti-hyperlipidemic effect of rice bran polysaccharide and its potential mechanism in high-fat diet mice. *Food & Function*, *8*(11), 4028-4041.

Park, S., Chang, H. C., & Lee, J. J. (2021). Rice bran fermented with kimchi-derived lactic acid bacteria prevents metabolic complications in mice on a high-fat and-cholesterol diet. *Foods*, *10*(7), 1501. https://doi.org/10.3390/foods10071501

Patimang, K. P. (2023). *Hubungan Faktor Risiko pada Penderita Diabetes Melitus Tipe 2 Dengan Kejadian Penyakit Jantung Koroner di Pusat Jantung Koroner RSUP Dr. Wahidin Sudirohusodo* (Doctoral dissertation, Universitas Hasanuddin).

Rashid, S., & Genest, J. (2007). Effect of obesity on high-density lipoprotein metabolism. *Obesity*, *15*(12), 2875-2888. https://doi.org/10.1038/oby.2007.342

Saphyakhajorn, W., Sirirat, R., & Sapwarobol, S. (2022). Effect of defatted rice bran supplementation on metabolic parameters and inflammatory status in overweight/obese adults with hypercholesterolemia: a randomized, placebo-controlled intervention. *BMC nutrition*, *8*(1), 94. https://doi.org/10.1186/s40795-022-00586-9

Shaper, A. G., Wannamethee, S. G., & Walker, M. (1997). Body weight: implications for the prevention of coronary heart disease, stroke, and diabetes mellitus in a cohort study of middle aged men. *Bmj*, *314*(7090), 1311. https://doi.org/10.1136/bmj.314.7090.1311

Sultani, R., Tong, D. C., Peverelle, M., Lee, Y. S., Baradi, A., & Wilson, A. M. (2020). Elevated triglycerides to high-density lipoprotein cholesterol (TG/HDL-C) ratio predicts long-term mortality in high-risk patients. *Heart, Lung and Circulation*, *29*(3), 414-421. https://doi.org/10.1016/j.hlc.2019.03.019

Xie, C., Wen, P., Su, J., Li, Q., Ren, Y., Liu, Y., ... & Ren, J. (2019). Elevated serum triglyceride and low-density lipoprotein cholesterol promotes the formation of colorectal polyps. *BMC gastroenterology*, *19*(1), 195. https://doi.org/10.1186/s12876-019-1115-9

