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THE EFFECT OF PHYSICAL ACTIVITY ON REDUCING BLOOD SUGAR LEVELS IN TYPE-2 DIABETES MELLITUS PATIENTS: SYSTEMATIC REVIEW

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ABSTRACT

Diabetes mellitus is a metabolic disease characterized by hyperglycemia due to abnormal insulin secretion. Diabetes mellitus is characterized by increased blood sugar levels exceeding normal limits, due to a deficiency of the insulin hormone produced by the pancreas, causing a decrease in blood sugar levels. This study aims to determine the effect of physical activity on reducing blood glucose levels in patients with type 2 diabetes mellitus. Methods: Literature searches were conducted on the following databases: PubMed, Embes, Web of Science, and Scopus. By including all observational studies, randomized controlled trials, quasi-experiments, case controls, and pre-experiments and radiating their quality using the Joanna Briggs Institute tool often referred to as (JBI). Criteria: Articles in English, published in internationally recognized journals, and discussing physical activity in relation to lowering blood glucose levels. Results: Fifteen studies ranging in size from 28 to 100 participants physical activity is effective in lowering blood glucose levels with regular exercise three times a week physical exercise can be applied to the age range of 30-85 years. Conclusion: For people with type 2 diabetes mellitus, physical activity plays a very important role in controlling blood glucose levels. When exercising, blood sugar levels are much lower than when not exercising. It can be concluded that physical activity can lower blood sugar levels in people with type 2 diabetes.

Keywords: blood sugar levels; diabetes mellitus; physical activity

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INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action, or both. Diabetes mellitus can be characterized by an increase in blood sugar levels beyond normal limits, due to a lack of the insulin hormone produced by the pancreas, causing a decrease in blood sugar levels. Type 2 diabetes occurs because pancreatic β cells produce insulin in small amounts or show insulin resistance (ADA, 2020)According to the International Diabetes Federation (IDF), there are 425 million diabetes sufferers worldwide, with ages ranging from 20 to 79 years. The global prevalence of diabetes sufferers in 2021 will reach 534 million people with a mortality of 6.7 million people, and the prevalence of diabetes in Southeast Asia in 2021 will reach 90 million people with a mortality of more than 747 thousand people (IDF, 2023). The World Health Organization (WHO) predicts that there will be an increase in the incidence of DM in Indonesia, reaching up to 21.3 million people. The 2018 Basic Health Research Report shows that the prevalence of DM in the adult population in Indonesia was 6.9% in 2013, increasing to 8.5% in 2018 2018 (Kemenkes, 2018).

According to the International Diabetes Association (IDF), most adults with diabetes are in lower-middle-income countries because eating habits are changing rapidly (IDF, 2023). In a survey of 195 countries in the world, it was found that many people consume the wrong type of food, and the food they consume is the biggest killer throughout the world (IDF, 2023).

Type-2 Diabetes Mellitus (T2DM) is a chronic disease whose prevalence is increasing globally, becoming a significant public health burden. One of the main pillars of managing T2DM is controlling blood glucose levels, which is directly linked to the risk of long-term complications. Although there are various management strategies, such as the use of medications and dietary changes, physical activity is widely recognized as an important factor. in controlling blood glucose levels in T2DM patients.

Physical activity has a significant effect on increasing insulin sensitivity and optimizing glucose metabolism in the body. Various studies have shown that regular physical exercise can help improve blood sugar control, reduce insulin resistance, and reduce the risk of developing T2DM complications. In addition, physical activity also plays a role in controlling body weight, which is a major risk factor in the development of T2DM (Colberg et al, 2016).However, although its benefits have been widely recognized, there are still challenges faced by individuals with T2DM in maintaining consistency in physical activity. Factors such as physical limitations, insufficient knowledge about the benefits of physical activity, and environmental and social factors often become obstacles on achieving optimal levels of physical activity (Cai et al, 2021). Therefore, a deeper understanding of the effect of physical activity on reducing blood sugar levels in T2DM patients is very important. By understanding the mechanisms involved in the interaction between physical activity and glucose metabolism, we can develop more effective intervention strategies in the management of T2DM (Hamasaki, 2016).

Further research is needed to explore the most beneficial types of physical activity, appropriate duration, and intensity, as well as supporting strategies that can help T2DM patients to maintain a healthy lifestyle (Hamasaki, 2016). Thus, this research is expected to provide new insights and more comprehensive information on the management of T2DM through the integration of physical activity as an integral part of the treatment plan. So, it can be expected to reduce the risk of complications and improve the quality of life for individuals living with this condition (Jang et al, 2019). Apart from that, the results of several previous studies will also be described to provide a more comprehensive picture of the effect of physical activity on reducing blood sugar levels in T2DM patients (Kasmad, 2022). Through a literature review, empirical evidence will be presented that shows a correlation between physical activity levels and blood glucose control, as well as factors that influence the effectiveness of physical activity interventions (Kurniawati et al., 2019). By summarizing previous findings, it is hoped that this research can make a valuable contribution to filling knowledge gaps and strengthen the scientific basis for better clinical practice recommendations in the management of T2DM. This study aims to determine the effect of physical activity on reducing blood glucose levels in patients with type 2 diabetes mellitus (Sadli et al, 2022).

METHOD

Literature Search Strategy

study is a *systematic review of research. A systematic review* was conducted to explain the effect of physical activity on reducing blood glucose levels in patients with type 2 diabetes mellitus according to the latest scientific evidence and best. The literature search was carried out in February 2024. The data used in this research is secondary data obtained from research results carried out by previous researchers and not from direct observation. Secondary data sources obtained were journal articles of international reputation in accordance with predetermined themes. The literature used was obtained from the PubMed, Embes, web of Science, and Scopus databases. Specific keywords were used to search for articles using the following terms: ("diabetes mellitus type 2*") OR ("physical activity" AND Reducing blood

sugar level*.) Articles included in the search were articles published between 2019 to 2023. In the search process, we used *Boolean operators and wildcard* characters appropriately to focus the search and detect singular or plural forms of the same terms in all used *databases*. Keyword searches used MeSH terms to include synonyms or spelling variations.

Inclusion and Exclusion Criteria

Articles are considered to meet the requirements if they are written in English and published in journals of international reputation. Articles were included if they discussed physical activity which was related to reducing blood glucose levels. Studies involving patients with type 2 diabetes mellitus, and research subjects involving patients with diabetes mellitus who did not engage in physical activity were not included in this systematic review.

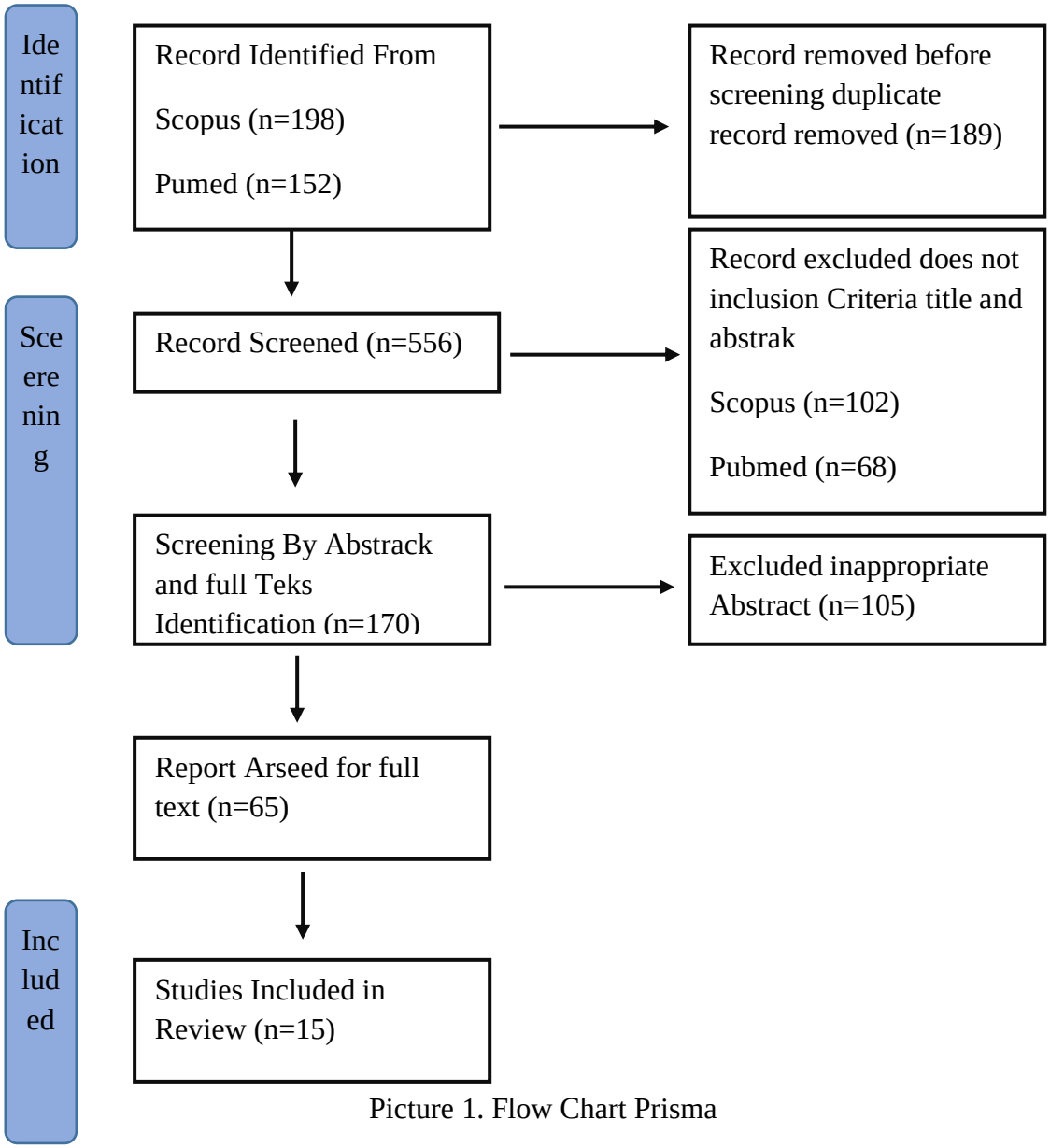
Article Selection

The data collection steps in this *systematic review research* begin with searching for articles. Researchers separately screened articles starting with selecting titles that were considered relevant. Next, read the abstract to filter articles that are deemed to meet the requirements. Finally, read *the full text* to find articles that meet the inclusion and exclusion criteria that have been determined according to the scope of the review. In terms of data extraction, we collectively decided what information might be relevant according to the review focus, clinical experience, and previously published reviews. Therefore, we created a table to highlight relevant data, and then we entered data from each article into the table and discussed possible inconsistencies. Finally, we reread *the full text* that we will use to ensure accuracy.

The article in this study carried out a quality assessment analysis with the instruments used which were sourced from The Joanna Briggs Institute Guideline (JBI) Critical Appraisal Tools commonly known as JBI, with the type of JBI adapting to the one used. The assessment on JBI is divided into the answer choices "yes", "no", "unclear" or "not applicable", with a value of 1 given to the answer "yes", and a value of 0 to the other answer choices. The critical appraisal stage aims to assess the quality of an article. Articles can be included in this study if the JBI score of more than 70% meets the critical appraisal criteria, so they are considered worthy and the research article is included in the criteria. This is done so that articles in systematic review studies avoid low-quality articles so that there is no bias in the validity of the results. The article search strategy was carried out using the PICOS framework.

Table 1.
PICOS Framework

Criteria	Inclusion	Exclusion
Participants	Type 2 diabetes patients	Patients who do not have type 2 diabetes
Intervention/Exposure	Physical activity or exercise	studies that did not involve physical activity or exercise interventions
Comparator	None	None
Outcomes	Reducing blood sugar levels or glycemic control	studies that do not address reducing blood sugar levels or glycemic control
Study Designs	Various types of studies include-, quasi-experimental research, pre-experimental, case-control, and case studies	Qualitative studies, systematic reviews, and meta-analyses
Publication years	2019-2024	Before the year 2019
Language	English	Other than English



Picture 1. Flow Chart Prisma

This study reviewed 15 articles regarding the effect of physical activity on reducing blood glucose levels in patients with type 2 diabetes mellitus conducted in the period 2019 to 2023.

RESULT

Table 1.
Research result

Title, Author, Year	Country	Research design	Research result
The Impact of Using Brisk Walking Exercise in Lower Blood Sugar of Patients with Type 2 Diabetes Mellitus (Kasmad et al 2022)	*America*	*Quasi-experimental*	Brisk walking training resulted in a significant reduction in blood sugar levels in type 2 diabetes mellitus patients involving 28 participants.

Title, Author, Year	Country	Research design	Research result
The effect of physical exercise on blood sugar control in diabetic patients (Wang et al 2021)	*China*	*Experimental*	Healthy physical exercise stabilizes blood sugar levels and reduces hemoglobin glycosylation levels in diabetes patients involving 41 participants.
The impact of exercise modalities on blood glucose blood pressure in patients with type 2 diabetes mellitus (Ambelu et al 2023) .	*America*	*Experimental design*	Combined strength and aerobic training were proven to have a greater impact on changing parameters such as body composition, blood pressure, and fasting blood glucose levels compared to individual training with 40 respondents.
The Effect of Prolanis Exercise Activities on Decreasing Blood Sugar Levels in Diabetes Mellitus Patients. (Silvia et al (2021) .	*Indonesia*	*Quasi-experimental*	Physical exercise in the form of proteins has been proven effective in lowering blood sugar levels in type 2 diabetes patients.
Relationship between exercise habits and blood sugar levels in type 2 diabetes mellitus patients (Grido et al 2023) .	*Africa*	*Case-Control*	There is a relationship between the amount, type, and duration of physical exercise and blood glucose levels in type 2 diabetes patients. Patients who exercise frequently and train for longer periods tend to have more controlled blood sugar levels with 80 respondents.
Health Module Intervention of Physical Activity (PA) in Controlling Blood Sugar Levels of People With Type 2 Diabetes Mellitus (Sadli et al 2022) .	*Indonesia*	*Quasi-experimental*	Providing a health module in the form of physical activity can reduce blood sugar levels in type 2 diabetes patients. This module can be a basis for evidence to help decision-makers in making relevant policies with a total of 100 respondents .
Intermittent Exercise in Reducing Glucose Levels in Type 2 Diabetes Mellitus Patients (Widayati et al 2021)	*Indonesia*	*Pre-experimental*	Intermittent exercise significantly reduces blood glucose levels in type 2 diabetes patients. The reduction in glucose levels can be achieved through physiological and psychological mechanisms.
Health Literacy Brisk Walking Exercise on Clinical Outcomes of Blood Sugar in Patients with Type 2 Diabetes Mellitus in Indonesia (Zainuddin et al 2023).	*Indonesia*	*Case-Control*	Doing brisk walking supported by health literacy can be a modifiable factor related to HbA1c levels in type 2 diabetes patients. Brisk walking exercise can be a solution to controlling blood sugar levels.
Effects of an Aerobic Physical Exercise Program on Blood Glucose Levels in Type-2 Diabetic Subjects, Associated with Pharmacotherapy and Diet Therapy (Almeida et al., 2020) .	*Brazil*	*Pre-experimental*	The results show that physical activity training determined by volume, intensity, frequency, and repetition can reduce blood glucose levels
The 10-week of aerobic-functional training improves fasting blood sugar insulin resistance, and lipid profile in patients with diabetic peripheral neuropathy (Beigi et al., 2022).	*Iran*	*Quasi experimental*	The research results show that aerobic exercise has a significant effect on reducing blood sugar levels where the fasting blood glucose index, insulin resistance and HOMA-IR insulin decreased significantly repeated measures showed a significant decrease in fasting blood sugar
The Effect of Walking Exercise on Blood Pressure and Blood Glucose in the Elderly (Rizka et al. , 2022)	*Indonesia*	*Experiment design*	Walking exercise has a significant effect on blood pressure and blood glucose in the elderly.
The Effect of Brisk Walking	*Indonesia*	*Quasi*	The results of the study show that physical exercise

Title, Author, Year	Country	Research design	Research result
Exercise on Reducing Blood Sugar Levels in Type II Diabetes Mellitus Patients at Grandmed Lubuk Pakam Hospital (Hayati et al. , 2021)		*experimental*	done 3 times 30 minutes per week can reduce the risk of type 2 DM. DM sufferers have uncontrolled blood glucose levels. Physical exercise is highly recommended for people with type 2 diabetes. Maintaining body functions so that they work well and maintaining stable blood sugar.
Effect of postprandial moderate-intensity walking for 15-min on glucose homeostasis in type 2 diabetes mellitus patients (Iida et al. , 2020)	*Japan*	*Randomized Controlled Trial*	The results of this study indicate that walking with moderate intensity postprandial is easy to carry out in life activities daily, effective for improving glucose homeostasis. Further studies should be investigated to clarify the relationship between postprandial walking and drug therapy (insulin and OHA), including insulin secretion ability.
The Effects of Combined Exercise Training (Resistance-Aerobics) on Serum Kinesin and Physical Function in Type 2 Diabetes Patients with Diabetic Peripherals Neuropathy (Seyedizadeh, Cheragh-Birjandi and Hamedi Nia, 2020)	*Iran*	*Randomized Controlled Trial*	The results showed that the increase in lower body strength was significant, it can be concluded that combined aerobic resistance training had a significant effect on lower body strengthening factors. a comparison between the two levels of aerobic endurance of the two groups showed that after eight weeks the aerobic endurance in the control group decreased significantly, and the effect size data showed that training had quite an effect on aerobic endurance.
Efficacy of Graded Activity with and without Daily-Monitored Walking on Pain and Back Endurance among Patients with Concomitant Low Back Pain and Type-2 Diabetes: (Idowu and Adeniyi, 2020)	*Ethiopian*	*Randomized Controlled Trials*	The results showed that activity assessed by daily monitored walking produced a positive effect on glycemic control resulting in further improvements good for static abdominal muscle endurance and static back extensors endurance.

The articles in this study consist of articles that comply with the inclusion criteria determined in this study, with all types of research being quantitative with research designs using randomized controlled trials (3), quasi-experiments (5), case-control (2), experiment (3) pre-experiment (2) the articles found were published from 2020 to 2023. The places where the study was conducted in this research article consisted of various countries from Indonesia, there were 6 articles (Sadli et al, 2022) (Silvia et al., 2021); (Widayati, 2021) (Zainuddin et al, 2023) (Rizka et al, 2022) (Hayati et al, 2021), Iran 2 articles (Seyedizadeh et al., 2020) (Beigi et al., 2022), Japan 1 article (Iida et al., 2020)Brazil 1 article (Almeida et al., 2020), Ethiopian 1 article (Idowu et al, 2020) Africa 1 article (Sriyono et al., 2023) , America 2 articles (Kasmad, 2022) (Ambelu, 2023), China 1 article (Wang et al, 2021). Not only in Indonesia, physical exercise is one of the physical exercises that is widely used in various countries to control glucose levels in patients with type 2 diabetes mellitus, it can also be done at various ages and genders as shown in Table 2.

Table 2.
Frequency distribution of patients with type 2 diabetes mellitus based on gender and age (n=15)

Variable		f	%
Gender	Woman	164	58.8%
	Man	115	41.2%
Age	Min	30	
	Max	85	
	Mean	50	

The results of this study show that the average age is 50 years with a minimum age of 30 and a maximum age of 85 years or classified as elderly, with the majority gender being female with a percentage of 58.8%.

DISCUSSION

Of the 15 journals reviewed above, each study has similarities and differences. The similarities between the journals above all discuss physical inactivity in reducing blood sugar levels in patients with type 2 diabetes mellitus. The research used was quasi-experimental and experimental. The research results obtained from the 15 journals above show that physical activity is effective in reducing blood sugar levels in patients with type 2 diabetes mellitus. This systematic review aims to explore patient blood glucose levels and patient adjustment after physical activity. Overall, the results obtained led to the identification of several factors associated with this health condition. Most of the articles explain that physical activity reduces blood glucose levels in type 2 diabetes mellitus patients.The majority of research results show that patients with physical activity have significantly lower glucose levels. This is in accordance with the results of research conducted (Kasmad, 2022), in his research explaining that the intervention group's effect of brisk walking exercise on reducing blood sugar levels in diabetes mellitus sufferers showed a significant value after being tested using the Wilcoxon statistical test. There was an effect of brisk walking exercise on reducing sugar levels. blood in type 2 diabetes mellitus sufferers is related to the energy use system during activity-, so that glucose in the blood is used to form energy instead of energy that has been used. In addition, physical activity or exercise can help control body weight which can trigger diabetes mellitus so that sensitivity to insulin will increase (Hayati et al, 2021). From the findings. Physical activity, according to several studies and scientific experts, can extend a person's life expectancy. Two to three times a week, for example, is sufficient physical activity and in the elderly, intermittent exercise has been shown to lower blood sugar levels. This is due to the fact that when elderly people do intermittent exercise, carbohydrates are burned through energy metabolism, which increases the rate of energy production in the body, resulting in a decrease in blood sugar levels (Widayati, 2021).

The results of the study show that there is a relationship between exercise frequency and blood sugar levels in T2DM patients. Diabetics who exercise three times a week will produce more insulin. In addition, contracting muscles will become more permeable. So insulin receptors increase in number and sensitivity in response to exercise (Sriyono et al., 2023). Aerobic (endurance) activities such as walking, swimming, running, and cycling are recommended for those suffering from T2DM. Similar findings were also found that aerobic exercise had an impact on reducing blood sugar levels in T2DM. This type of physical exercise can directly cause an increase in insulin sensitivity (Sriyono et al., 2023). Another study similar (Ambelu, 2023) to this study found that combined exercise (aerobic exercise

plus strength training) led to a decrease in fat levels around the abdominal area, and using a combination of aerobic exercise plus strength training was the most effective exercise program for burning fat as well as weight loss. blood and fasting blood glucose in type 2 diabetes patients is higher than when doing strength training alone (Sriyono et al., 2023). In terms of therapy for type 2 diabetes, it is seen as an integral part of improving insulin resistance and maintaining target levels of blood glucose control in addition to weight loss. In the current study, the exercise program was found to significantly reduce blood glucose levels, systolic and diastolic blood pressure, and body fat percentage (Hayati et al, 2021).

These findings are consistent with previous studies which revealed that exercise in type 2 diabetes patients is effective in improving blood glucose control and insulin resistance by increasing blood glucose intake and utilization in skeletal muscle. Therefore, aerobic and resistance exercises are effective in improving insulin resistance and reducing blood glucose levels. blood glucose in T2DM patients (Ambelu, 2023). The existence of good social support also has a positive effect on improvement. From a review conducted (Idowu et al, 2020). managing patients with LBP and T2DM simultaneously. It can be concluded that patients with co-occurring LBP and T2DM will require an additional daily monitored home walking program that may not only resolve their LBP problem but also improve their glycemic control (Kasmad, 2022). Graded activity with monitored walking had a significant positive effect on the glycemic control of patients with concomitant LBP and T2DM compared with those undergoing GA alone. This may lead to improved general health status, increased exercise tolerance, and increased PA. Apart from medication and diet, PA is also important in achieving glucose control in T2DM patients (Widayati, 2021). There is a lot of evidence that walking, a form of PA, has beneficial effects on glycemic control and LBP (Qiu S, 2014). Walking is a moderate-intensity sport with a lower risk of musculoskeletal injury causing cardiovascular harm compared to more strenuous exercise (Idowu et al, 2020).

Research (Wang et al, 2021) confirms that exercise can increase muscle glycogen synthesis and increase glucose transport phosphorylation in insulin-stimulated muscle cells. Exercise can directly improve abnormal lipid metabolism associated with abdominal obesity syndrome and adjust plasma lipoprotein composition (Kasmad, 2022). The results after doing healthy physical exercise, blood sugar levels in diabetes patients tend to be stable, and glycosylated hemoglobin levels decrease. The blood sugar levels of patients who do not participate in healthy physical exercise are unstable, and their glycosylated hemoglobin levels do not improve. Exercise can increase fiber protein activity (Hamasaki, 2016). Exercise increases insulin activity. Exercise increases the glucose transporter GLUT4 and plasma membrane GLUT4, which mediate glucose transport in skeletal muscle and adipose tissue. In several literature findings, it is explained that walking is an activity that is classified as economical and has low risk. Walking is a recommendation and activity that is very useful for lowering blood pressure (Rizka et al, 2022). In several studies, it has been explained that physical exercise has a good impact on the cardiorespiratory system. Heart capacity will also increase according to the changes that occur through good and regular exercise. The results of this research have proven that walking can reduce blood glucose levels in patients with type 2 diabetes mellitus (Sadli et al, 2022). Walking with moderate and high intensity can reduce blood glucose because it increases glucose absorption by muscles compared to hepatic glucose release during activity (Zainuddin et al, 2023). The results of the study show that carrying out DM self-management more effectively can meet the patient's need for long-term education regarding physical activity which is very supportive in self-management of T2DM patients. Thus, it can be said that physical activity can maintain the blood glucose levels of patients with type 2 diabetes mellitus and can help delay or prevent diabetes complications and reduce excessive impacts.

CONCLUSION

Based on the analysis of 15 articles, the results were found that physical activity has a positive effect in preventing or managing blood glucose control in diabetes mellitus sufferers. Apart from that, physical activity is also effective in improving blood glucose control and insulin resistance by increasing the intake and use of blood glucose in muscles. The majority of research results show that patients with physical activity have significantly lower glucose levels than patients who do not carry out daily activities, have higher glucose levels and patients who engage in physical activity have been shown to lower blood sugar levels. This is due to the fact that when doing sports or physical activity, carbohydrates are burned through energy metabolism, which increases the rate of energy production in the body, resulting in a decrease in blood sugar levels. For this reason, it is recommended that diabetes sufferers do physical activity, especially moderate-intensity physical activity, which can reduce blood glucose quickly.

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