

Healthy Lifestyle Education Intervention on Blood Sugar Levels of Diabetes Mellitus Patients at Tompasso Community Health Center North Sulawesi Province, Indonesia

Meildy E. Pascoal¹, Angeli Y. Lumantouw², Nonce N. Legi³, Jufri Sineke⁴, Irza N Ranti⁵, Vera T. Harikedua⁶, Fitriyani M. Otoluwo⁷, Kevin G. Pascoal⁸

¹⁻⁷ Department of Nutrition, Ministry of Health Polytechnic, Manado, Indonesia

⁸ Department of Medical Laboratory Technology, Manado Health Polytechnic, Indonesia

DOI: <https://doi.org/10.51244/IJRSI.2026.1303000243>

Received: 02 April 2026; Accepted: 08 April 2026; Published: 22 April 2026

ABSTRACT

Diabetes Mellitus (DM) requires disciplined self-management through diet and physical activity. Failure to adhere to these pillars can lead to unstable blood glucose levels. Lifestyle-based education is one of the most effective ways to reduce the burden of diabetes in the elderly. Key lifestyle factors such as diet, interpersonal relationships, spiritual growth, and stress management play an important role in improving health and managing diabetes. Poor eating habits, including low fruit and vegetable intake and high sugar consumption, are common in elderly with diabetes. Objective: To analyze the effect of healthy lifestyle education on nutritional intake, physical activity, and blood sugar levels in DM patients at the Tompasso Community Health Center. Method: Pre-experimental research with a one-group pretest-posttest design. The sample consisted of DM patients who were given dietary and physical activity education interventions. Intake data were measured by food recall, physical activity with a questionnaire (MET), and blood sugar levels were measured before and after the intervention. Data analysis used statistical tests (Paired T-Test).

The study results showed significant changes in nutritional intake: energy decreased (1270.6 kcal to 1236.5 kcal), carbohydrates decreased drastically (2131 grams to 1828 grams), while protein and fat experienced adjustments. Physical activity increased significantly from an average of 452.88 METs to 725.15 METs. Average blood sugar levels decreased from 130.06 mg/dL to 125.212 mg/dL with a p-value of 0.000 ($p < 0,05$).

Conclusion: Healthy lifestyle education effectively improved diet, increased physical activity, and lowered blood sugar levels in patients with diabetes mellitus at the Tompasso Community Health Center. Future research should explore the long-term impact and integration of similar education programs into broader public health strategies.

Keywords: Diabetes Mellitus, Education, Diet, Physical Activity, Blood Sugar.

INTRODUCTION

Diabetes mellitus, often abbreviated as DM, is a condition caused by metabolic disorders in the body. The body's inability to effectively produce insulin, a hormone that regulates blood sugar balance, is often the cause. As a result, blood sugar levels rise, a condition known as hyperglycemia. Due to damage to the pancreatic beta cells, which are responsible for insulin synthesis, this disease is characterized by high blood sugar levels (Ratih et al., 2020).

Risk factors for diabetes mellitus can be divided into two categories: modifiable and non-modifiable. Non-modifiable factors include genetic predisposition, age, and gender. Meanwhile, modifiable factors relate to lifestyle, such as a high-sugar diet and smoking. (Fitriyah & Herdiani, 2022). In addition, research by Azriful et al. (2024) shows that lack of physical activity contributes to an increased risk of diabetes mellitus. Therefore, it

is crucial to raise public awareness regarding the factors that influence this disease (Kesehatan, 2024). One very important aspect for people with diabetes mellitus is controlling blood glucose levels. Choosing the right foods can help maintain balanced blood sugar levels in those with diabetes. Thus, dietary factors and meal planning are closely related to the management of diabetes mellitus. (Garedo et al., 2024)

An unhealthy and unbalanced diet can trigger diabetes mellitus. Therefore, changing eating habits is crucial for people with diabetes to maintain stable blood glucose levels. With proper dietary management, the risk of hyperglycemia and serious complications can be reduced. (Kisnawaty et al., 2023).

Good, regular physical activity has many benefits for the body, especially for people with diabetes mellitus. It can help control blood glucose levels, maintain weight, and increase physical strength. Exercise, such as gymnastics, plays a crucial role in managing diabetes mellitus. It not only improves insulin sensitivity but also contributes to blood sugar control. (Balyan et al., 2023). Physical activity plays a vital role in managing T2DM by improving insulin sensitivity, supporting weight management, and improving cardiovascular health. Even modest increases in physical activity have been shown to significantly improve glycemic control and reduce dependence on medications. (Hadi et al., 2025) However, in Indonesia, as shown in previous studies, public awareness of the importance of physical activity is still low. (Bayudam & Yuliastrid, 2022).

The development of technology and increasingly modern lifestyle changes have caused many people to live a sedentary lifestyle, with minimal physical activity in their daily lives. (Rokhim & Suyoko 2024). Much of the work being done online, the increasing use of private vehicles, and people's tendency to spend their free time on digital devices are further reducing daily physical activity levels. This situation has resulted in an increased risk of NCDs and a decreased overall quality of life for the community. Likewise, in Bangladesh, physical inactivity is common among T2DM patients due to factors such as urbanization, sedentary work, and limited recreational facilities. (Moniruzzaman et al., 2017).

Lifestyle modifications, including diet, smoking cessation, and reducing alcohol consumption, are also important for managing T2DM. A diet high in fiber and low in processed sugars improves glycemic control and reduces diabetes-related complications. (Ambika Satija, 2018) Smoking and excessive alcohol consumption further impair glycemic control and increase cardiovascular risk. (Hadi et al., 2025) In Bangladesh, dietary habits and lifestyle behaviors are shaped by cultural and socioeconomic factors, which may influence the success of general lifestyle recommendations. (Rahman, 2022).

The importance of investigating the effects of physical activity and lifestyle on T2DM patients, as found in the Bangladesh study, is crucial. Understanding the relationship between physical activity, lifestyle, and diabetes management is crucial for tailoring interventions to the specific needs of this population. Identifying lifestyle patterns that influence glycemic control can facilitate the development of personalized treatment plans. (Shin et al., 2020) Such research provides insights that can guide prevention strategies to reduce the incidence of T2DM. By highlighting modifiable risk factors, public health initiatives can be designed to promote healthy behaviors and effectively address the burden of diabetes in Bangladesh. (Chowdhury et al., 2024).

Many people with diabetes have limited knowledge about diet and the importance of exercise. High carbohydrate consumption and low physical activity (sedentary) are the main triggers for glycemic control failure. At the Tompaso Community Health Center, 199 people were still found to have uncontrolled blood sugar levels or a lack of regular education.

Unlike previous studies that focused solely on total calorie restriction, this study highlights macronutrient recomposition and a significant increase in MET (Metabolic Equivalent of Task) units through an adaptive educational approach in a rural area (Tompaso Community Health Center). This provides a new perspective that effective glycemic control depends not only on reduced intake but also on a balanced diet and measured physical activity intensity.

MATERIALS AND METHODS

Quantitative research with a Quasi-experimental research design with a pre-post test or experiment is an experimental activity. The research was carried out in January 2025. The location of implementation was in the Tompaso Community Health Center work area.

The population of Diabetes mellitus sufferers at the Tompaso Health Center is 99 people from all villages in the Tompaso sub-district. The sampling technique uses Non-Probability sampling with a sample size of 50 respondents. The research sample is determined by total sampling that meets the criteria.

Inclusion criteria consist of:

- a. Diabetes mellitus sufferers who can read and write.
- b. Diabetes mellitus sufferers who have good hearing.
- c. Diabetes mellitus sufferers who are willing to be respondents.

Exclusion criteria consist of:

- a. DM sufferers who were sick and were being treated at the time the study was conducted.
- b. DM sufferers who moved house at the time the study was conducted.
- c. DM sufferers who experience complications such as stroke, CKD.

Types And Methods of Data Collection

1. Data Types

Data types consist of primary data and secondary data.

- a. Primary data includes data on preference levels, sample characteristics, intake, physical activity levels and blood sugar levels.
- b. Secondary data includes the profile of Kotabunan Community Health Center

2. How to collect data

- a. Macronutrient intake was obtained based on the results of a 24-hour recall analyzed using a nutrient survey.
- b. Data on physical activity levels were obtained based on interviews using the GPAQ questionnaire and analyzed using calculations of physical activity levels in low, medium and high categories.
- c. Blood sugar level examination data is carried out directly.

DATA ANALYSIS

To determine the effect of physical activity education and dietary patterns on blood sugar levels of diabetes mellitus sufferers before and after the educational intervention, a paired t-test analysis was carried out. There is a difference if the p value is <0.05 (CI 95%).

RESULTS AND DISCUSSION

Sample Character

The sample consisted of 52 people with diabetes mellitus at the Tompaso Community Health Center. The

average age of the sample was 46-64 years (46.3%), and the majority were female (74.9%).

Table 1. Sample Distribution Based on Age, Gender and Occupation.

Characteristics	Amount	%
Age		
20 - 45 years	9	17.2
46 - 64 years	24	46.3
> 65 years	19	36.5
Total	52	100
Gender		
Woman	39	74.9
Man	13	25.1
Total	52	100
Work		
Work	33	63.4
Doesn't work	19	36.6
Total	52	100

Nutritional Intake

Nutrient intake is the amount of nutrients consumed from food. Sample nutrient intake is the intake of macronutrients (energy, protein, fat and KH) before and after the intervention.

Table 2. Distribution of samples based on macronutrient intake

Nutritional Intake	Mean±SD	Min-Max
Pre Energy	1270.6 cal ± 498.36	425 - 2326 cal
Energy Post	1236.5 cal±361.95	643 - 2081 cal
Protein Pre	44.03 gr ± 17.85	14 - 83 gr
Protein Post	46.51±14.03	23 - 74 gr
Pre Fat	23.03 gr ± 16.80	3 – 69 gr
Fat Post	31.36 gr ± 18.12	7 – 79 grams
KH Pre	2,131 gr ± 9.66	2.59 – 421 gr
KH Post	1,828 gr ± 7.44	2.59 – 386 gr

The sample macronutrient intake based on table 2 shows that the average energy intake before was 1270.6 kcal, energy after 1236.5 kcal, protein before 44.03 grams, protein after 46.51 grams, fat before 23.03 grams, fat after 31.36 grams, carbohydrate after 2131 grams and carbohydrate after 1828 grams.

Physical activity

Physical activity was the indicator assessed in this study as a result of the intervention or education provided over 7 days. Physical activity before and after can be seen in Table 3.

Table 3. Physical activity of samples before and after intervention

Physical activity	Mean±SD	Min-Max
Pre-physical activity	452.88 MET ±708.64	0 – 3478 MET
Post physical activity	725.15 MET ±668.77	0 – 3607 MET

The physical activity of the sample based on Table 3 appears to have increased, with the average physical activity before the intervention being 452.88 MET and the physical activity after the intervention being 725.15 MET.

Blood sugar level analysis

Analysis of blood sugar levels before and after the provision of education on diet and physical activity showed changes in energy intake before 1270.6 cal, energy after 1236.5 cal, protein before 44.03 grams, protein after 46.51 grams, fat before 23.03 grams, fat after 31.36 grams, carbohydrates before 2131 grams and carbohydrates after 1828 grams. In addition, the assessment indicator in this intervention is physical activity which has increased, it can be seen that the average physical activity before the intervention was 452.88 MET and physical activity after the intervention was 725.15 MET. The results of the analysis test on blood sugar levels before and after the intervention. about distribution In the paired t test there was a significant difference in value between blood sugar levels before education and after education about diet and physical activity with a mean value before treatment of 130.06 decreasing to 125.212 after receiving intervention in the form of education about diet and physical activity. The results of the data obtained using the paired t-test showed that there was an influence of providing education about diet and physical activity on blood sugar levels as indicated by a p-value of 0.000 <0.05.

DISCUSSION

The results of the study showed that before the intervention of providing education, respondents who had a poor diet were 37 people with a percentage of 71.1%, and respondents who had a sufficient diet were only 11 people with a percentage of 21.1%, and the fewest respondents had a diet that was more. And the results of the study after the intervention showed that there was an increase in the number of respondents who had a sufficient diet of 13 people with a percentage of 25.1% and those who had a diet that was more before and after the intervention there was no change. This shows that there was a change in the respondents' eating patterns after the intervention was carried out. Eating patterns including the amount, type and irregular schedule can have an impact on blood sugar levels which are indicators of the risk or incidence of diabetes mellitus.

In this study, the educational intervention resulted in an increase in average healthy lifestyles before the intervention compared to after the intervention. This finding is in line with research, (Rababa et al., 2021;Jiang et al., 2019)where education was positively correlated with the lifestyle of the study subjects. This finding is also in line with research by Sarah et al., (2023) which showed that educational interventions focused on dietary adherence and self-care behaviors significantly improved health outcomes in patients with type 2 diabetes.(Sara et al., 2023)Similarly, Ranjbaran et al. highlighted the effectiveness of Health Action Process Approach (HAPA)-based interventions in improving adherence to diet and medication, emphasizing the

importance of self-efficacy and planning in diabetes management.(Ranjbaran et al., 2022)This finding is supported by the fact that educational interventions improve lifestyle, and these lifestyle improvements, through a causal relationship, lead to a significant reduction in diabetes complications in older adults. Key factors in diabetes management include dietary adherence, stress avoidance, and adherence to medication regimens. Diabetes has earned a special place among non-communicable diseases due to its complications. It can easily lead to leg amputations by creating foot ulcers.(Rakhshani et al., 2026).

In this study, educational interventions led to an increase in average nutritional status before and after the intervention. These results are consistent with research from(Sibagariang & Lumban Gaol, 2022) Diet also significantly influences blood sugar levels in people with diabetes mellitus, as revealed in the study. The results showed that respondents who maintained a healthy diet did not develop diabetes mellitus. Conversely, many respondents did not maintain regular eating habits, did not limit their consumption of high-sugar foods, and frequently consumed fried foods and sweetened drinks.(Sibagariang & Lumban, 2022).

The results of this study are also in line with research by Ischak et al., (2024) who stated that of the total of 84 respondents, the majority showed poor eating patterns, with 59 of them (70.2%) identified as such. The results of the statistical analysis showed a p-value of 0.011, which indicates a significant relationship between eating patterns and blood sugar levels in diabetes mellitus patients at the Internal Medicine Polyclinic of Selasih Regional General Hospital, Pelalawan Regency. The odds ratio (OR) value obtained was 4.365, which means that patients with poor eating patterns have a 4.365 times higher risk of experiencing uncontrolled blood sugar levels.(Ischak et al., 2024).

In this study, the educational intervention led to an increase in mean nutritional status in the intervention group compared to the control group. This finding is consistent with research(Mirzaei et al., 2020)and (Marques et al. (2019) explained that education has succeeded in improving the eating habits of the elderly through health interventions on individual behavior, encouraging compliance and increasing patient determination to adhere to their diet.

The results of the study showed that before the intervention, the respondents had the most low levels of physical activity, as many as 45 respondents with a percentage of 86.6%, moderate activity as many as 5 respondents with a percentage of 9.6% and the least had high activity as many as 2 people with a percentage of 3.8%. And the results of the study after the intervention showed an increase in the number of respondents with moderate levels of physical activity as many as 24 people with a percentage of 46.2%, low physical activity as many as 26 respondents with a percentage of 50% and respondents with high physical activity there was no change after the intervention. The results of the study showed that before the education, most respondents with diabetes mellitus did not have sufficient physical activity and were classified as low-level physical activity, the majority of elderly people did not exercise. People who do not exercise, their muscles do not use sugar reserves for energy, this causes their blood sugar levels to increase.

The results of this study align with research by Al Ozairi et al. (2023), which showed that physical activity can help lower blood sugar levels in people with diabetes mellitus. Furthermore, physical activity performed at night has also been shown to be beneficial in reducing blood glucose levels. Exploratory analysis indicates that physical activity can extend sleep duration and reduce the incidence of hyperglycemia.(Al Ozairi et al., 2023)

The results of this study align with those of Azhari and Septimar (2022), who stated that there is a significant relationship between physical activity and blood glucose levels, with a p-value of 0.03 (<0.05). Physical activity helps control blood glucose levels. Based on this and previous research, it can be concluded that the majority of people with type 2 diabetes mellitus have a good level of physical activity. This is due to their awareness of maintaining their health, such as regular light exercise and adjusting their diet to control blood glucose levels. (Azhari & Septimar, 2022).

This study demonstrates that a combined approach of physical activity and dietary modification is effective in improving body composition, glycemic control, lipid profiles, and insulin sensitivity in male recreational athletes aged 30–45 years with type 2 diabetes. These findings suggest that integrating structured exercise, particularly resistance training, with individualized dietary guidance provides substantial benefits in managing

glycemic levels and reducing cardiovascular risk. In clinical practice, this highlights the practical value of lifestyle-based strategies as an essential part of diabetes care.(Chouk et al., 2025).

The results of the study showed that the blood sugar levels of respondents before the intervention showed that most had controlled blood sugar levels of 48 respondents with a percentage of 92.3% and those who were not controlled were 5 people with a percentage of 7.7%. and the blood sugar levels of respondents after education showed that 100% of respondents had controlled blood sugar levels.

The results of this study are in line with research by Lestari (2022) which shows a significant influence between adherence to dietary patterns and physical activity on blood sugar levels in diabetes mellitus patients at the Cipayang District Health Center.(Lestari & Nusantara, 2022).

CONCLUSION

1. The sample macronutrient intake based on table 2 shows that the average energy intake before was 1270.6 kcal, energy after 1236.5 kcal, protein before 44.03 grams, protein after 46.51 grams, fat before 23.03 grams, fat after 31.36 grams, carbohydrate after 2131 grams and carbohydrate after 1828 grams.
2. Physical activity increased The physical activity of the sample showed that the average physical activity before the intervention was 452.88 MET and physical activity after the intervention was 725.15 MET.
3. Paired test analysis showed that education regarding diet and physical activity influenced blood sugar levels in diabetes mellitus patients before and after the education. The study found changes in blood sugar levels followed by changes in diet and physical activity behavior.

SUGGESTION

The public is encouraged to maintain a regular diet, adhering to the 3 Js (amount, type, and schedule of meals) to control blood sugar levels and prevent the risk of diabetes mellitus. Adequate physical activity is also recommended to help the body manage blood sugar levels, especially for those with diabetes mellitus. Future research should explore the long-term impact and integration of similar educational programs into broader public health strategies.

This research has been received from the Health Polytechnic Ethics Commission of the Ministry of Health Manado Number: KEPK /01/ 12/498/2024. December 10, 2024

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

1. Al Ozairi, E., ElSamad, A., Al Kandari, J., Hamdan, Y., Taliping, D., & Gray, SR (2023). The effect of timing of remotely supervised exercise on glucose control in people with type 1 diabetes during Ramadan: A randomized crossover study. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, 17(9), 102845. <https://doi.org/10.1016/j.dsx.2023.102845>
2. Ambika Satija, FBH 2018. (2018). Plant-based diets and cardiovascular health. *Trends Cardiovasc Med*, 28(7), 437–441. <https://doi.org/10.1016/j.tcm.2018.02.004>. Plant-based
3. Azhari, R., & Septimar, ZM (2022). Relationship Between Physical Activity and Blood Glucose Levels in Type 2 Diabetes Mellitus Patients in Bugel Mas Indah Housing Area RW 009 Relationship Between Physical Activity and Blood Glucose Levels in Type 2 Diabetes Mellitus in Bugel Housing Area, Mas . *Nusantara Hasana Journal*, 2(7), Page.
4. Balyan, Sri Andala, & Yudi Akbar. (2023). The Relationship Between Physical Activity and Quality of Life in Diabetes Mellitus Patients. *Assyifa Journal of Islamic Nursing Science*, 8(2), 1–9. <https://doi.org/10.54460/jifa.v8i2.66>
5. Bayudamai, CP, & Yuliastrid, D. (2022). Level of Motivation to Exercise and Physical Activity in Adolescents During the Covid-19 Pandemic. *Journal of Sports Health*, 10(4), 7–12.

6. Chouk, K., Triki, R., & Dergaa, I. (2025). Effects of combined diet and physical activity on glycemic control and body composition in male recreational athletes with type 2 diabetes mellitus. *Front. End(June)*, 1–10. <https://doi.org/10.3389/fendo.2025.1525559>
7. Chowdhury, H.A., Joham, A.E., Kabir, A., Rahman, AKMF, Ali, L., Harrison, C.L., & Billah, B. (2024). Exploring type 2 diabetes self-management practices in rural Bangladesh: facilitators, barriers and expectations—a qualitative study protocol. *BMJ Open*, 14(5), 11–17. <https://doi.org/10.1136/bmjopen-2023-081385>
8. Fitriyah, CN, & Herdiani, N. (2022). Sugar Consumption and Smoking Habits with the Incidence of Diabetes Mellitus at the Gading Community Health Center in Surabaya. *Jik Journal of Health Sciences*, 6(2), 467. <https://doi.org/10.33757/jik.v6i2.567>
9. Garedo, A.W., Tesfaye, G.T., Tamrat, R., & Wynendaele, E. (2024). Glycemic control and associated factors in patients with type 2 diabetes in Southwest Ethiopia : a prospective observational study.
10. Hadi, HM, Shimul, MMH, Hossain, MS, Sultana, A., Hossain, MK, Khandker, S., & Khan, S. (2025). Effect of Physical Activity and Dietary Changes on Management of Type 2 Diabetes Mellitus Patients: A Case–Control Study in Bangladesh. *Endocrinology, Diabetes and Metabolism*, 8(3), 1–18. <https://doi.org/10.1002/edm2.70051>
11. Ischak, NI, Handayani, S., Rofiqoh, R., & Widhi, AS (2024). The Relationship Between Physical Activity and Dietary Patterns and Blood Sugar Levels in Diabetes Mellitus Patients. *Encyclopedia of Journals*, 6(3), 142–147.
12. Jiang, Q., Li, J., Sun, P., Wang, L., Sun, L., & Pang, S. (2019). Effects of lifestyle interventions on glucose regulation and diabetes risk in adults with impaired glucose tolerance or prediabetes: a meta-analysis. *Arch Endocrinol Metab.*, 16(2). <https://doi.org/10.20945/2359-3997000000441>
13. Kisnawaty, SW, Sofyan, A., & Mustikaningrum, F. (2023). Counseling on Dietary Management for Diabetes Mellitus Patients in the Prolanis Group at the Ngemplak 1 Community Health Center. *Indonesian Community Service Journal*, 3(6), 1727–1734. <https://doi.org/10.54082/jamsi.1007>
14. Lestari, DA, & Nusantara, A. (2022). The Effect of Dietary Adherence and Physical Activity on Blood Sugar Levels in Diabetes Mellitus Patients at the Cipayung District Community Health Center, Jakarta, 2022. *Malahayati Nursing Journal*, 4(9), 2282–2294. <https://doi.org/10.33024/mnj.v4i9.6961>
15. Mirzaei, A., Ramezankhani, A., Tanjani, P.T., Ghaffari, M., Jorvand, R., Momeni, K., & Heidarianzadeh, Z. (2020). Research Paper The Effectiveness of Health Literacy Based Educational Intervention on Nutritional Outcomes of Elderly. *Iranian Journal of Aging*, 15(3). <https://doi.org/doi:10.32598/15.3.2569.1sija/15.3.2569>
16. Moniruzzaman, M., Ahmed, MSAM, & Zaman, M.M. (2017). Physical activity levels and associated socio-demographic factors in Bangladeshi adults: a cross-sectional study. *BMC Public Health*, 17(1), 1–8. <https://doi.org/10.1186/s12889-016-4003-z>
17. Muhammad Robit Ziyadatur Rokhim, AS (2024). Analysis of Physical Fitness Related to Sedentary Lifestyle Patterns Among Junior High School Adolescents (13-15 Years Old). *JPO: Journal of Sports Achievement*, 7(4), 324–328.
18. Rababa, M., Ali, N. Al, & Alshaman, A. (2021). Health Promoting Behaviors, Health Needs and Associated Factors among Older Adults in. 9(2), 106–116. <https://doi.org/10.30476/ijcbnm.2020.87493.1443.106>
19. Rahman, M.A. (2022). Socioeconomic inequalities in the risk factors of noncommunicable diseases (hypertension and diabetes) among Bangladeshi population: Evidence based on population level data analysis. *PLoS ONE*, 17(9 September). <https://doi.org/10.1371/journal.pone.0274978>
20. Rakhshani, T., Rastegar, P., Kashfi, S. M., Taravatmanesh, S., & Kamyab, A. (2026). The effect of educational intervention on the lifestyle changes of elderly people with diabetes. *BMC Endocrine Disorders*, 26(31). <https://doi.org/doi:10.1186/s12902-025-02155-0>
21. Ranjbaran, S., Shojaeizadeh, D., Dehdari, T., Yaseri, M., & Shakibazadeh, E. (2022). The effectiveness of an intervention designed based on health action process approach on diet and medication adherence among patients with type 2 diabetes : a randomized controlled trial. *Diabetology & Metabolic Syndrome*, 14(3), 1–10. <https://doi.org/10.1186/s13098-021-00773-x>
22. Sara, M., Moghimi, S., Payandeh, A., & Ranjbaran, S. (2023). Effects of Educational Interventions on Dietary Adherence among Type 2 Diabetes in Zahedan: Using the Health Action Process Approach. *Ethiop J Health Sci*, 33(4), 571–580. <https://doi.org/doi:10.4314/ejhs.v33i4.3>

-
23. Shin, S.-W., Jung, S.-J., Jung, E.-S., Hwang, J.-H., Kim, W.-R., So, B.-O., Park, B.-H., Lee, S.-O., Cho, B.-H., Park, T.-S., Kim, Y.-G., & Chae, S.-W. (2020). Effects of a Lifestyle-Modification Program on Blood-Glucose Regulation and Health Promotion in Diabetic Patients: A Randomized Controlled Trial. *Journal of Lifestyle Medicine*, 10(2), 77–91. <https://doi.org/10.15280/jlm.2020.10.2.77>
24. Sibagariang, EE, & Lumban Gaol, YC (2022). The Relationship Between Diet and Physical Activity Patterns and the Incidence of Diabetes Mellitus During the Covid-19 Pandemic. *STM (Science and Medical Technology) Journal*, 5(1), 43–49. <https://doi.org/10.30743/stm.v5i1.234>