



Effect of Physical Activity and Health Education Intervention on Glycemic Type 2 Diabetes Mellitus Patients Attending Borno State Specialist Hospital, Maiduguri

A. ABDULSALAM

University of Maiduguri, Borno State, Nigeria

YUNUSA MAKO MOHAMMED

Bayero University, Kano, Kano state, Nigeria

A. HARUNA

Maryam Abacha University, Nigeria

Bayero University, Kano, Nigeria

LATEEFAT N.G. IMAM

University of Maiduguri, Borno State, Nigeria

SABO HADIZA

Shehu Sule College of Nursing and Midwifery, Damaturu, Yobe State, Nigeria

MUSTAPHA UMAR

Borno State University, Borno State, Nigeria

OLUFEMI SEGUN SHOYEMI

National Open University of Nigeria

Abstract. This study assessed effect of physical activity and health education intervention on glycemic Type 2 diabetes mellitus patients attending Borno State Specialist Hospital, Maiduguri. To achieve this, two hypotheses were tested. Pre-test post-test research design was adopted for the study. The sampled population is forty (40) type 2 diabetics patients attending Borno State Specialist Hospital, Maiduguri. Availability sample procedure was used to select all respondents for the study. The participants completed a general information form included question on age, marital status, family history of the disease, duration of the disease, clinical characteristics, awareness of diabetic complications, taking oral diabetic among others. The researchers recorded the last reading for (glycated hemoglobin [HbA1c]) for each patient.

Education intervention was conducted in type 2 diabetes mellitus samples for 8 weeks containing lectures, discussion and physical activity. At the meetings, they were recommended and gave the information about diabetes and its complications, proper diet, exercise every day at least 30 min such as bike, walking, and aerobic, taking education regularly as directed by the physician, self-monitoring patient's blood sugar, diabetic foot care, and not smoking. Descriptive statistics of frequency count, percent, mean and standard deviation was used to described the respondent characteristic parameter while inferential statistics of The Wilcoxon signed rank test was used to test the formulated hypotheses at 0.05 level of significance. The result shows that both physical activity and health education intervention have

significant effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients ($P < 0.05$). It was then recommended that medical practitioners should provide health education intervention programs that will increase awareness among diabetes mellitus patients.

Keywords: Physical Activity, Health Education, Intervention, Glycemic Type 2 Diabetes, Mellitus Patients.

1. Introduction

Physical activity is broadly defined as any bodily movement that is above resting conditions, whereas exercise is planned or structured movement with specific intent on gains in aerobic and/or muscular fitness. Most recommendations by the American College of Sports Medicine (ACSM) and/or American Diabetes Association (ADA) for physical activity/exercise focus on frequency, intensity, and modality to favorably impact glycemic control (Colberg, 2016; Piercy, 2018). Included within modality are considerations including volume or the duration/repetitions of the exercise being completed. Additionally, aerobic exercise intensity is primarily determined using a percentage of one's maximal heart rate (% HRmax) and maximal oxygen consumption and utilization (%VO₂max) 5, 6. It is also worth mentioning that rating of perceived exertion (RPE) is a practical tool people can use to estimate exercise intensity if they are unable to use heart rate or have maximal fitness tests conducted (Colberg, 2016; Piercy, 2018).

Type 2 Diabetes Mellitus (T2DM) is one of the main causes of increasing global health morbidity and mortality for 80-90% of all diabetes cases (Dixit, Maiya, & Shastri, 2017). The increasing prevalence of T2DM is followed by some of the most influential factors such as age, obesity and a sedentary lifestyle (Lazarevic et al., 2006). The factors that affect the increase of T2DM over a long period of time leads to a variety of abnormalities in various organs, including microvascular, macrovascular, neurological and infectious complications (Najafipour, Aliasgarzadeh, Niafar, & Mobasser, 2012). The number of persons with diabetes continues to increase worldwide, and the International Diabetes Federation (IDF) reported that the number of patients with diabetes worldwide was projected to increase to more than 300 million people in 2025 and 366 million by 2030 (International Diabetes Federation, 2013; Lee, & Kang, 2015). Diabetes, a metabolic disorder characterized by hyperglycemia, is divided into two types. Type 1 diabetes occurs when the pancreas fails to secrete

insulin, and type 2 diabetes occurs when the pancreas retains some capacity to secrete insulin but insulin resistance is increased for a variety of reasons (Karoline de Moraes, Sales & Alves de Almeida, 2015). Insulin controls blood glucose by facilitating glucose intake or inhibiting gluconeogenesis. Insulin resistance is a condition in which the action of insulin is decreased, although the level of insulin is not insufficient. Chronic hyperglycemia is definitely related to complications of diabetes that damage the kidneys, eyes, nerves, heart, and blood vessels (Alsenany & Al Saif, 2015). Therefore, glycemic control is the most fundamental way to manage this disease.

It is estimated that 90% of cases of type 2 diabetes could be prevented if people adopted healthy lifestyle behaviors, including regular physical activity, a moderate diet, and modest weight loss. For people with prediabetes, healthy lifestyle measures are more effective than medication for delaying or preventing the development of diabetes, and exercise (endurance and/or strength training) are important to prevent diabetes. Also important is a moderate diet to control body fat. Nigeria is a developing nation that is plagued with low level of education, superstition, poverty, poor health care services, and near nonexistent health statistics. If the costs of diabetes in America are more than USD 132 billion a year (according to the American Diabetes Association) and about 100 million people have diabetes mellitus (Hales, 2009), the situation in Nigeria could be better imagined than experienced. Sequel to this, it became imperative to review preventive efforts because prevention of diabetes mellitus is better than cure, and also because Nigeria offers abundant opportunities for physical activity and local diet, the key preventive and management components of diabetes mellitus.

Diabetes is considered as a serious condition that can be prevented through proper information and provision of proper health education interventions, and provision of health education sessions produces incredible change in the knowledge, attitude, and the behaviour among the patients to manage their self -blood sugar level more efficiently (Pai, Chiu, Liu, Chen, & Peng, 2021, Alibrahim, A., AlRamadhan, Johny, Alhashemi, Alduwaisan, & Al-Hilal, 2021). DM type 2 is a common multifactorial genetic syndrome that affects the individual's families. Different risk factors like unhealthy life style, smoking, alcohol consumption, family history and diet are the major leading cause of type 2 diabetes; uncontrolled blood sugar may lead to further complications of renal failure, myocardial infarction, amputation, blindness, and hypertension (Anjana, Unnikrishnan, Mugilan Jagdish,

Parthasarathy & Deepa, 2018; Kalra, Das, Md, Shaikh, Shah, & Rehim, 2021).

Proper compliance with dietary guideline, self-care, physical activity, and treatment may reduce the progression of disease, and the most common cause of increased prevalence of diabetes among the general population is lack of knowledge and physical inactivity (Eknithiset, Samrongthong & Kumar, 2018; Stenov, Wind, Vallis, Reventlow & Hempler, 2019). Health care providers strongly recommend the diabetic patients to exercise regularly, to follow their dietary plan and to adhere with medication schedule, and it is also important for diabetic patients to have a regular health check -ups for their personal health (Cunningham, Crittendon, White, Mills, Diaz, & LaNoue, 2018). Health education strategy is very important in maintaining of blood sugar level, which will help population to be aware of the disease and its consequences, and maintain that health care facilities should provide necessary information about diabetes on regular patient counselling sessions along with their routine treatment that might benefit their health outcome positively (Lee, Chan, Chua, Ng, Paraidathathu & Lee 2016). Health education trainings /workshops/ seminars with proper information are the utmost need of the patients for timely reduction of morbidity and enhance the confidence among diabetic patients by self-care diabetes management (Gurmu, Gela, & Aga, 2018). Adeniyi, Ogwumike, Oguntola and Adeleye (2015), conducted study in Nigeria and found that a total of 156 representing 68.7% of the participants presented with low levels of physical activity, while the remaining 21.3% presented with moderate to high level of physical activity. It is against this back ground that this study was conducted to examine effect of physical activity and health education intervention on glycemic type 2 diabetes mellitus patients attending Borno State Specialist Hospital, Maiduguri.

1.1 Hypotheses

The following hypotheses were tested:

Ho₁: Physical activity and health education intervention has no significant effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients.

Ho₂: Physical activity and health education intervention has no significant effect on fasting blood sugar [HbA1c] of Type 2 Diabetes Mellitus Patients.

2. Research Methodology

2.1 Research Design

Pre-test post-test research design was adopted for the study. Smith (2021), the pre-test post-test research design is useful for evaluating the effectiveness of interventions. The design involves measuring the participants' levels on an outcome variable before and after the intervention (Johnson, 2019). The differences between the pre-test and post-test scores can provide insights into the intervention's impact. However, as pointed out by Brown (2020), this design has limitations, such as the possibility of participant attrition and maturation effects. To overcome these limitations, researchers can employ a control group or use a mixed-methods approach that includes qualitative data collection (Davis, 2018).

The participants completed a general information form included question on age, marital status, family history of the disease, duration of the disease, clinical characteristics, awareness of diabetic complications, taking oral diabetic or insulin injection, smoking, following any diet, daily activity, and education level. We recorded the last reading for (glycated hemoglobin [HbA1c]) for each patient. Education intervention was conducted in type 2 diabetes mellitus samples for 8 weeks containing lectures, discussion and physical activity. At the meetings, they were recommended and gave the information about diabetes and its complications, proper diet, exercise every day at least 30 min such as bike, walking, and aerobic, taking education regularly as directed by the physician, self-monitoring patient's blood sugar, diabetic foot care, and not smoking. Each giving education, we always examine weight, waist size, blood pressure, and FBS.

The education services included, about self-management plan like examined Fasting Blood Sugar (FBS) by self with the portable measuring instrument, and injected insulin by self, knowledge about glycemic control by HbA1C every 3 months. Since almost all patients did not know about HbA1c, they just know that FBS examination was enough for glycemic control. Furthermore, we gave the patient diet and exercise management. Giving the education for diabetes mellitus patients was necessary for increasing of the understanding the patients about the disease because there were still many type 2 diabetes mellitus patients that have a lack of knowledge about the management of the disease both about the diet and the physical exercise. We advised the patients for exercise every day minimal for 30 min. Every month until 8 weeks, we gave the education and we always examine FBS the patients every 2 weeks and in the 8

weeks, we examined HbA1c for the patients. The sampled population is forty (40) type 2 diabetics patients attending Borno State Specialist Hospital, Maiduguri. And availability sample procedure was used to select all respondents for the study. Descriptive statistics of frequency count, percent, mean and

standard deviation was used to described the respondent characteristic parameter while inferential statistics of The Wilcoxon signed rank test was used to test the formulated hypotheses at 0.05 level of significance.

3. Results

Table 1: Respondent characteristic Parameter n=40

Variables	n	%
Gender		
Male	10	25
Female	30	75
Age group		
Early elderly (40–55 y)	11	27.5
Further elderly (55–65 y)	15	37.5
Seniors (>65 y)	14	35
Education levels		
Primary high school	2	5
SSCE Certificate	26	90
Tertiary Certificate	2	5
Familial history		
Maternal history	4	10
Paternal history	6	15
Not knowing	30	75
Management of diet		
Regular	12	30
Irregular	28	70
Type of physical activity		
Jogging	15	62.5
trekking	25	37.5
Type of treatment		
Oral diabetic	38	95
Insulin injection	2	5

Table 1 which is on respondent characteristic parameter indicated that 10 (25%) were male, while 30(75%) were female. The table also revealed that 11(27.5%) were 40–55 years, 15(37.5%) were 55–55 years, while 14(35%) of the respondents were 65years and above. Similarly, the shows that 2(5%) of the respondents were primary leaving school certificate, 26(90%) were SSCE certificate, while 2(5%) were tertiary certificate holder. 4(10%) of the participants had maternal history, 6(15%) had paternal history, while 30(75%) had unknowingly. On the aspect of diet management, 12(30%) of respondents engaged in regular exercise while, 28(70%) do not practice exercise. 15(62.5%) of the patients chose to jog, while 25(37.5%) chose trekking distance as type of physical exercise. Furthermore, most of our respondents 38(95%) used oral diabetic treatment while 2(5%) used insulin injection.

Ho₁: Physical activity and health education intervention has no significant effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients.

Table 2: Wilcoxon signed rank test summary on effect of physical activity and health education intervention on glycated hemoglobin [HbA1c (%)] on Type 2 Diabetes Mellitus Patients

variables	Mean	Standard Deviation	Median	Z	Prob
Pre test	8.89	1.79	8.50	4.191	0.019
Post test	8.67	1.64	8.34		

Z=4.191; P<0.019

A Wilcoxon signed-rank test showed that a 8 week, trice weekly physical activity and health education intervention did elicit a statistically significant change in glycated hemoglobin [HbA1c] on Type 2 Diabetes Mellitus Patients ($Z = 4.191, p = 0.019$). Indeed, median of physical activity and health education intervention Score rating was 8.50 for pre- treatment and 8.34 for post-treatment. Therefore, physical activity and health education intervention have significant effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients ($P < 0.05$).

H_0 : Physical activity and health education intervention has no significant effect on fasting blood sugar [HbA1c] of Type 2 Diabetes Mellitus Patients.

Table 3: Wilcoxon signed rank test summary on effect of physical activity and health education intervention on fasting blood sugar [FBS (mg/dl)] on Type 2 Diabetes Mellitus Patients

variables	Mean	Standard Deviation	Median	Z	Prob
Pre test	241.83	88.75	238.41	3.283	0.001
Post test	217.88	66.42	215.53		

$Z=3.283; P < 0.001$

A Wilcoxon signed-rank test showed that 8 weeks, trice weekly physical activity and health education intervention did elicit a statistically significant change in fasting blood sugar (FBS) on Type 2 Diabetes Mellitus Patients ($Z=3.283; P < 0.001$). Indeed, median of physical activity and health education intervention Score rating was 8.50 for pre- treatment and 8.34 for post-treatment. Therefore, physical activity and health education intervention have significant effect on fasting blood sugar (FBS) of Type 2 Diabetes Mellitus Patients ($P < 0.05$).

4. Discussion of findings

This study assessed effect of physical activity and health education intervention on glycemic type 2 diabetes mellitus patients attending Borno State Specialist Hospital, Maiduguri. The result indicated that physical activity and health education intervention have significant effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients ($P < 0.05$). The result of this study is consistence with the study of Rusdiana, Savira, Widjaja and Ardinata (2020), who assessed effect of health education on control glycemic at Type 2 Diabetes Mellitus Patients and found a significant decrease on glycemic control on FBS for the Type 2 diabetes mellitus participants, but there was no significant HbA1c value by the end of the health education for 3 months. A study conducted by (Heisler, Smith, Hayward, Krein and Kerr 2003), assessed the effect of diabetes self-management education on HbA1c level and FBSnat type 2 diabetes mellitus patients in PHC in Binjai city showed that a decrease in HbA1c and FBS after giving education for 3 months which is in line with the result of this study. Other research showed that educational interventions effectively improved glycemic control and are, thus highly recommended for diabetic patients (Rusdiana, Savira & Amelia, 2018). Furthermore, the other research about analysis of factors affecting the self-care behaviors of diabetes mellitus type 2 patients in Binjai, North Sumatera – Indonesia showed that

self-care behaviors of type 2 diabetes mellitus in Binjai are significantly influenced by motivation, self – efficacy, communication, knowledge, and attitude (Rusdiana, Savira & Amelia, 2017).

Moreover, a related study conducted by Park and Lee (2015), found that Factors found to be significantly related to glycemic control included income level, physical activity based on intensity of aerobic exercise, use of diabetes medicine, presence of hypertension, duration of diabetes, and waist circumference. In addition, engaging in combined low- and moderate-intensity aerobic exercise when adjusted for resistance exercise was found to lower the risk of glycemic control failure. The authors explained further that If a patient with type 2 diabetes gets moderate exercise, the amount of glucose in peripheral use will become greater than the level of glucogenesis in the liver, thus decreasing blood glucose. Although the secretion of blood insulin is also decreased, hypoglycemia will rarely occur (Min, & Park, 2006). However, high-intensity aerobic exercise can promote glucogenesis and induce hyperglycemia by increasing the concentration of blood cat-echolamine.

Health education is an important intervention in preventing the general public from non-communicable diseases. The respondent’s knowledge improved significantly after face-to-face 8 weeks session on diabetes. Research suggests that the timely information could prevent a large number of diabetes-related risk factors among the patients. Hence, this study has highlighted the value of health education sessions among Type 2 Diabetes Mellitus Patients. This can be confirmed as physical activity and health education intervention have significant effect on fasting blood sugar (FBS) of Type 2 Diabetes Mellitus Patients ($P < 0.05$). The result of this study is agreed with the study of Nazar, Khan, Kumar and Hafeez (2019), who studied effectiveness of health literacy intervention on cardiovascular diseases among university students of Pakistan, and reported that

mortality and morbidity by CVD can be reduced by the effective awareness intervention. The finding of this study is similar with the findings of Kumar, Rehman, Baloch, Vankwani, Somrongthong, and Pongpanich (2022) who reported that health education intervention has proved to be effective for the prevention of diabetes among teaching staff. However, prior to this intervention, participants had limited knowledge about diabetes, which statistically improved after giving the health education sessions at their work place. These findings were supported the interventional studies conducted in Pakistan (Khan, Walley, Khan, Hicks, Ahmed & Khan, 2018; Akhtar, Nasir, Abbas, & Sarwar, 2019), where it has been proved that the health education can change individual's knowledge and behaviors to prevent certain diseases and infections.

5. Conclusion

It was concluded that physical activity and health education intervention have effect on glycated hemoglobin [HbA1c] of Type 2 Diabetes Mellitus Patients.

6. Recommendations

The following recommendations were made:

- Medical practitioners should provide health education intervention programs that will increasing awareness among diabetes mellitus patients.
- Exercise such as jogging or aerobic for 30 min every day or awareness of activity daily should be considered important in the management of diabetes mellitus.

References

- Adeniyi, A.F., Ogwumike, O.O., Oguntola, D.A. & Adeleye, J.O (2015). Interrelationship among physical activity, quality of life, clinical and sociodemographic characteristics in a sample of Nigerian patients with type 2 diabetes. *AJPARS* Vol. 7, Nos. 1 & 2, June 2015, pp.12 – 18.
- Akhtar S., Nasir J.A., Abbas T., & Sarwar A. (2019). Diabetes in Pakistan: a systematic review and meta-analysis. *Pak J Med Sci.*35(4):1173–8.
- Alibrahim, A., AlRamadhan, D., Johny, S., Alhashemi, M., Alduwaisan, H., & Al-Hilal, M. (2021). The effect of structured diabetes self-management education on type 2 diabetes patients attending a primary health Center in Kuwait. *Diabetes Res Clin Pract.* 171:108567.
- Alsenany, S., & Al Saif, A. (2015). Incidence of diabetes mellitus type 2 complications among Saudi adult patients at primary health care center. *J Phys Ther Sci*, 27: 1727–1730. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)].
- Anjana R.M., Unnikrishnan R., Mugilan P., Jagdish P.S., Parthasarathy B., Deepa M. (2018). Causes and predictors of mortality in Asian Indians with and without diabetes-10 year follow-up of the Chennai urban rural epidemiology study (CURES - 150). *PLoS One.*13(7): e 0197376.
- Brown, J. (2020). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.
- Colberg, S.R. (2016). Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association *Diabetes Care*, 39 (11) pp. 2065-2079
- Cunningham A.T., Crittendon D.R., White N., Mills G.D., Diaz V., & LaNoue, M.D. (2018). The effect of diabetes self-management education on HbA1c and quality of life in African-Americans: a systematic review and meta-analysis. *BMC Health Serv Res.*18(1):367.
- Davis, B. D. (2018). *Statistical Analysis for the Behavioral Sciences* (7th ed.). Cengage Learning.
- Dixit, S., Maiya, A., & Shastry, B. A. (2017). Effect of moderate-intensity aerobic exercise on glycosylated haemoglobin among elderly patients with type 2 diabetes & peripheral neuropathy. (January), 129– 132. <https://doi.org/10.4103/ijmr.IJMR>.
- Eknithiset R., Samrongthong R., & Kumar R (2018). Factors associated with knowledge, perception, and practice toward self-care among elderly patients suffering from type 2 diabetes mellitus in rural Thailand. *J Ayub Med Coll Abbottabad*; 30(1):107–10.
- Gurmu Y., Gela D., & Aga F. (2018). Factors associated with self-care practice among adult diabetes patients in west Shoa zone, Oromia regional state, Ethiopia. *BMC Health Serv Res.*;18(1):732.
- Hales, D (2009). *An invitation to Health, 2009-2010* edition. Boston, MA: Wadsworth Cengage Learning; 2009.
- Heisler M., Smith D.M., Hayward R.A., Krein S.L., & Kerr E. A. (2003). How well do patients assessments of their diabetes self-management correlate with actual glycemic control and receipt of recommended diabetes

- services? *Diabetes Care*;26(3):738-43. <https://doi.org/10.2337/diacare.26.3.738> PMID:12610031.
- International Diabetes Federation, (2013): *IDF Diabetes Atlas*. Brussels: International Diabetes Federation, 2013. [[Google Scholar](#)] [[Ref list](#)]
- Johnson, J. (2019). Evaluating the effectiveness of interventions using pre-test post-test research design. *Journal of Applied Research*, 12(2), 45-58.
- Kalra S., Das A.K., Md F., Shaikh K., Shah P., & Rehman A.A, (2021). Glucodynamics and glucocracy in type 2 diabetes mellitus: Clinical evidence and practice-based opinion on modern sulfonylurea use, from an international expert group (South Asia, Middle East & Africa) via modified Delphi method. *Curr Med Res Opin*;37(3):403-9.
- Karoline de Morais, P., Sales, M.M, Alves de Almeida J. (2015). Effects of aerobic exercise intensity on 24-h ambulatory blood pressure in individuals with type 2 diabetes and prehypertension. *J Phys Ther Sci*, 27: 51-56. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
- Khan M.A., Walley J.D., Khan N., Hicks J., Ahmed M., & Khan S.E., (2018). Effectiveness of an integrated diabetes care package at primary healthcare facilities: a cluster randomised trial in Pakistan. *BJGP Open*.2(4):bjgpopen18X101618.
- Kumar R., Rehman S., Baloch M.G, Vankwani M., Somrongthong R., & Pongpanich S. (2022). Effectiveness of health education intervention on diabetes mellitus among the teachers working in public sector schools of Pakistan *BMC Endocrine Disorders* 22:194 <https://doi.org/10.1186/s12902-022-01110-7>.
- Lazarevic, G., Antic, S., Cvetkovic, T., Vlahovic, P., Tasic, I., & Stefanovic, V. (2006). A physical activity programme and its effects on insulin resistance and oxidative defense in obese male patients with type 2 diabetes mellitus. 583-590.
- Lee J.Y., Chan C.K., Chua S.S., Ng C.J., Paraidathathu T., & Lee K.K., (2016). Intervention for diabetes with education, advancement and support (IDEAS) study: protocol for a cluster randomised controlled trial. *BMC Health Serv Res*;16(1):524.
- Lee, S., S., & Kang S. (2015): Effects of regular exercise on obesity and type 2 diabetes mellitus in Korean children: improvements glycemic control and serum adipokines level. *J Phys Ther Sci*, 27: 1903-1907. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
- Min K.W., & Park S.W. (2006): Physical activity and type 2 diabetes mellitus. *Diabetes Metab J*, 30: 1-9.
- Najafipour, F., Mobasseri, M., Yavari, A., Nadrian, H., Aliasgarzadeh, A., Abbasi, N. M., ... Sadra, V. (2017). Effect of regular exercise training on changes in HbA1c, BMI and VO 2 max among patients with type 2 diabetes mellitus: An 8-year trial. 1-7. <https://doi.org/10.1136/bmjdr-2017-000414>
- Nazar M., Khan S.A., Kumar R., & Hafeez A. (2019). Effectiveness of health literacy intervention on cardiovascular diseases among university students of Pakistan. *BMC Health Serv Res*.19(1):504.
- Pai, L., W., Chiu, S., C., Liu, H., L., Chen, L., L., & Peng, T (2021). Effects of a health education technology program on long-term glycemic control and self-management ability of adults with type 2 diabetes: a randomized controlled trial. *Diabetes Res Clin Pract*. 175: 108785. [Return to ref 6 in article](#) [[Article CAS](#)] [[Google Scholar](#)]
- Park, J. & Lee, Y. (2015). Effects of exercise on glycemic control in type 2 diabetes mellitus in Koreans: the fifth Korea National Health and Nutrition Examination Survey (KNHANES V) 3560 *J. Phys. Ther. Sci*. Vol. 27, No. 11, 2015.
- Piercy, K.L. (2018). *The Physical Activity Guidelines for Americans*
- Rusdiana R, Savira M. & Amelia R. (2017). Characteristics of Type 2 diabetes mellitus patients based on blood sugar level and HbA1c in Binjai public health centres. *Adv Sci Lett*;23(4):3599-601. <https://doi.org/10.1166/asl.2017.9190>.
- Rusdiana R., Savira M., Amelia R. (2018). The effect of diabetes self-management education on HbA1c level and fasting blood sugar in Type 2 diabetes mellitus patients in primary health care in Binjai city of North Sumatera, Indonesia. *Open Access Maced J Med Sci*. 6(4) :715-718. <https://doi.org/10.3889/oamjms.2018.169> PMID:29731946
- Rusdiana R., Savira M., Widjaja S.S., & Ardinata D. (2020). The Effect of Health Education on Control Glycemic at Type 2 Diabetes Mellitus Patients. *Open Access Maced J Med Sci*. April 25; 8(E):133-137. <https://doi.org/10.3889/oamjms.2020.337>.
- Smith, A. (2021). Understanding the impact of interventions using pre-test post-test research design. *Research Insights* 5(3), 123-136.

- Stenov V., Wind G., Vallis M., Reventlow S., Hempler N.F. (2019). Group-based, person-centered diabetes self-management education: Healthcare professionals' implementation of new approaches. *BMC Health Serv Res.* 19(1):368.
- Zibaenzhad M.J., Aghasadeghi K., Baheri F.Z., Khalesi E., Zamirian M. & Moaref A. (2015). The effect of educational intervention on glycemic control in patients with Type 2 diabetes mellitus. *Int Cardiovasc Res J.*;9(1):17-21.