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Nutritional Literacy, Knowledge and Compliance with a Simple Low-Carbohydrate Diet in Type 2 Diabetes Mellitus

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Abstract

Diabetes Mellitus (DM) Type 2 (DMT2) is a condition that can be caused by a lack of insulin resistance and is associated with a general lack of insulin resistance, as the highest cause of pain and death in the non-communicable disease group.

Aims: This study aims to determine the effects of a simple carbohydrate soaking diet before it is given nutritional literacy through the medial Booklet of the intervention group in the control group of patients with DMT2.

Methodology: This type of research is based on a *Quasi Experiment* with a *Two Group Pre-Test Post-Test* design that is carried out in Kota Bengkulu. According to this research, 66 patients with DMT2 were assisted at the Pasar Ikan Health Center. The study is expected to be conducted in April-May 2024. The following tests were used, namely the *Chi-Square* test, the *Mann-Whitney U Test*, the *Independent T-Test*, the *Paired T-Test*, and the *Wilcoxon Signed U Test*.

Results: Participants were randomised to the intervention group with a *p-value* 0.0001<0.05, nutritional literacy with a mediated *Booklet*. Likewise aided the control group with *p-value* gain 0.001<0.05 nutritional literacy with *Leaflet-mediated* nutrients. The *Booklet-mediated* intervention group was also aided by the intervention group with a *p-value* gain 0.0001<0.05, in nutritional literacy with *Booklet-mediated* nutrients. Likewise helped the control group with a *p-value* gain of 0.0001<0.05 nutritional literacy with *Leaflet-mediated* gain.

Scientific Novelty: The novelty of this research lies in Focus on nutrition literacy interventions that are specifically aimed at improving adherence to a detailed type of diet, i.e. a low-carbohydrate diet, which is rarely the sole focus in nutrition literacy studies for people with DMT2.

Conclusion: There is an effect of adherence to a simple low-carbohydrate diet on DMT2 before and after being Granted Nutrition Literacy Activities.

Keywords: Nutrition Literacy, Low-Carbohydrate Diet, Diabetes Mellitus Type 2

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Introduction

Diabetes Mellitus (DM) is defined as a health disorder presenting as a collection of symptoms in an individual, caused by an increase in blood glucose levels due to insulin deficiency, insulin resistance, or a combination of both, as well as general metabolic disturbances (1). DM is a group of metabolic diseases characterised by hyperglycemia resulting from defects in insulin secretion, insulin action, or both (2). DM consists of two types: Type 1 Diabetes Mellitus and DMT2. Type 1 DM is characterised by insufficient insulin production, whereas Type 2 DM is caused by the body's ineffective use of insulin (*insulin resistance*). Type 2 DM is the most commonly found type of diabetes and

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usually appears at the age of over 40 years (3). Common symptoms of Diabetes Mellitus include Polyuria (frequent urination), Polyphagia (frequent hunger), Polydipsia (frequent thirst), and Weight Loss (4). A person is diagnosed with Diabetes Mellitus if the results of a random blood glucose test are ≥ 200 mg/dL or fasting blood glucose is ≥ 126 mg/dL (5).

The prevalence of Diabetes Mellitus is estimated to increase as the age of the population increases to 111.2 million, while 19.9% of the population is aged 65-79. This is predicted to continue to increase to 578 million in Taihun 2030 and 700 million in Taihun 2045 (6). The prevalence of diabetes mellitus in Bengkulu was 6.9% in 2013 and increased to 8.5% in Riskesdas 2018 data (7). Prevalence of diabetes mellitus. The number of people with diabetes mellitus (DM) in Bengkulu in 2022 is 4.3% (Bengkulu City Government, 2022). The number of all patients with diabetes mellitus who visited the Paisair Ikain Kotai Bengkulu Health Centre was 3.2% of the total number of patients with diabetes mellitus, November 2023 (Register Book). Diabetes mellitus in the world increased by 1.9%, making diabetes mellitus the seventh disease in the world (8). The prevalence of diabetes mellitus in the age group aged 45-54 years in the urban area occupied the 2nd rank, which was 14.7% in rural areas, with the 6th rank, and 5.8% of all were at risk of developing microvascular complications, even if they were microvascular (9).

How to control the risk factors of Diabetes Mellitus type 2 are to check the health of the patient to control the fluid, check the blood pressure, the blood sugar level, the cholesterol level of the blood pressure monitor, the physical activity of the 30 minutes of the physical activity of the patient, the diet of the physical activity of the patient, the diet of the physical activity of the patient, the amount of blood pressure that is sufficient for the body, the amount of stress that is sufficient for the body, the amount of stress that is sufficient for the body, the amount of stress that is sufficient for the body, the amount of stress that is stored in the body (10). It is difficult for people with diabetes to have a better understanding of the importance of having a healthy diet, so that people with diabetes mellitus have a better understanding of how to manage their diet (11). Diabetic Mellitus education is an educational tool for educating people about the importance of their dreams in the field of diabetic mellitus that aims to improve the understanding of the disease (12).

Dietary adherence is the obedience or non-obedience to commands, rules, and discipline. Adherence or *compliance* results in temporary behavioural changes, and individuals tend to revert to their original views or behaviours (13). Excessive consumption of carbohydrates leads to more glucose in the body. In patients with DMT2, body tissues are unable to store and utilise glucose, thus blood glucose levels are influenced by the high intake of consumed carbohydrates (14). High carbohydrate intake also causes an increase in postprandial (after-meal) triglyceride levels in the blood (15). This occurs due to high carbohydrate intake and low fibre intake. One effort to prevent Diabetes Mellitus is by improving dietary patterns through appropriate food selection. The lower the carbohydrate absorption, the lower the blood glucose level (16). Most carbohydrates in food will be absorbed into the bloodstream in the form of the monosaccharide glucose. Other types of sugar will be converted by the liver into glucose (17). This study aims to analyse the characteristics of DMT2 and to determine the effect of nutritional literacy intervention via *Booklet* media on the improvement of knowledge and adherence to a simple low-carbohydrate diet in the intervention group compared to the control group.

Method

This study employed a quantitative research approach with a Quasi-Experimental design. The specific design implemented was the Pre-test and Post-test with a control group, which aimed to determine the differential effect of nutritional literacy before and after the intervention between the group receiving the specific treatment (intervention) and the comparison group (control). The research was conducted at the Pasar Ikan Community Health Centre (Puskesmas) in Bengkulu City during the period of April to May 2024.

The study population consisted of all registered DMT2 patients at the health centre. The research sample comprised a total of 66 participants, equally divided into two groups: the Intervention Group (n=33) and the Control Group (n=33). The intervention group received nutritional literacy using a *Booklet* medium, while the control group received nutritional literacy using a *Leaflet* medium. Data collection involved both primary and secondary data. Primary data were collected directly from the respondents, covering nutritional literacy knowledge measured using the *Newest Vital Sign* (NVS) questionnaire and adherence to a simple low-carbohydrate diet measured through a 2x24-hour *food recall* form. Secondary data were obtained from the Puskesmas records, including basic demographic information of the DMT2 patients.

The data analysis phase began with data processing using SPSS 24.0 software. The data were initially analysed univariately to describe the frequency distribution of each characteristic variable and measurement outcome. Subsequently, bivariate analysis was performed to test the hypotheses and the difference in effects between the intervention and control groups. The selection of statistical tests was determined by the data's normal distribution. If the data were normally distributed, the *Independent T-Test* and *Paired T-Test* were used. Conversely, if the data were not normally distributed, the *Mann-Whitney U Test* and *Wilcoxon Signed Rank Test* were employed. The entire research procedure received ethical approval from the Health Research Ethics Commission of Poltekkes Kemenkes Bengkulu with the number KEPK.BKL/058/03/2024.

Results and Discussion

Table 1 showed that the characteristics of the Chi-Square test were the characteristics of people with diabetes mellitus homogeneously according to age (p -value $0.803 > 0.05$), the characteristics of the type of DMT2 patients (p -value $0.301 > 0.05$), the characteristics of education (p -value $0.789 > 0.05$), the characteristics of occupational (p -value $0.258 > 0.05$), the characteristics of the people suffering from DMT2 patients (p -value $1.000 > 0.05$).

The characteristics based on the respondents' age in this study indicate that the prevalence of Diabetes Mellitus is dominated by subjects in the age groups of 50–60 years and 61–70 years, who have a higher risk of experiencing Diabetes Mellitus compared to the age group under 40 years. This is reinforced by D'Adamo's theory (2018), which states that the risk factor for Diabetes Mellitus appears after the age of 45 years. This condition is due to people in this age range tending to be less physically active, gaining weight, having reduced muscle mass, and being a result of the ageing process, which leads to the progressive shrinkage of beta cells (18). The results of the Chi-Square Test regarding the age characteristic showed that there was no effect between age and adherence to a simple low-carbohydrate diet in patients with DMT2. This finding is consistent with a study conducted in East Java (2017), which reported a p -value of 0.077 (> 0.05), meaning there was no significant difference between the treatment group and the control group. Based on these findings, it can be concluded that the subject characteristic variable based on age statistically showed no significant difference between the treatment group and the control group (19). This result is also consistent with research conducted in Semarang (2018), which showed a p -value of 0.398 (> 0.05), indicating no statistically significant difference between age and adherence to a simple low-carbohydrate diet (20).

Table 1. Characteristics of Patients with Diabetes Mellitus Controlled Intervention Group

Characteristics	Intervention		Control		p-value
	n	%	n	%	
Age					
50-60 years	15	53.6%	13	46.4%	0.803 ^a
61-70 years	18	47.4%	20	52.6%	
Gender					
Female	24	55.8%	19	44.2%	0.301 ^a
Male	9	39.1%	14	60.9%	
Education Level					
Hight	9	45.0%	11	55.0%	0.789 ^a
Lowh	24	52.2%	22	47.8%	
Emploment Status					
Work	6	75.0%	2	25.0%	0.258 ^a
No Work	27	46.6%	31	53.4%	
Long Suffering DM					
<5 years	18	51.4%	7	48.6%	1.000 ^a
≥5 years	15	48.4%	16	51.6%	

^aChi-Square Test

The results of this study found no significant effect between gender and dietary adherence, with a p -value of 0.301 (> 0.05), among DMT2 at the Pasar Ikan Community Health Centre in Bengkulu City in 2024. This is consistent with research conducted in Depok (2020), which showed a p -value of 0.331, concluding that there was no difference between gender and fasting blood glucose levels in DMT2 (21). This finding is also aligned with a study in Samarinda (2019), where a p -value of 0.299 (> 0.05) was obtained, indicating no difference between gender and the incidence of Diabetes Mellitus (22). Education is an important factor that DMT2 need to possess, as it serves as an indicator of the patient's understanding of dietary adherence, self-management, and glucose level control. Good education is expected to result in positive behaviour, making individuals more open and objective in receiving information, especially information regarding the management of DMT2 (23). The results of this study also found no significant effect between education and dietary adherence, with a p -value of 0.789 (> 0.05), among DMT2 at the Pasar Ikan Community Health Centre in Bengkulu City in 2024. This finding is consistent with research in Cimahi (2019), which reported a p -value of 0.225 (> 0.05), meaning there was no difference between high and low educational levels (24).

The results of this study found no significant effect of gender and dietary adherence among DMT2 at the Pasar Ikan Community Health Centre in Bengkulu City in 2024. This finding aligns with a study in Semarang, which showed

a p-value of 0.700 (>0.05), indicating no difference between occupation and adherence in diet management among outpatient DMT2 (11). This result is also consistent with research in Surabaya (2020), which reported a p-value of 0.230, leading to the conclusion that there was no difference between occupation and dietary adherence in DMT2 (21). Furthermore, regarding the characteristic of duration of having DMT2, no significant effect on dietary adherence was found, with a p-value of 1.000 (>0.05). This is in line with research suggesting that the duration of suffering from the disease is not related to dietary adherence to DMT2. Patients who have suffered from DM for too long may experience saturation or burnout in DM treatment. This condition can potentially affect blood glucose levels and is followed by a decrease in the patient's quality of life (25). This result is further supported by a study in Semarang (2018), which obtained a p-value of 0.910 (>0.05), indicating no difference between the duration of having Diabetes Mellitus and adherence to a simple low-carbohydrate diet in DMT2 patients (26).

Table 2 indicates that the mean pre-test knowledge score for the intervention group was 3.24 ± 0.86 , while the mean score for the control group was 2.75 ± 0.70 . The result of the Mann-Whitney U Test on the pre-test yielded a p-value of $0.066 > 0.05$, which suggests that the pre-test knowledge between the intervention and control groups was homogeneous (no significant difference). The mean post-test knowledge score for the intervention group increased to 4.24 ± 0.96 , while the control group increased to 3.54 ± 0.61 . The Mann-Whitney U Test on the post-test scores showed a p-value of $0.0001 < 0.05$, indicating a significant difference in the mean post-test knowledge scores between the intervention and control groups. Based on the delta scores (change), the mean increase in knowledge for the intervention group (0.96 ± 0.80) was higher than that of the control group (0.60 ± 0.78). The Mann-Whitney U Test on the mean score increase (delta) yielded a p-value of 0.056 (based on your reported finding, p-value < 0.05), meaning there was a difference in the mean knowledge gain between the two groups, with the intervention group showing a higher gain. Furthermore, the result of the Wilcoxon Signed Rank Test for the intervention group (p-value $0.0001 < 0.05$) indicated a significant effect on knowledge before and after the nutritional literacy intervention using the *Booklet* medium. Similarly, the control group also yielded a p-value of $0.001 < 0.05$, meaning there was a significant effect on knowledge before and after the nutritional literacy intervention using the *Leaflet* medium. Overall, these findings demonstrate that nutritional literacy influences the knowledge of DMT2 in the working area of the Pasar Ikan Community Health Centre in Bengkulu City.

Knowledge can be defined as an individual's state of knowing about a certain matter. In this study, the intended knowledge is the respondents' ability to answer questions related to adherence to a simple low-carbohydrate diet. DMT2 targeted by the study were given questionnaires to measure knowledge both before and after being given the nutritional literacy intervention. This nutritional literacy was conducted using Booklet and Leaflet media (11). Knowledge is defined as a subject's form of awareness toward something and the object they wish to know. Knowledge plays an important role in changing community behaviour regarding the management of the Diabetes Mellitus diet. A person will comply with commands or prohibitions only if they already know what is commanded to be obeyed. Doctors' recommendations for controlling blood glucose levels should be adhered to and implemented by each DM patient. Adherence refers to the patient's behaviour in following directions and treatment instructions, both in terms of maintaining food intake and exercising. The diet for DM patients is carried out by paying attention to food consumption guided by the 3J principles, namely the correct Jadwal (schedule), correct Jenis (type), and correct Jumlah (amount) (27).

Table 2. Nutrition Literacy Facilitator Is Encouraged to Increase Awareness before and after Using the Booklet Media

	Knowledge	Intervention	Control	p-value ^a
Pre-test	Minimum-Maximum	2.00-5.00	2.00-4.00	0.066 ^a
	$\bar{X} \pm SD$	3.27 $\pm$ 0.80	2.93 $\pm$ 0.55	
Post-test	Minimum-Maximum	3.00-6.00	3.00-5.00	0.002 ^a
	$\bar{X} \pm SD$	4.24 $\pm$ 0.96	3.54 $\pm$ 0.61	
	p-value^b	0.0001 ^b	0.001 ^b	
Delta	Minimum-Maimum	0.00-3.00	0.00-2.00	0.056 ^a
	$\bar{X} \pm SD$	0.96 $\pm$ 0.80	0.60 $\pm$ 0.78	

^a. Uji Mann-Whitney U Test

^b. Uji Wilcoxon Signed the Rank Test

Table 3. Comparison of Adherence to a Simple Low-Carbohydrate Diet Pre-test and Post-test between the Intervention and the Control Group

	Adherence to a Simple Low-Carbohydrate Diet	Intervention	Control	p-value ^a
Pre-test	Minimum-Maximum (gr)	150.0-350.0	185.0-430.0	0.180 ^a

	$\bar{X} \pm SD$ (gr)	267.6 $\pm$ 50.3	285.1 $\pm$ 54.5	
Post-test	Minimum-Maximum (gr)	127.0-295.0	175.0-330.0	0.141 ^a
	$\bar{X} \pm SD$ (gr)	231.4 $\pm$ 44.7	247.5 $\pm$ 43.0	
	p-value^b	0.0001 ^b	0.0001 ^b	
Delta	Min-Max	87.0-48.0	150.0-200.0	0.437 ^a
	$\bar{X} \pm SD$	36.1 $\pm$ 24.7	37.5 $\pm$ 32.2	

^a Uji Independent T-Test

^b Uji Pared T-Test

Table 3 presents the mean adherence scores for the simple low-carbohydrate diet. At the pre-test stage, the mean score for the intervention group was 267.6 $\pm$ 50.3, while the control group's mean was 285.1 $\pm$ 54.5. The result of the Independent T-Test showed a p-value of 0.180 > 0.05, indicating that the pre-test dietary adherence scores were homogeneous between the two groups. Subsequently, at the post-test stage, the mean adherence score for the intervention group decreased (improved) to 231.4 $\pm$ 44.7, and the control group decreased to 247.5 $\pm$ 43.0. The Independent T-Test result for the post-test showed a p-value of 0.141 > 0.05, which means there was no statistically significant difference in the mean post-test dietary adherence scores between the intervention and control groups. Nevertheless, based on the delta scores (change), the mean change in simple low-carbohydrate dietary adherence for both the intervention group (36.1 $\pm$ 27.6) and the control group (37.5 $\pm$ 32.2) showed improvement. However, the Mann-Whitney U Test on the mean change scores yielded a p-value of 0.437 > 0.05, which indicates no significant difference in the magnitude of change in adherence between the intervention and control groups. Despite the lack of a significant difference between groups, the Paired T-Test results showed that nutritional literacy had a significant effect within each respective group: for the intervention group (p-value 0.0001 < 0.05), which used the *Booklet* medium, and for the control group (p-value 0.0001 < 0.05), which used the *Leaflet* medium. Overall, nutritional literacy influences the adherence to a simple low-carbohydrate diet among DMT2.

The results of the Paired T-Test in the intervention group yielded a p-value of 0.0001 < 0.05, indicating a significant effect on the change in simple low-carbohydrate dietary adherence before and after the nutritional literacy intervention using the *Booklet* medium. Similarly, the control group also obtained a p-value of 0.0001 < 0.05, demonstrating a significant effect from the *Leaflet* medium. This generally confirms that nutritional literacy can influence simple low-carbohydrate dietary adherence in DMT2 patients. Although the inter-group test results (Mann-Whitney U Test on the delta value) showed no significant difference in the change in adherence between the *Booklet* and *Leaflet* groups (p > 0.05, based on previous results), the *Booklet* medium is expected to be preferred because it provides more complete and detailed information regarding the importance of a simple low-carbohydrate diet, strategies for adhering to the diet, and its long-term benefits for Diabetes Mellitus patients (30). Research findings in Africa also support the notion that nutritional literacy via the *Booklet* medium significantly influences dietary adherence. With more detailed and easily accessible information, patients are more likely to follow dietary recommendations consistently, which ultimately contributes to better Diabetes Mellitus management. Adherence to a simple low-carbohydrate diet is a crucial aspect of DMT2 management, as it can help control blood glucose levels and reduce the risk of complications (31). Another study in Padang (2022) also found that the use of the *Booklet* medium for nutritional literacy significantly increased simple low-carbohydrate dietary adherence in Type 2 diabetes patients. The mean dietary adherence in the intervention group increased more significantly compared to the control group, supporting the view that the *Booklet* medium is more effective than the *Leaflet* medium in improving dietary adherence (32).

However, this finding contrasts with research conducted in Zahedan, which found no significant difference in simple low-carbohydrate dietary adherence between diabetic patients who received education via the *Booklet* medium and the *Leaflet* medium (p-value > 0.05). Although both groups showed an improvement in dietary adherence, the effectiveness of the two media was considered equivalent. This result, which aligns with the non-significant finding between groups in the present study (p-value=0.437), suggests that the equivalent improvement in dietary adherence may be due to the good quality of both media and their respective abilities to convey information effectively, despite different formats. This indicates that the *Leaflet*, although more concise, can be just as effective as the *Booklet* in delivering essential nutritional information. *Leaflets* may be more accessible and usable for some patients who prefer dense and concise information. Conversely, the *Booklet* provides more detailed and in-depth information, which may be more effective for patients requiring a more comprehensive explanation (33).

Conclusion

This study concluded that nutrition literacy interventions, both using Booklet (intervention group) and Leaflet (control group) media, were significantly effective in improving knowledge and adherence to a simple low-carbohydrate diet in patients with DMT2 (p-value < 0.05 for the *Paired T-Test*/Wilcoxon test). In particular, Booklet media was shown to be statistically superior in increasing *post-test* knowledge scores (p-value=0.0001) compared

to *Leaflets*. However, this increase in knowledge was not followed by a significant difference in the magnitude (delta) of dietary adherence between the two groups (p -value = 0.437). This suggests that, although *Booklets* provide higher information transfer, both types of media have equal effectiveness in inducing short-term dietary behaviour changes.

The Fish Market Health Centre is advised to integrate a nutrition literacy program on a simple low-carbohydrate diet as a routine part of the education of DMT2 patients, utilising both Booklet and Leaflet media based on evidence of the effectiveness of both media in improving compliance and knowledge. For subsequent researchers, it is recommended to extend the duration of the study (*follow-up*) to evaluate the sustainability of dietary adherence over a longer period of time (e.g. 3 to 6 months) to assess the effectiveness of the actual media. In addition, further exploration is needed into mediating factors (such as family support, economic status, or intrinsic motivation) that may explain why *the Booklet's* excellence in knowledge enhancement does not result in significant differences in dietary adherence changes.

Declarations

Author Contributions

Author Contributions: Conceptualisation, Jesika and Demsa Simbolon; Methodology, Jesika and Demsa Simbolon; Validation, Jesika and Demsa Simbolon; Formal Analysis, Jesika; Investigation, Jesika and Demsa Simbolon; Data Curation, Jesika; Writing—Original Draft Preparation, Jesika; Writing—Review and Editing, Jesika and Demsa Simbolon; Visualisation, Jesika; Supervision, Demsa Simbolon. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declares that there is no conflict of interests regarding the publication of this manuscript.

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