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THE EFFECT OF APPLICATION A MODIFIED T-MODEL PLATE ON GD2JPP LEVELS AND AVERAGE GLYCEMIC LOAD OF DMT2 PATIENTS MENU

Pengaruh Penerapan Modifikasi Piring Model-T terhadap Kadar GD2JPP dan Rerata Beban Glikemik Menu Pasien DMT2

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ABSTRACT

Background: Type 2 Diabetes Mellitus (DM) is a metabolic disease with a high prevalence in Indonesia. Its management emphasizes TNM using the "T-shaped plate" concept as a modification of the 3J principle . Although the effectiveness of a similar portion approach has been shown globally, there has been no specific study in Indonesia that analyzes the effect of the T-shaped plate concept on levels 2HBP and the average daily glycemic load of the menu in patients with Type 2 DM. Objective: This study aims to analyze the effect of using a T-shaped plate on 2HBP and the average daily glycemic load of the menu in patients with Type 2 DM. Method: This study uses a quantitative method with a pre-test post-test control group design, involving two groups, namely treatment and control for one month of intervention. Using paired t-test statistical test Results: Type 2 DM patients are elderly (60-74 years), female, elementary school graduates, with cardiovascular disorders, DM <5 years, and regularly taking medication. There is an increase in energy, carbohydrate, and fiber intake, as well as changes in the type of food ingredients and the accuracy of meal schedules. The results showed no significant effect of the modified T-plate on GD2JPP levels in type 2 diabetes patients. The statistical test result for the control group was 0.66 (>0.05), while for the treatment group, the p-value was 0.07 (<0.05). A significant effect was found in the treatment group with a p-value of 0.00 (<0.05). However, there was no significant effect in the control group with a p-value of 0.25 (>0.05). Conclusion: the results show that the use of T-shaped plates is not significantly related to GD2JPP levels but is significantly related to the average daily glycemic load.

Keywords*: glycemic load; post-prandial blood glucose; T-shaped plate; Type 2 Diabetes Mellitus*

ABSTRAK

Latar Belakang: Diabetes Melitus (DM) Tipe 2 adalah penyakit metabolik dengan prevalensi tinggi di Indonesia, termasuk Kota Malang. Penanganannya menekankan TNM menggunakan konsep "piring model T" sebagai modifikasi prinsip 3J (tepat jenis, jumlah, dan jadwal) yang berfokus pada pembagian porsi visual: 50% sayur, 25% karbohidrat, dan 25% protein. Meskipun efektivitas pendekatan porsi serupa telah ditunjukkan secara global, belum ada studi spesifik di Indonesia yang menganalisis pengaruh konsep piring model T terhadap kadar GD2JPP dan rata-rata beban glikemik menu harian pada pasien DM Tipe 2. Tujuan: Penelitian ini bertujuan untuk menganalisis pengaruh penggunaan piring model T terhadap kadar GD2JPP dan rata-rata beban glikemik menu harian pada

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penderita DM tipe 2. Metode: Desain penelitian ini menggunakan metode kuantitatif dengan rancangan pre-test post-test control group, melibatkan dua kelompok yaitu perlakuan dan kontrol selama satu bulan intervensi. Menggunakan uji statistik paired t-test Hasil: Pasien DM Tipe 2 adalah lansia (60-74 tahun), perempuan, lulusan SD, dengan gangguan kardiovaskular, DM <5 tahun, dan rutin mengkonsumsi obat. Terdapat peningkatan asupan energi, karbohidrat, dan serat, serta perubahan jenis bahan makanan dan ketepatan jadwal makan. Kesimpulan: hasil menunjukkan bahwa penggunaan piring model T tidak berhubungan secara signifikan terhadap kadar GD2JPP namun berhubungan signifikan dengan rata-rata beban glikemik harian.

Kata Kunci : beban glikemik; Diabetes Melitus Tipe 2; piring model T; glukosa darah post prandial

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia (PERKENI, 2021). According to the World Health Organization (WHO), approximately 422 million people worldwide suffer from diabetes, with 1.5 million annual deaths caused by this disease. In Indonesia, data from the 2019 Basic Health Research (Riskesdas) shows a doctor-diagnosed diabetes prevalence of 1.5%. East Java Province has a higher prevalence rate, at 2.02%, while Malang City recorded 1.40%. According to the Malang City Health Profile, the number of DM sufferers in this region reached 20,771 by 2024. The high incidence of DM indicates the need for treatment for this disease.

DM management is carried out through the five pillars of DM management initiated by PERKENI. One of these is Medical Nutrition Therapy (TNM). TNM includes the application of the 3J principle (correct type, correct amount, and correct schedule) to correct an unbalanced diet cycle. Unlike type 1 diabetes mellitus (DM), which is autoimmune, type 2 diabetes mellitus (DM) begins with insulin resistance due to an unhealthy lifestyle. Consuming high-glucose foods and a lack of fiber, coupled with a sedentary lifestyle, leads to impaired insulin function (Widiasari et al., 2021). One application of the 3J principle is the T-shaped plate concept developed by the Indonesian Ministry of Health within the Obesity Eradication Movement (GENTAS) program.

The TDM plate model was implemented by modifying the Ministry of Health's GENTAS T-shaped plate using the 3J principle, with visual portion divisions as follows (50% vegetables, 25% carbohydrates, 25% protein) without the

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need for weighing. Clear portion divisions through plate dividers make it easier for patients, especially the elderly, to regulate appropriate meal sizes. This concept uses foods with a low to medium glycemic index (GI), which are safer for blood glucose levels. A 2:1 fiber to carbohydrate ratio helps slow glucose absorption and stabilize blood glucose. Maneesing et al. (2023) stated that boxed meal portions, a method similar to the T-shaped plate, can play an important role in blood glucose control.

Blood glucose control can be achieved through the use of a T-shaped plate by increasing fiber intake up to two times that of carbohydrates. Increased fiber consumption, especially soluble fiber, works by forming a viscous gel in the small intestine, slowing glucose absorption and helping lower blood glucose levels. Research by Viapita et al. (2021) showed a significant association between increased fiber consumption and reduced GD2JPP, further supported by the findings of de Carvalho et al. (2017) that soluble fiber intake from both food and supplements effectively suppresses postprandial glucose increases. In addition to fiber, lower carbohydrate intake reduces the substrate for breakdown into glucose, thereby reducing the stimulation of insulin secretion and postprandial blood glucose fluctuations (Evert, A. B., et al. 2019).

The reduced proportion of carbohydrates in a T-shaped plate also directly reduces the total glycemic load of the meal. Research (Dwipajati, 2023) indicates that the use of a T-shaped plate can reduce carbohydrate intake. Soviana & Pawestri (2020) explain that the reduction in glycemic load occurs because the glycemic load depends not only on the glycemic index but also on the total amount of carbohydrates consumed. However, it is important to note that this strategy must be implemented carefully, as demonstrated by Hardy et al. (2020), who found that a high glycemic load can interfere with the blood glucose-lowering effect even when fiber intake is increased. The T-shaped plate is effective in reducing glycemic load and blood glucose levels only when implemented with a controlled carbohydrate proportion and the selection of low-glycemic fiber sources.

Based on research by Maneesing et al. (2023) and Dwipajati (2023) above, using portioned meal approaches such as the

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use of T-shaped plates and portioned meal boxes, showed changes in blood glucose levels in patients with type 2 diabetes mellitus. However, to date, no research in Indonesia has specifically analyzed the effect of T-shaped plates on 2-hour postprandial blood glucose levels (2HBP) and the average daily glycemic load in patients with type 2 diabetes mellitus. This indicates an important research gap that needs to be filled in order to produce more contextual and applicable interventions. Therefore, this study aims to further examine and assess the effect of T-shaped plates on 2-hour postprandial blood glucose levels (2HBP) and the average daily glycemic load in patients with type 2 diabetes mellitus. Therefore, the results of this study should become the basis for more effective nutritional interventions. Based on the background presented above, the problem formulation in this thesis is as follows: How the use of a T-shaped plate affects on the GD2JPP levels and the average glycemic load of the daily menu affect on the blood glucose levels of Type 2 Diabetes Mellitus sufferers.

METHOD

Design, place and time

This study employed a quantitative, quasi-experimental research design. The treatment units were patients with type 2 diabetes mellitus (DM). This study employed a pre-test, post-test, control group design. The control and treatment groups underwent GD2JPP levels and intake interviews using a 24-hour recall form before and after the intervention. The study was conducted from June to July 2025 in the Dinoyo Community Health Center (Puskesmas) area, encompassing five sub-districts: Dinoyo, Ketawanggede, Merjosari, Sumbersari, and Tlogomas.

Population and Samples

The population was all outpatients with type 2 diabetes mellitus aged 45-65 years. The sample consisted of patients with type 2 diabetes mellitus within the Dinoyo Community Health Center area. Thirty individuals met the inclusion criteria, and two individuals met the exclusion criteria. The sample was then divided into control and treatment groups, each consisting of 15 individuals.

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Data Collection

GD2JPP level data was collected after T-plate implementation by drawing blood samples with a lancet by another healthcare professional, then analyzing the samples using a glucometer with glucose blood strips. The average glycemic load of the daily menu was calculated by multiplying the carbohydrate content of the food by the glycemic index of the food, then calculating the average.

Data analysis

Data was collected and analysis after samples give ethical approval number 01.07.01/UN32.14.2.8/LT/2025 for dietary pattern and blood glucose. Level data were then analyzed using statistical tests using SPSS for Windows version 25 to test the research hypotheses. Data normality was tested using Shapiro-Wilk. If the data were normally distributed, the homogeneity test was continued, and the results were verified. If the data were homogeneous and normally distributed, parametric statistical tests were used using the paired t-test. If the data were not normally distributed, non-parametric statistical tests were used using the Wilcoxon test..

RESULTS AND DISCUSSION

The highest number of Type 2 Diabetes Mellitus sufferers were in the elderly age group (60–74 years), female with an elementary school education. The number of Type 2 Diabetes Mellitus sufferers without comorbidities was higher in the control group. Most Type 2 DM sufferers in the control group had had diabetes for less than 5 years, while in the experimental group, 8 had had diabetes for more than 5 years.

The control group showed an increase in average GD2JPP levels from pre-test to post-test, which is considered poor glycemic control. Before the intervention, the average value was 268.14 g/dL, then increased to 278.57 g/dL after the intervention. However, in the treatment group, there was a decrease in average GD2JPP levels from pre-test to post-test. The average GD2JPP level in the pre-test was 260.14 g/dL, decreasing to 227.43 kcal in the post-test. Although there was a decrease in glycemic control in the treatment group, it was still classified as poor glycemic control. In the control group, the average GD2JPP level increased by 10.43 g/dL, while in the treatment group, the average GD2JPP level decreased by 32.71 g/dL.

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Table 1. The Effect of T-Shaped Plate Modification to GD2JPP Level

Group		Mean	SD	*p-value*
Control	Pre	268,14	122,31	0,663
	Post	278,57	122,86	
Treatment	Pre	260,14	74,88	0,072
	Post	227,43	81,21	

Sumber : Data Primer yang diolah (2025)

Table 1 shows the results of the paired t-test for the control and treatment groups before and after the intervention. The results showed no significant effect of the modified T-plate on GD2JPP levels in type 2 diabetes patients. The statistical test result for the control group was 0.66 (>0.05), while for the treatment group, the p-value was 0.07 (<0.05). Although the effect was not significant, the treatment group experienced a decrease in average GD2JPP levels, while the control group experienced an increase.

The results indicate that the intervention did not have a significant effect on reducing GD2JPP levels. This may be due to the relatively short duration of the study. The relatively short duration of the intervention was likely insufficient to induce profound physiological adaptations in insulin sensitivity and pancreatic beta cell function. This is in line with research (Li et al., 2022; Silva et al., 2022) which states that non-pharmacological interventions to improve glycemic control, particularly postprandial glucose levels, generally require a minimum of 8 to 12 weeks to show statistically significant effects.

This is because cellular repair mechanisms, such as increased GLUT4 transporter expression and improved mitochondrial function, as well as adaptations in insulin secretion, are processes that require time and consistent stimulation (Jiang et al., 2021). The duration of the intervention in this study may have only been in the early phase of this adaptation process, so the changes that occurred had not yet reached the point where differences between groups became significant. Another cause is the presence of extreme values (outliers) that influence the analysis results. The GD2JPP value remained constant at 500 mg/dL in the control group and decreased drastically to 76 mg/dL in the treatment group. These extreme values disproportionately affect the mean and significantly increase the variance. Outliers influence potential differences between the two groups and bias the test results. Meng, Z., Wang, J., Lin, L., & Wu,

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C. (2024) found that even a single outlier can drastically alter the results of a study and even increase the risk of incorrect conclusions. Therefore, additional analyses should be conducted, both with and without the outlier.

In addition to these statistical factors, clinical and nutritional factors also play a role. Fourth, uncontrolled changes in nutritional intake. The treatment group actually showed an average increase in energy (+5.4%) and carbohydrate (+3.4%) intake, while the control group showed a significant decrease in carbohydrate intake (-13.7%). These dietary changes can influence the net effect of the treatment. The increased intake in the treatment group may have masked the positive effects of the intervention, while the decreased intake in the control group actually had an independent positive effect, equalizing the outcomes of the two groups. This finding is consistent with research by Evert et al. (2019), which states that variation in daily carbohydrate intake is a major determinant of postprandial glycemic variability.

Insufficient fiber intake can directly impact blood glucose control. This is evident in the respondents' fiber intake, which was still below the recommended intake, indicating that they were not receiving the full benefits of the intervention. Research by Wu et al. (2023) confirms that dietary fiber can improve the taste of food. satiety and effectively lower post-prandial blood glucose levels. Furthermore, another study by Weickert & Pfeiffer (2018) explains that fiber plays a vital role in improving insulin sensitivity, which is the opposite of insulin resistance. This mechanism allows the body's cells to use glucose more efficiently, helping to maintain stable blood sugar levels. The findings from these two studies support the hypothesis that respondents' deficient fiber intake contributes to difficulties in optimally controlling their blood glucose levels.

Another factor is the imbalance in baseline characteristics and adherence. The control group unexpectedly demonstrated a higher level of adherence to meal schedules (86% adherence) than the treatment group (57%). Meal schedule adherence is a crucial factor in glycemic control in diabetes. Furthermore, differences in clinical profiles, such as medication regimens, duration of diabetes, and comorbidities, were unequally distributed between the two groups at

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baseline. This dissimilarity in baseline conditions introduces bias and makes it increasingly difficult to isolate and prove the net effect of the intervention. Yang, S., et al. (2019) stated that imbalances in baseline data between groups can occur, especially in cluster-based randomized trials, and this can lead to biased or inaccurate treatment results.

The treatment group was dominated by individuals who had suffered from type 2 diabetes mellitus (DM) for more than 5 years. Laiteerapong et al., (2019); Ahlqvist et al., (2018) stated that the duration of DM was negatively correlated with therapy response. Patients with longer-standing diabetes exhibited beta cell dysfunction that was more difficult to repair and more severe insulin resistance. A longitudinal study showed that the decline in beta cell function occurs progressively, and after 5 years, many patients experience significant loss of beta cell function, severely limiting their capacity to respond to interventions aimed at increasing insulin secretion (Wang et al., 2021). Based on research by Fuchs & Wewalka (2020), populations with long-standing diabetes are known as "difficult-to-treat" and require a more aggressive and longer-term approach to achieve glycemic targets. Therefore, the intervention duration, which has not yet reached the optimal period, and the characteristics of the study subjects, who fall into the category of long-standing diabetes with more severe beta cell dysfunction, are strong reasons why the intervention effect was not statistically significant in this study.

The Effect of Implementing the Modified T-Model Plate on the Average Daily Glycemic Load of Type 2 Diabetes Mellitus Patients

The control group showed a decrease in the average glycemic load from 7.10 at pre-test to 6.04 at post-test. The average daily glycemic load in this group was already in the low category, both before and after the intervention. Meanwhile, the treatment group also experienced a significant decrease. Their average glycemic load dropped from 12.49 at pre-test (moderate category) to 6.09 at post-test (low category). The average decrease in glycemic load in the control group was 1.06. In contrast, the treatment group experienced a much greater decrease, at 6.4. These changes indicate positive results in both groups after the intervention.

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Table 2. The Effect of T-Shaped Plate Modification on Mean Glycemic Load

Group		Mean	SD	*p-value*
Control	Pre	7,10	3,31	0,258
	Post	6,04	3,27	
Treatment	Pre	12,49	3,31	0,00
	Post	6,08	2,16	

Source: Primer Data Processed (2025)

Table 2. shows the results of the paired t-test for the control and treatment groups before and after the intervention. A significant effect was found in the treatment group with a p-value of 0.00 (<0.05). However, there was no significant effect in the control group with a p-value of 0.25 (>0.05). Although both groups experienced a decrease in their mean glycemic load, the results indicate that the decrease in the treatment group was large enough to reach statistical significance.

The significant decrease in the mean glycemic load in the treatment group was a result of the intervention using a T-shaped plate. This plate principle emphasizes a larger portion of fiber (vegetables and fruit) than carbohydrates, as well as the selection of foods with a medium to low glycemic index (GI). This mechanism aligns with research by Silva et al. (2019), which found that a plate model is effective in improving dietary adherence and controlling glycemic intake. The concept of glycemic load (GI) is more comprehensive than GI because it considers both the GI and the amount of carbohydrate consumed. Vega-López et al. (2018) defined GI as the product of GI and carbohydrate content, providing a more accurate picture of a food's impact on blood glucose response. Thus, a food with a low GI but consumed in large quantities can have a high GI, while a food with a high GI but consumed in small quantities can have a low GI.

In the treatment group, the use of T-plates successfully increased fiber intake while reducing simple carbohydrate intake from rice and other refined carbohydrate sources. The majority of carbohydrate intake then came from vegetables and fruits, which are rich in fiber and contain complex carbohydrates and natural sugars such as fructose. Increased fiber intake has been shown to slow glucose absorption and improve insulin sensitivity, which directly contributes to a reduction in total glycemic load (Reynolds et al., 2020). Furthermore,

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although fruit contains fructose, consuming it in its whole form (not juice) along with its fiber does not negatively impact glycemic control and is actually recommended in diabetes management. diabetes (Evans et al., 2017). The combination of reducing refined carbohydrates, increasing fiber, and selecting low-GI carbohydrate sources was key to lowering glycemic index (BG) in the treatment group.

In contrast, in the control group, the intervention provided only standard information on the 1300 kcal DM diet without visual strategies like the T-plate. Traditional recommendations such as "4 servings of rice (@50g) and 3 servings of vegetables" tended to be less effective in significantly changing behavior and portion perception. Without clear visual emphasis on the proportion of fiber that should dominate half the plate, subjects tended to revert to old habits where carbohydrates still constitute the largest component of the meal (Potter et al., 2021). As a result, total carbohydrate intake and food composition did not change significantly, resulting in no improvement in the glycemic load of the overall daily intake. Adversely, total carbohydrate intake and food composition change significantly for treatment group, resulting improvement in the glycemic load of the overall daily intake. This suggests that the use of visual aids such as the T-plate is more effective in encouraging sustainable changes in eating behavior than recommendations without visual aids.

The research duration is about 30 days. It limits the more effective behavior to improve patients health. Future research should be done by add more duration to get more effective behavior. There is a neet to get more samples that this resachr who have samples 30 respondents. Future research should add more samples to get more reliable results.

CONCLUSION

Patients with type 2 diabetes experienced increased energy intake, carbohydrate intake, and fiber intake. Although the average intake of both groups increased, it was still classified as a deficit. Glycemic control in both groups was still classified as poor, and there was no effect of the T-shaped plate on GD2JPP levels in patients with type 2 diabetes (p-value > 0.05). The mean glycemic load in the

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treatment group after the intervention was classified as low glycemic load, and there was an significat effect of the T-shaped plate on the average daily glycemic load in patients with type 2 diabetes (p-value > 0.05).

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