OPEN ACCESS

Indonesian Journal of Human Nutrition
P-ISSN 2442-6636
E-ISSN 2355-3987
www.ijhn.ub.ac.id

Effect of Brown Rice Intervention on BMI and Waist Circumference in Patients with Type 2 Diabetes Mellitus

Dea Intan Permatasari [1*)], Endang Sutjiati[2], Etik Sulistyowati[2]

[1*)] Undergraduate Program in Applied Nutrition and Dietetics, Department of Nutrition, Malang Health Polytechnic
[2]Applied Nutrition and Dietetics Study Program, Department of Nutrition, Malang Health Polytechnic

Corresponding author: Dea Intan Permatasari. E-mail: deaintan.di@gmail.com

Accepted: August 2022 Reviewed: October 2022 Published: July 2022

ABSTRACT

Brown rice, derived from white rice with the removal of the husk, contains higher dietary fiber and a lower glycemic index than regular white rice. These advantages can be an alternative diet for individuals with type 2 diabetes mellitus. Type 2 diabetes mellitus is a metabolic disease ranked as the fourth leading cause of death in the world, often associated with obesity. In addition, insulin insensitivity in individuals with type 2 diabetes leads to increased hunger (polyphagia) and overeating, resulting in increased BMI and waist circumference. The purpose of this study is to determine the effect of the brown rice diet intervention on BMI and waist circumference of patients with type 2 diabetes. This study was a pre-experimental study without control variables and the sample was not selected randomly, using a one-group pretest-posttest design with a 3-month intervention. Data analysis in this study used the Shapiro-Wilk normality test followed by the paired t-test to determine the difference between two paired samples. The statistical results showed significant changes in BMI and abdominal circumference ($p = 0.002$ and $p = 0.008$, respectively). In conclusion, there are differences in BMI and abdominal circumference of patients with type 2 diabetes mellitus before and after the intervention of a brown rice-based diet menu.

Keywords: type 2 diabetes mellitus, brown rice, BMI, waist circumference

INTRODUCTION

Diabetes Mellitus (DM) is a global health threat. According to data from the World Health Organization (WHO), the number of people with DM in Indonesia is projected to increase from 8.4 million in 2000 to approximately 21.3 million in 2030. The International Diabetes Federation (IDF) stated the same fact. Data on IDF confirms this trend, estimating that the number of diabetics in Indonesia in the age range of 20-79 years will increase from 10 million in 2015 to

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

16.2 million in 2040. Hence, Indonesia will rank sixth for people with DM Type 2 in the world by 2040 (1).

Being overweight or obese can serve as a trigger for DM. Research conducted on the population shows that the likelihood of developing DM in obese people is greater than in slim people. Type 2 DM is often associated with unhealthy lifestyle factors. There are 90-95% of all people with DM suffer from type 2 diabetes (2).

Poor diet and irregular exercise can increase the risk of central obesity. Central obesity can be measured using abdominal circumference, while Body Mass Index (BMI) can be used to determine whether someone is obese or not (3).

Most diabetic patients frequently feel hungry because the intake they consume cannot be converted into energy. Therefore, it often causes DM patients to overeat and results in an increase in BMI and abdominal circumference. According to Fatimah (2015), this situation occurs due to cellular insensitivity to insulin. Blood sugar will rise as a result of the decreased insulin secretion by pancreatic beta cells or impaired insulin function (insulin resistance).

According to research by Kozuka et al. (2013), brown rice has the potential to improve glucose tolerance and insulin resistance in type 2 DM sufferers. In addition, switching the source of carbohydrate intake from white rice to brown rice significantly reduces body weight and improves glucose and fat metabolism in people with metabolic syndrome. Brown rice is a grain that can only be consumed once the aleurone layer of rice or the outermost layer and rice husk have been removed (6). Compared to white rice, brown rice contains four times higher fiber and has a lower glycemic index, making it a healthier choice for people with obesity and diabetes to consume (5).

Brown rice has high LPL levels (*lipoprotein lipase*), which help inhibit fat accumulation and ultimately reduce the risk of central obesity. Abdominal circumference and BMI are two parameters in determining the nutritional status of whether a person is obese or not. Insufficient fiber consumption increases the likelihood of the occurrence of obesity, whereas an adequate consumption of fiber can reduce the risk of obesity and other degenerative diseases, such as DM type 2 (7).

RESEARCH METHODS

Design/Research Design

This research used a pre-experimental design without control variables, and the sample is not randomly selected (8). This study used a single-group design with one-group pretest-posttest. Testing was carried out before and after the intervention, and the differences between the results pretest-posttest were assessed as the effect of the intervention (9). The intervention was carried out for three months for each respondent.

Data Source

All data collected were primary data obtained through several methods including direct interviews and direct anthropometric measurements. The data collected included characteristics of the respondents (gender, age, occupation, medical history), weight, height, and food intake.

Research Target

The research respondents were all outpatients diagnosed with type 2 DM at Griya Bromo Clinic, Malang, Indonesia. The inclusion criteria were as follows: female, aged 40-60 years, BMI ranging from 24-28 kg/m^2, HbA1c ≤8% treated with 1 or a combination of OAD (Anti-Diabetic Drugs), and willingness to participate as a research respondent (proven by signing the informed consent).

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

The exclusion criteria included the presence of heart, kidney, and malignancy disorders, a history of gastrointestinal disorders requiring long-term medical therapy, an active smoker, and antibiotic use in the month prior to fecal sampling.

Development of Data Collection Instruments and Techniques

Data on respondents' characteristics were collected using a questionnaire. The nutritional status of the respondents was determined from BMI measurements using a microtoa with an accuracy of 0.1 cm to measure height and Bioelectrical Impedance Analysis for body weight measurement. Then, BMI was categorized into six groups: underweight (<18.5), normal range (18.5 – 22.9), overweight (≥23), at risk (23.0 – 24.9), obesity I (25.0 – 29.9), and obesity II (≥30). Weight measurements were conducted every month. Abdominal circumference was measured using the metline with an accuracy of 0.1 cm and categorized as normal (≤80 cm) or indicative of abdominal obesity (>80 cm). Abdominal circumference measurements were carried out before and after the intervention.

Food intake data prior to the intervention were taken using a semi-quantitative food frequency method to find out the description of the respondents' eating habits. During the intervention, food intake data were collected using a food record method three times a week for 12 weeks, specifically on two working days (Monday and Wednesday) and one day off (Saturday).

The intervention was given in the form of three main meals (with brown rice as the staple food) and three side dishes every Monday and Saturday. On Sundays, respondents were free to consume personal food while still paying attention to their daily needs.

Data Analysis Technique

The data were analyzed using the SPSS version 15 statistical program. The data normality test was carried out by testing Sapphire Wilk because the number of samples was below 50 people. Then, the test Paired T-test with a 5% error rate was performed to find out the differences between paired samples.

This research has received a Certificate of Eligibility for Research Ethics from the Ethics Commission of the Faculty of Medicine, University of Brawijaya Malang with a certificate number 143/EC/KEPK/07/2016.

RESEARCH RESULT

Overview of Respondents

All respondents were female, ranging in age from 40 to 60 years. Table 1 shows 66.6% of the respondents belong to the early elderly group (46-55 years).

Table 1. Total Distribution of Respondents by Age

No	Age (Year)	Amount	
		n	%
1	36 – 45	1	5,6
2	46 – 55	12	66,6
3	56 – 65	5	27,8
Total		18	100

Most of the respondents are housewives (61.1%). Data on respondents' occupation distribution can be seen in Table 2.

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

Table 2. Distribution of Respondents' Occupation

Profession	Amount	
	n	%
Teacher	1	5,6
Housewife	11	61,1
Posyandu cadres	1	5,6
Headmaster	1	5,6
Church officer	1	5,6
Notary officer	1	5,6
Tailor	2	11,1
Total	18	100

In fact, one-third of the total respondents had a history of hypercholesterolemia, which is characterized by a total serum cholesterol level higher or equal to 200 mg/dL.

Furthermore, 83.3% of respondents had been living with type 2 DM for more than 6.5 years. The duration of suffering from type 2 DM was calculated from the time of the initial diagnosis. The data are presented in Table 3.

Table 3. Duration of Respondents Suffer

Duration (year)	Frequency	
	n	%
< 6,5	15	83,3
≥ 6,5	3	16,7
Total	18	100

Description of Respondents' Energy Intake

Table 4 shows that prior to receiving the intervention, 27.8% of respondents had moderate to severe deficit consumption levels, while 22.2% of respondents had a level of energy intake that exceeds their needs. However, after the intervention, the energy intake of the respondents improved, declining from the mild to normal deficit category.

Table 4. Distribution of Respondents' Energy Adequacy Levels

Energy Adequacy Level	Respondents' amount			
	Pre		Post	
	n	%	n	%
Severe deficit (<70%)	3	16,7	0	0
Moderate deficit (70 – 79%)	2	11,1	0	0
Mild deficit (80 – 89%)	3	16,7	8	44,4
Normal (90 – 119%)	6	33,3	10	55,6
Excess (>120%)	4	22,2	0	0

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

Description of Respondents' Fat Intake

Before the intervention, more than half of the respondents (55.5%) had fat intake below the RDA, while 16.7% of respondents had fat intake above the RDA. After the intervention, fat intake improved to a mild to normal deficit category. The data can be seen in Table 5.

Table 5. Average Level of Respondents' Fat Intake

Intake Level Classification	Amount			
	Pre		Post	
	n	%	n	%
Below the RDA (<90% RDA)	10	55,5	6	33,3
Normal (90 – 119% RDA)	5	27,8	12	66,7
Above RDA (>119% RDA)	3	16,7	0	0

Description of Respondents' BMI and Abdominal Circumference

Table 6 shows that more than half of the respondents (66.6%) were included in the obesity category I before receiving the intervention. However, the prevalence of respondents experiencing obesity I decreased by around 5% after receiving the intervention. Statistical test results also show a significant p-value of 0.002 ($p<0.05$). Furthermore, before the intervention, 83.3% of respondents were included in the abdominal obesity category; but, after the intervention, 22.2% of respondents showed a reduction in abdominal circumference and approached normal.

Table 6. Distribution of Respondents' BMI Classification and Abdominal Circumference

Variable	Pre		Post		P*
	Total		Total		
	n	%	n	%	
BMI					
Underweight (<18,5)	0	0	0	0	
Normal (18,5 – 22,9)	3	16,7	4	22,2	
Overweight (≥ 23,0)	0	0	0	0	
Risky (23,0 – 24,9)	3	16,7	3	16,7	
Obesity I (25,0 – 29,9)	12	66,6	11	61	
Obesity II (≥ 30,0)	0	0	0	0	
Abdominal circumference					
≤ 80 cm	3	16,7	2	11,1	
>80 cm	15	83,3	16	88,9	

*Statistic test

DISCUSSION

Overview of Respondents

All respondents in this study were female. The selection of female respondents was based on that women have a higher tendency to experience an increase in body mass index than men. This increase in body mass index is associated with the development of obesity, which is a risk factor for type 2 DM. It aligns with previous research conducted by Aamir et al. (2019) and Tripathy et al. (2017) that reported a higher prevalence of diabetes among

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

women in population surveys. Furthermore, premenstrual syndrome and postmenopausal changes contribute to the accumulation of body fat, thereby increasing the risk of developing type 2 diabetes mellitus in women (12).

In this study, respondents in the early elderly age group (46-55 years) are the most age group with type 2 DM. This finding is in line with research conducted by Cho in Asiimwe et al. (2020) that the highest prevalence of diabetes is in the age range of 45-64 years. It is because aging leads to a decline in carbohydrate metabolism, resulting in reduced blood glucose usage and glucose tolerance, as well as an increased likelihood of insulin resistance (14).

Table 2 shows that most of the respondents are housewives. Housewives have a lot of free time which results in a lack of physical activity. This sedentary lifestyle increases the risk of obesity, which is a risk factor for type 2 DM (15).

In addition to type 2 DM, some respondents also had a history of hypertension and hypercholesterolemia. The combination of type 2 DM and high cholesterol levels is proven to increase insulin plasma production, which will lead to decreased pancreatic function and beta cell dysfunction, resulting in type 2 DM (16). Furthermore, hypertension is also known to be one of the complications of diabetes, and vice versa. Patients with DM can experience an increase in blood pressure; 40-60% of cases of diabetes are also exhibiting high blood pressure. Diabetes accompanied by hypertension increases the risk of stroke and myocardial infarction due to progressive arteriosclerosis. Type 2 diabetes results in hyperinsulinemia, which stimulates sympathetic nerve activity and increases renin excretion. Active renin, in turn, will activate the sympathetic nervous system and increase cardiac output and vascular resistance. This mechanism will increase blood pressure (17).

There are 83.3% of respondents who have been diagnosed with type 2 DM for more than 6.5 years. It is important to note that as the duration of type 2 DM increases, the likelihood of experiencing complications also rises. Besides, as the duration of suffering increases, individuals may experience a decrease in their knowledge and skills related to the treatment of DM (18). This is attributed to factors such as boredom from sufferers so that it will reduce the quality of life. Consequently, the quality of life of DM patients can be improved by adopting a healthy lifestyle, one of which is by adhering to dietary recommendations designed for individuals with DM.

Analysis of Respondents' Energy and Fat Intake

Table 4 shows that before receiving the intervention, 27.8% of respondents had moderate to severe deficit consumption levels, while 22.2% of respondents had a level of energy intake exceeding their needs. People with DM are advised to follow the three eating principles (right amount, schedule, and type). The principle of eating the right amount emphasizes the importance of aligning calorie intake with daily needs. In this study, respondents received a diet tailored to their calorie needs so that their calorie intake was neither excessive nor lacking. In line with Putra, I. W. A., & Berawi (2015), patients with DM must avoid consuming excessive calories to prevent further complications. Determining the daily calories must consider several factors, such as nutritional status, age, stress, and physical activity.

One of the objectives of providing nutritional therapy to diabetic

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

patients, especially type 2 diabetes mellitus, is to maintain body weight within the normal range. Type 2 DM patients with obesity are advised to lose weight to improve glycemic control (20). Data in Table 4 show that 44.4% of respondents had a mild deficit in energy adequacy, and 55.6% of respondents were in the normal category. These findings are in line with the fact that 66.6% of respondents were classified as obesity I, suggesting the need for gradual weight reduction. Providing a mild level of calorie deficit is known to help improve BMI and abdominal circumference in people with obesity. Excessive calorie reduction, on the other hand, may not help improve the BMI and abdominal circumference of respondents with type 2 DM, but it increases the risk of other complications, such as hypoglycemia.

Besides the calorie intake, the selection of food ingredients for people with DM needs to be carefully considered. Patients with DM are not advised to consume food with a high Glycemic Index. Before the intervention, the respondents had the habit of consuming white rice as their staple food, which has a high glycemic index and can increase glucose intolerance. In addition, consuming white rice as a staple food will have an impact on the glycemic index load because of the dominant portion of white rice (21).

The dietary intervention given to respondents in this study was implemented using brown rice as a substitute for white rice. It is because brown rice is unpolished rice, so the amylose content is higher than white rice. According to research by Fa et al. (2019), higher amylose content in food leads to a lower glycemic index value.

Regarding fat intake, data in Table 5 shows that more than half of the respondents (55.5%) had fat intake below the RDA prior to the intervention, while 16.7% of respondents had fat intake above the RDA. Excessive fat intake, if it is not balanced with adequate physical activity, can cause fat accumulation. This fat accumulation can increase the occurrence of central obesity. From Table 5, the average fat intake during the intervention was also given below the RDA to match the RDA because 83.3% of respondents had central obesity, marked by abdominal circumference higher than 80 cm, before the intervention. Central obesity occurs when there is an accumulation of fat in a part of the body, one of which is accumulation in the abdomen or intra-abdominal and subcutaneous in the abdominal area (23). According to Bertalina & Muliani (2016), central obesity is closely related to the incidence of type 2 DM. One of the causes of central obesity is excessive consumption of fat, which causes fat accumulation.

Analysis of BMI and Respondents' Abdominal Circumference Changes

Body mass index and abdominal circumference are parameters commonly used to determine whether a person is obese or not. Obesity is a known risk factor for obesity (24). A person is stated to be obese if the BMI is $\geq$ 25 kg/m^2. BMI is applicable across the general population and does not depend on age and gender, but it may not be suitable for pregnant women and also muscular athletes.

Obesity has long been associated with a risk factor for type 2 DM. Obesity can cause insulin resistance and damage to pancreatic β cells, resulting in inadequate insulin production. One of the main contributing factors to insulin resistance is due to the elevation of plasma-free fatty acids (25).

Weight control needs to be done to reduce the risk of metabolic diseases,

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

including Type 2 DM. Calorie-deficit diets are commonly employed as a method to control weight (26). This study used a DM diet of 1300 -1500 kcal/day with brown rice as the staple food for type 2 DM patients with obesity. After a 3-month intervention, there was a decrease in the prevalence of obesity among respondents. Apart from being affected by mild calorie deficits, another contributing factor to improving weight is the consumption of brown rice, which is high in fiber. The high fiber content in brown rice slows down gastric emptying compared to white rice, leading to increased satiety and reduced excessive intake (27).

The results of this study showed a 5% decreased prevalence of obesity in respondents. The results of this study are in line with the research of Sawada et al. (2019), that consuming brown rice as the main food can play a role in controlling body weight. The statistical test results also showed a significance value or p-value of 0.002 ($p < 0.05$). Hence, it could be concluded that there was a difference in the BMI of respondents with type 2 DM before and after the brown rice-based diet menu intervention.

Excessive fat intake can trigger excess fat accumulation in the body and can cause central obesity when fat accumulates in a specific area. After the intervention, 22.2% of respondents achieved abdominal circumference close to normal. It can be attributed to the controlled intake of fat and calories during the intervention. Research by Hooper et al. (2015) also supports this by stating that a controlled fat diet has been shown to reduce body weight and body fat percentage, resulting in improvements in body weight and abdominal circumference. The results of the statistical test showed a p-value of 0.008 ($p < 0.05$), meaning that there was a difference between the abdominal circumference of respondents with type 2 DM before and after the intervention with the brown rice-based diet menu.

Effect of Brown Rice-Based Diet on Improvement of BMI and Abdominal Circumference

The results of this study show that the brown rice-based diet intervention improved the respondent's BMI and abdominal circumference, as indicated in Table 6. This improvement is attributed to the nutritional content of brown rice, which is better than ordinary white rice. Brown rice contains phytosterols, which act as antioxidants. Phytosterols can enhance the activity of lipoprotein lipase (LPL), an enzyme that will inhibit fat accumulation in peripheral tissues (6).

Besides, brown rice also contains gamma-oryzanol, which is an anti-obesity substance. Administering gamma-oryzanol in experimental animals fed a high-fat diet to become obese showed positive results that gamma-oryzanol is able to control weight gain and help reduce the possibility of dyslipidemia in experimental animals (30). Research by Francisqueti et al. (2017) also states that gamma-oryzanol plays a role in preventing weight gain. In line with this research, the results of this study also showed a significant improvement in the respondents' BMI and abdominal circumference.

Brown rice also contains high fiber, which contributes to its lower glycemic index than white rice. The fiber in brown rice can help reduce weight because fiber can promote satiety (6). A similar study conducted by Delzenne et al. (2020) stated that increased dietary fiber intake, either from fiber-rich foods or supplements, can help maintain or promote weight loss in individuals who are overweight.

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9

CONCLUSION

The brown rice-based diet intervention had a significant effect on the BMI and abdominal circumference of the respondents in this study. The intervention resulted in a 5.6% decrease in the prevalence of obesity I and a 5.5% increase in the prevalence of respondents with normal BMI category. Statistical test results also showed that changes in BMI before and after the intervention were significant (0.002; $p<0.05$).

Furthermore, 22.2% of respondents experienced a decrease in abdominal circumference, close to normal following the brown rice-based diet menu intervention. The statistical test results also showed significant changes in abdominal circumference before and after the intervention (0.008; $p<0.05$). However, 88.9% of respondents still had central obesity, as their abdominal circumference exceeded the normal limits of 80 cm.

ACKNOWLEDGMENTS

The authors thank Prof. Dian Handayani, SKM, M.Kes, PhD who has provided the opportunity to join the research team. The author also thanks Dr. Ir. Endang Sutjiati and Dr. Etik Sulistyowati, SST., S.Gz., M.Kes who have guided the completion of this thesis.

REFERENCES

1. Sahlan Zamaa M, Sainudin S. Hubungan Kepatuhan Pengobatan Dengan Kadar Gula Darah Sewaktu Pada Pasien Diabetes Melitus Tipe II. Jambura Nurs J. 2019;1(1):11–8.
2. Nuraini HY, Surpiatna R. ARTIKEL PENELITIAN Hubungan Pola Makan , Aktivitas Fisik dan Riwayat Penyakit Keluarga Terhadap Diabetes Melitus Tipe 2. 2016;05(01):5–14.
3. Sagita RW, Rusita I, Anto YV. Hubungan Indeks Massa Tubuh (Imt) Dengan Kadar Glukosa Darah Pada Pasien Dengan Diabetes Melitus Tipe 2 Di Rsud Wates. 2020;09(1):14–8.
4. Fatimah RN. Diabetes Melirus Tipe 2. J Major. 2015;4(5):93–101.
5. Kozuka C, Yabiku K, Takayama C, Matsushita M, Shimabukuro M, Masuzaki H. Natural food science based novel approach toward prevention and treatment of obesity and type 2 diabetes: Recent studies on brown rice and γ-oryzanol. Obes Res Clin Pract [Internet]. 2013;7(3):e165–72. Available from: http://dx.doi.org/10.1016/j.orcp.2013.02.003
6. Sulistyowati E, Rudijanto A, Soeharto S, Handayani D. The Identification of Characteristic Macro- and Micronutrients and the Bioactive Components of Indonesian Local Brown Rice as a Functional Feed in Obesity Nutrition Therapy. Curr Nutr Food Sci. 2019;16(4):494–500.
7. Maryusman T, Fauziyah A, Fatmawati I, Firdausa NI, Imtihanah S. Pengaruh Kombinasi Diet Tinggi Serat dan Senam Aerobik terhadap Penurunan Berat Badan. J Kedokt dan Kesehat. 2018;14(1):56.
8. Sugiyono. Metode Penelitian Kombinasi (Mix Method). Bandung: Alfabeta; 2015.
9. Suherman E. Strategi Pembelajaran Matematika Kontemporer. Bandung: JICA

UPI; 2013.

10. Tripathy JP, Thakur JS, Jeet G, Chawla S, Jain S, Pal A, et al. Prevalence and risk factors of diabetes in a large community-based study in North India: results from a STEPS survey in Punjab, India. Diabetol Metab Syndr. 2017;9(8):1–8.

11. Aamir AH, Ul-Haq Z, Mahar SA, Qureshi FM, Ahmad I, Jawa A, et al. Diabetes Prevalence Survey of Pakistan (DPS-PAK): Prevalence of type 2 diabetes mellitus and prediabetes using HbA1c: A population-based survey from Pakistan. BMJ Open. 2019;9(2):1–9.

12. Trisnawati SK, Setyorogo S. Faktor Risiko Kejadian Diabetes Melitus Tipe II Di Puskesmas Kecamatan Cengkareng Jakarta Barat Tahun 2012. J Ilm Kesehat. 2013;5(1):6–11.

13. Asiimwe D, Mauti GO, Kiconco R. Prevalence and Risk Factors Associated with Type 2 Diabetes in Elderly Patients Aged 45-80 Years at Kanungu District. J Diabetes Res. 2020;2020.

14. Ha MS, Son WM. Combined exercise is a modality for improving insulin resistance and aging-related hormone biomarkers in elderly Korean women. Exp Gerontol [Internet]. 2018;114(May):13–8. Available from: https://doi.org/10.1016/j.exger.2018.10.012

15. Vaidya A, Krettek A. Physical activity level and its sociodemographic correlates in a peri-urban Nepalese population: A cross-sectional study from the Jhaukhel-Duwakot health demographic surveillance site. Int J Behav Nutr Phys Act. 2014;11(1).

16. Sorop O, van den Heuvel M, van Ditzhuijzen NS, de Beer VJ, Heinonen I, van Duin RWB, et al. Coronary microvascular dysfunction after long-term diabetes and hypercholesterolemia. Am J Physiol - Hear Circ Physiol. 2016;311(6):H1339–51.

17. Ohishi M. Hypertension with diabetes mellitus: Physiology and pathology review-article. Hypertens Res. 2018;41(6):389–93.

18. Roifah I. Analisis Hubungan Lama Menderita Diabetes Mellitus Dengan Kualitas Hidup Penderita Diabetes Mellitus. J Ilmu Kesehat. 2017;4(2):7.

19. Putra, I. W. A., & Berawi K. Empat Pilar Penatalaksanaan Pasien Diabetes Mellitus Tipe 2. Majority [Internet]. 2015;4(9):8–12. Available from: http://juke.kedokteran.unila.ac.id/index.php/majority/article/view/1401

20. L. Kathleen Mahan JLR. Krause's Food & The Nutrition Care Process. Poisoning & Drug overdose. Canada: El; 2017.

21. Kaur B, Ranawana V, Henry J. The Glycemic Index of Rice and Rice Products: A Review, and Table of GI Values. Crit Rev Food Sci Nutr. 2016;56(2):215–36.

22. Fa A, Ch W, Dn F, Ne S. Hubungan antara Kandungan Karbohidrat dan Indeks Glikemik pada Pangan Tinggi Karbohidrat

Relationship between Carbohydrate Content and the Glycemic Index in High-Carbohydrate Foods. 2019;(September).

23. Wijaya A, Wande N, Wirawati IAP. Hubungan lingkar perut dengan kadar gula darah puasa pada mahasiswa Fakultas Kedokteran Universitas Udayana angkatan 2014. Intisari Sains Medis. 2019;10(2):279–83.

24. PERKENI. Pengelolaan dan Pengobatan Diabetes Melitus Tipe 2 Dewasa. Pedoman Pengelolaan dan Pencegah Diabetes Melitus Tipe 2 di Indones. 2019;1:132.

25. Verma S, Hussain ME. Obesity and diabetes: An update. Diabetes Metab Syndr Clin Res Rev [Internet]. 2017;11(1):73–9. Available from: http://dx.doi.org/10.1016/j.dsx.2016.06.017

26. Ruban A, Stoenchev K, Ashrafian H, Teare J. Current Treatments for Obesity. Clin Med (Northfield Il) [Internet]. 2019;19(3):205–12. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6542229/pdf/clinmed-19-3-205.pdf

27. Pletsch EA, Hamaker BR. Brown rice compared to white rice slows gastric emptying in humans. Eur J Clin Nutr [Internet]. 2018;72(3):367–73. Available from: http://dx.doi.org/10.1038/s41430-017-0003-z

28. Sawada K, Takemi Y, Murayama N, Ishida H. Relationship between rice consumption and body weight gain in Japanese workers: White versus brown rice/multigrain rice. Appl Physiol Nutr Metab. 2019;44(5):528–32.

29. Hooper L, Abdelhamid A, Bunn D, Brown T, Summerbell CD, Skeaff CM. Effects of total fat intake on body weight. Cochrane Database Syst Rev. 2015;2015(8).

30. Wang L, Lin Q, Yang T, Liang Y, Nie Y, Luo Y, et al. Oryzanol Modifies High Fat Diet-Induced Obesity, Liver Gene Expression Profile, and Inflammation Response in Mice. J Agric Food Chem. 2017;65(38):8374–85.

31. Francisqueti FV, Minatel IO, Ferron AJT, Bazan SGZ, Silva V dos S, Garcia JL, et al. Effect of gamma-oryzanol as therapeutic agent to prevent cardiorenal metabolic syndrome in animals submitted to high sugar-fat diet. Nutrients. 2017;9(12).

32. Delzenne NM, Olivares M, Neyrinck AM, Beaumont M, Kjølbæk L, Larsen TM, et al. Nutritional interest of dietary fiber and prebiotics in obesity: Lessons from the MyNewGut consortium. Clin Nutr. 2020;39(2):414–24.

DOI: https://doi.org/10.21776/ub.ijhn.2023.010.01.9