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Review Article: Systematic Review, Meta-Analysis, Integrative Review, Scoping Review

EFFECTIVENESS OF WALKING EXERCISE ON HBA1C AND BMI OF DIABETES MELLITUS TYPE 2: A SYSTEMATIC REVIEW

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Abstract

Background: Survey data shows that there are 51.9% of DM sufferers who do not exercise as an alternative to controlling diabetes. Walking exercise has been demonstrated to have an impact on BMI and HbA1c in one trial, but only in people with prediabetes.
Objective: Analyzed the results of primary research regarding the effectiveness of walking exercise in controlling the HbA1c and body mass index (BMI).
Methods: Design of this study was a systematic review. Data sources of this article was from 4 databases (Scopus, EBSCO, Proquest and Pubmed). Search for articles for the last 10 years, Mar 2015- Mar 2024. The research method used PRISMA 2020 guidelines. Article selection used the PICO framework. Medical Subject Heading (MeSH) is used to search for keywords. The quality assessment of an article is assessed using the Joanna Briggs Institute (JBI) format.
Results: Walking exercise has a positive effect on HbA1c and BMI. Four of the eight articles showed a significant effect of walking exercise on reducing HbA1c. Three of the 7 articles showed a significant effect of walking exercise on reducing BMI.
Conclusion: Walking exercise is a type of physical exercise that is considered to have a positive effect on body health for both diabetics and non-diabetics. Walking exercise can improve the metabolic status of diabetes sufferers by reducing blood glucose levels, HbA1c and BMI.

Keyword: *HbA1c, BMI, Type 2 Diabetes, Walking Exercise*

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INTRODUCTION

Diabetes mellitus or DM is brought on by insufficient insulin production by the pancreas or by inefficient insulin utilization by the body's cells (WHO, 2023). If diabetes is not appropriately managed, it might lead to major complications. One form of non-pharmacological management that people with diabetes should consistently practice is physical activity. However, according to survey data, 51.9% of people with diabetes do not exercise as a means of managing their condition (Riskesdas, 2018). This percentage is fairly high and may eventually experience more severe problems from diabetes.

The global prevalence of diabetes sufferers in 2021 will reach 536 million people with mortality reaching 6.7 million people(IDF, 2021). The prevalence of diabetes in Southeast Asia in 2021 will reach 90 million people with a mortality of more than 747 thousand people(IDF, 2021). In Indonesia, the prevalence of diabetes will reach 19 million people in 2021 with 27% microvascular complications and 16.3% microvascular complications (IDF, 2021).

Genetics and unhealthy behavioral variables, such as a poor diet and inactivity, might exacerbate type 2 diabetes or lead to its consequences (Petroni et al., 2021). Therefore, there is a chance of elevated blood glucose levels in diabetics who do not exercise and manage their food; if this happens frequently, problems from diabetes may arise. According to Ganiyu et al., (2013) , the primary causes of non-compliance with exercise were inadequate knowledge, the belief that exercise exacerbates their illness, and a lack of exercise partners. Other factors influencing exercise physical activity (EPA) include low social support, resistance to physical exercise programs, low self-evaluation, and lack of awareness (El Haddad et al., 2023).

Maintaining stable blood glucose levels with non-pharmacological self-management, such as physical exercise, is one way to avoid issues. According to a meta-analysis, diabetics who were physically active had 2.4 times better blood glucose management than the control group (Asfaw & Dagne, 2022). Physical activity lowers blood glucose levels because it engages muscles, which have insulin receptors. Muscle tissue prepares glucose during and after activity (Harvard, 2023).

Walking is a highly effective kind of physical exercise. Walking exercises are designed to help people reach higher improvement goals. According to Harvard, (2023), walking upstairs or at a high intensity is more beneficial than walking at a leisurely pace. Glycemic control is significantly improved by walking exercise, according to a meta-analysis of RCT research on the effectiveness of aerobic exercise (Gao et al., 2021). Similarly, several studies demonstrate how walking exercise affects body weight. Body mass index (BMI) is a better measure of a diabetic patient's body proportions than body weight alone since it accounts for both height and body weight. Body weight is a useful tool for evaluating a patient's metabolic health. Walking exercise has been demonstrated to have an impact on BMI and HbA1c in one trial, but only in people with prediabetes (Wang et al., 2023). Up until now, no systematic analysis has examined how walking exercise affects long-term glycemic management, specifically BMI and HbA1c.

Objective(s): The aim of this systematic review was to analyzed the effectiveness of walking exercise to controlling HbA1c and BMI of diabetic sufferers.

METHODS

Design

The method used by the author is a systematic review. A systematic review is a way to synthesize and evaluate the range of evidence available in multiple primary studies (Phillips & Barker, 2021). This method was carried out according to PRISMA 2020 guidelines (Page et al., 2021).

Search Methods

The procedure of searching the literature was done till March 20, 2024. Using four databases—Scopus, ProQuest, EBSCO, and Pubmed—an article search covering research conducted over the last ten years, from 2015 to 2024, was conducted. Use boolean operators and keywords to find articles. The Medical Subject Heading (MeSH) technique and keywords from multiple publications on the same subject were employed by the researchers to determine keywords.

Table 1 PICOS

PICOS	Inclusion Criteria	Exclusion Criteria
Population	Type 2 diabetes (T2DM)	Type 1 diabetes (T1DM) Gestational Diabetes Pre-Diabetes Risk of diabetes Non-human experiments
Intervention	Walking exercise Walking training Brisk walking	Nordic walking Running Jogging
Comparison	Comparing walking exercise with other exercises Comparing walking exercise with control group	Compare with pharmacology test No comparator
Outcomes	Metabolic outcome: HbA1C and BMI.	Not discussing the impact of walking exercise on HbA1c and BMI
Study design and publication type	Randomized Controlled Trial Randomized Crossover Trial Randomized Clinical Trial	Quasy experimental Article review Cross-sectional Sudy cohort Case report/case study

Search Outcome

Academic databases were searched to find the publications that were evaluated. Articles are chosen according to how well-suited or pertinent they are to the subject. Reading the abstract and title helped with the initial screening process to see if the walking exercise topic was appropriate. Before undergoing additional analysis, articles that satisfied the inclusion criteria were carefully reviewed to guarantee the legitimacy and relevance of their content.

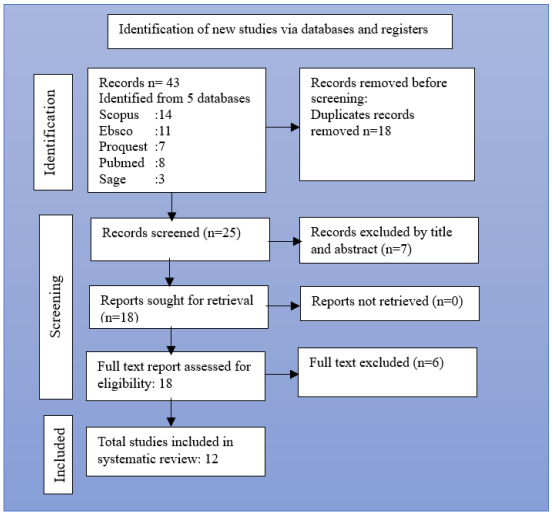

Figure 1 Screening Article

Quality Appraisal

The quality assessment of an article can be seen as assessed by the Joanna Briggs Institute (JBI). The articles that less than 70% are excluded.

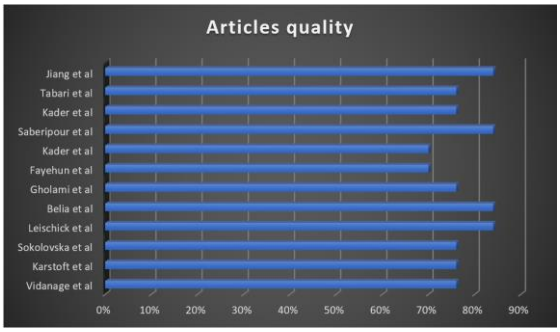

Figure 2 Article Quality

Data Abstraction

The literature search found 43 articles which removed 18 articles because of duplicated data. Also 7 articles were excluded because the title and abstract were not appropriate. Six articles were excluded again because of the full text was not appropriate with the PICOT.

Data Analysis/ Synthesis

In this article, the authors analyzed 12 articles by assessing and reading them

thoroughly, analyzing them from title to conclusion. The articles were appropriate for the criteria and research topic. The articles also provided complete data to review or analyze.

RESULTS

Researchers use narrative tables to compile and summarize selected research. These tables help identify findings aligned with the research questions and objectives. The data entered into these tables includes information such as author, year, research objectives, research design, sample size, and study outcomes.

There were a total of 12 articles analyzed, with 3 articles describing output about HbA1c, 5 articles about HbA1c and 4 articles about BMI. There were a total of 639 patients with type 2 DM who were respondents to a total of 12 articles. Of the 8 articles assessing the effectiveness of walking exercise on HbA1c, 4 of them were statistically significant and the other 4 were not statistically significant. Among the 7 articles that assessed the effectiveness of walking exercise on BMI, 3 were significant and 3 were not statistically significant. However, 1 more article showed significance in the prepost test walking exercise but when compared with the control group, it did not show significance.

DISCUSSION

After this article was analyzed, two outcome items were found. Positive changes are seen in most variables. Every HbA1c and BMI assessment revealed a decline, while some only revealed non-statistically significant declines. A comprehensive review and meta-analysis examining the impact of physical activity, including walking, cycling, resistance training, and aerobic exercise. The average follow-up period was 21 weeks, and the typical training session lasted 45 minutes. Following the intervention, almost all of the trials showed decreases in the following parameters: BMI ($P = 0.04$), waist circumference ($P = 0.007$), fasting blood glucose ($P = 0.03$), and glycated hemoglobin (HbA1c; $P < 0.0001$) (Shah et al., 2021). Research from systematic reviews and meta-analyses supports these findings, demonstrating that the walking group's FBG and HbA1c significantly decreased by 12.37 mg/dL and 0.35%, respectively, in comparison to the control group (Dhali et al., 2023). According to analysis of available RCTs, regular walking training, particularly when under supervision, improves blood pressure, body weight, cardiorespiratory fitness, and glucose control in individuals with type 2 diabetes (T2DM) (Moghetti et al., 2020). An essential tool for tracking the body's metabolic state is blood glucose. Exercise decreases blood glucose in a number of ways. Muscle cells are better equipped to employ available insulin to take up glucose during and after action when insulin sensitivity is increased. Whether or not insulin is present, cells can absorb glucose and use it as energy when muscles contract during activity (Colberg et al., 2016).Pancreatic β-cell function and insulin sensitivity are enhanced by maintaining lower levels of sedentary behavior and higher levels of physical activity (Colberg et al., 2016). This also affects systemic and central insulin sensitivity and glucose absorption (Bird & Hawley, 2017). Systemic skeletal muscle glucose absorption, which is required to initiate skeletal muscle contraction during exercise, is the primary mechanism behind the influence of exercise on glycemic variability (Richter & Hargreaves, 2013). Increased insulin-independent glucose absorption results from exercise activating alternative molecular signals that can circumvent skeletal muscle deficiencies in insulin signaling. Improved skeletal muscle insulin sensitivity and overall metabolic health are linked to enhanced GLUT4 protein expression and skeletal muscle mitochondria during exercise training (Stanford & Goodyear, 2014).

Table 2 Article Review

Title Author, year	Design Population Procedure	Outcomes
Impact of aerobic exercises on taste perception for sucrose in patients with type 2 diabetes mellitus; A randomized controlled trial (Vidanage et al., 2022)	**Design:** Randomized controlled trial **Population:** 118 T2DM **Procedure:** 30 minutes walking/day 4-5 days 6 months	HbA1c of experimental group Pre: 8.0 % Posts: 7.6 % HbA1c of control group Pre: 7.94 % Posts: 8.27 % P-value between pre post test experimental group is significant (p=0.047) and p-value between experiment and control group is also significant (p=0.018)
The effects of 2 weeks of interval vs continuous walking training on glycaemic control and whole-body oxidative stress in individuals with type 2 diabetes: a controlled, randomised, crossover trial (Karstoft et al., 2017)	**Design:** Randomized controlled crossover trial **Population:** 14 T2DM **Procedure:** 60 minutes/session 5 sessions/week 2 weeks	HbA1c of IWT group Pre: 6.6 % Posts: 6.5 % HbA1c of CWT group Pre: 6.7 % Posts: 6.6 % HbA1c of control group Pre: 6.6 % Posts: 6.6 % p-value between intervention vs control group is not significant.
Impact of interval walking training managed through smart mobile devices on albuminuria and leptin/adiponectin ratio in patients with type 2 diabetes	**Design:** Randomized controlled trial **Population:** 40 T2DM **Procedure:** 60 minutes/session	HbA1c of intervention group Pre: 6.9 % Posts: 6.6 % HbA1c of control group Pre: 6.7 % Posts: 6.9%

(Sokolovska et al., 2020)	3 sessions/week 16 weeks	p-value between intervention vs control group is not significant with p=0.09 BMI of intervention group Pre: 32.6 kg/m2 Post: 31.9 kg/m2 BMI of control group Pre: 32.2 kg/m2 Post: 32.4 kg/m2 p-value between intervention vs control group is not significant.
Exercise Improves Cognitive Function—A Randomized Trial on the Effects of Physical Activity on Cognition in Type 2 Diabetes Patients (Leischik et al., 2021)	**Design:** Randomized controlled trial **Population:** 55 T2DM **Procedure:** 40 minutes/session 3 times/week 12 weeks	HbA1c walking group Pre: 7.3 % Post: 7.2 7% HbA1c control group Pre: 7.0 % Posts: 7.04 % p-value between pre post test is not significant and also p-value between walking and control group is not significant. BMI walking group Pre: 34.40 kg/m2 Post: 34, 03 kg/m2 BMI control group Pre: 33.80 kg/m2 Post: 33.71 kg/m2 p-value between pre post test is not significant and p-value between walking and control group is also not significant.
Exercise individualized by TRIMPi method reduces arterial stiffness in early	**Design:** Randomized controlled trial **Population:**	HbA1c of AIT group Pre:6.9 % Posts: 6.6 %

onset type 2 diabetic patients: A randomized controlled trial with aerobic interval training (Bellia et al., 2017)	22 T2DM **Procedure:** 6 minutes/session 3 sessions/week 12 weeks	HbA1c of SOC group Pre: 6.8 % Posts 6.4 % p-value between intervention vs control group is not significant (p=0.072)
Effect of aerobic training on nerve conduction in men with type 2 diabetes and peripheral neuropathy: A randomized controlled trial (Gholami et al., 2018)	**Design:** Randomized controlled trial **Population:** 24 T2DM **Procedure:** 45 minutes/session 3 sessions/week 12 weeks	HbA1c of experimental group Pre: 8.3 % Posts: 7.7 % HbA1c of control group Pre: 8.6 % Posts: 8.5 % p-value of pre post test experimental group is significant with p<0.05 and p-value between experimental and control group is significant with p<0.05 BMI of experimental group Pre: 28.7 kg/m2 Post: 28.3 kg/m2 BMI of control group Pre: 29.0 kg/m2 Post: 28.9 kg/m2 p-value between pre post experimental group is not significant and p-value between experimental group and control group is not significant to.
Walking prescription of 10 000 steps per day in patients with type 2 diabetes mellitus: a randomized trial in Nigerian general practice (Fayehun et al., 2018)	**Design:** a randomised design with two conditions **Population:** 46 T2DM Procedure: 10,000 steps/day 10 weeks	HbA1c (%) mean Walking group Pre:6.84 % Post:6.26 % control group Pre:6.36 % Post:6.82 %

		P value between intervention and control group p=0.015
Aerobic exercises alleviate symptoms of fatigue related to inflammatory cytokines in obese patients with type 2 diabetes. (Abd El-Kader et al., 2016)	**Design:** Randomized controlled trial **Population:** 80 T2DM **Procedure:** 45 minutes/session 3 sessions/week 12 weeks	BMI of intervention group Pre: 31.65 kg/m2 Post: 26.82 kg/m2 BMI of control group Pre: 31, 14 kg/m2 Post: 31.82 kg/m2 p-value between pre post test of intervention group is significant ($p<0.05$) and p-value between intervention and control group is also significant ($p<0.05$).
Aerobic exercise training modulates biochemical parameters in type 2 diabetic patients with chronic hepatitis C (Abd El-Kader et al., 2017)	**Design:** Randomized controlled trial **Population:** 40 T2DM **Procedure:** 40 minutes/session 5 sessions/week 12 weeks	The mean values of (HOMA-IR), TC, LDL-c, TG, virologic response and Body Mass Index (BMI) were significantly decreased in group (A), while there were no significant changes in group (B) Also there was a significant difference between both groups at the end of the study.
Comparing the Effect of Walking and Yoga on Clinical and Laboratory Parameters in Men with Type II Diabetes: A Randomized Controlled Clinical Trial (Saberipour et al., 2020)	**Design:** Randomized controlled trial **Population:** 98 T2DM **Procedure:** 60 minutes/session 3 sessions/week 8 weeks	BMI of walking group Pre: 27.01 kg/m2 Post: 26.69 kg/m2 BMI of control group Pre: 28.72 kg/m2 Post: 28.82 kg/m2 p-value between pre post walking group is not significant with p=0.07 and p-value between walking and control group is significant with p=0.024

The Effect of 8 Weeks Aerobic Exercise on Insulin Resistance in Type 2 Diabetes: A Randomized Clinical Trial (Motahari-Tabari et al., 2014)	**Design:** Randomized clinical trial **Population:** 53 T2DM **Procedure:** 40 minutes/session 3 sessions/week 8 weeks	BMI of experimental group Pre: 29.74 kg/m2 Post: 29.53 kg/m2 BMI of control group Pre: 30.35 kg/m2 Post: 30.31 kg/m2 p-value between pre post test of experimental group is significant (p=0.01), but there is no significant difference betweek experiment and control group.
Aerobic exercise training at maximal fat oxidation intensity improves body composition, glycemic control, and physical capacity in older people with type 2 diabetes (Jiang et al., 2020)	**Design:** Randomized controlled trial **Population:** 49 T2DM **Procedure:** 60 minutes/session 3 sessions/week 16 weeks	HbA1c experimental group Pre: 6.90 % Posts: 6.21 % HbA1c control group Pre: 6.84 % Posts: 6.92 % p-value between pre post test of experimental group is significant (p<0.01) and p-value between experiment and control group is significant (p<0.01).

Given that blood glucose serves as a source of metabolic energy, the body will benefit from having the proper level or quantity of blood glucose. A disorder that causes major health issues when blood glucose levels rise noticeably and persistently. Because of this, raising the body's requirement for blood glucose may be a better strategy than lowering blood glucose levels. Walking exercise is a basic form of physical activity that has a lot of benefits. Exercise that involves walking causes more cellular activity than normal. Of course, this requires energy in the form of blood glucose. This is what is broadly described in the decrease in blood glucose levels as a result of physical exercise such as walking exercise.

The article analysis's findings demonstrate that walking exercise has a considerable favorable impact on HbA1c. Four of the eight articles that were examined produced noteworthy and encouraging outcomes. Conversely, the other does not demonstrate statistical significance and merely has a favorable effect. These findings agree with a number of studies and analysis.Walking dramatically reduced HbA1c (glycosylated hemoglobin A1c) by 0.50%. Walking under supervision was linked to a significant drop in HbA1c, however walking unattended showed no beneficial effects (Qiu et al., 2014). Long-term exercise training was found to have a substantial impact on HbA1C, BMI, and Vo2max in another study (Najafipour et al., 2017). Walking and weight training for at least five days a week are associated with lower HbA1c levels in both men and women (Yun et al., 2022).According to Grace et al., (2017), a systematic review and meta-analysis of 27 RCT publications revealed a substantial moderator effect whereby the percentage of HbA1C% decreased with each extra week of exercise, ranging from 0.009 to 0.04% with p = 0.002. A drop in HbA1c levels is linked to training volume, frequency, and intensity (Boule &sigal, 2023 in (Kirwan et al., 2017)), although there isn't enough evidence to say which of these three is superior at this point. Glycemic control biomarkers, such as HbA1c values, can be used to demonstrate how exercise lowers blood glucose levels. Glycated or glycosylated hemoglobin is referred to as HbA1c. It arises from the reaction of blood glucose with hemoglobin, a protein found in red blood cells that transports oxygen throughout the body. You can obtain a general idea of the average blood glucose level of diabetes patients over a period of weeks or months by monitoring their HbA1c. This measurement of glucose regulation is the outcome of glucose molecules binding to hemoglobin over the course of a red blood cell's 120-day life. The total amount of glucose in the system at that particular moment is exactly proportionate to the amount of glucose that combines with these proteins. HbA1c will be increased if BG levels have been elevated in the last several weeks (Wake, 2020).

BMI-related search results also reveal a number of publications with beneficial outcomes. This is consistent with another research. Following a 12-week program of moderate-intensity walking exercise, the participants' body composition significantly decreased, with significant groupings based on weight, body mass index, body fat percentage, high sensitivity of C-reactive protein, interleukin-6, and tumor necrosis factor-α. noteworthy in the group that exercised (Son et al., 2023). Exercise intervention participation decreased body weight, BMI, and visceral fat deposition but did not significantly enhance lean body mass, according to one meta-analysis involving 16 studies (Lee & Lee, 2021). According to a prior meta-analysis of three studies, exercise interventions helped overweight or obese people lose weight, increase lean body mass, and reduce their waist circumference, BMI, and body fat percentage (Stoner et al., 2016). Another study used a curriculum that ran for ten weeks, five days a week. Body mass index, waist and hip circumference, skinfold thickness of the belly, subscapular region, biceps, and triceps were measured both before and after. Women who engaged in aerobics and brisk walking for ten

weeks saw a drop in all values (Melam et al., 2016).

However, it cannot be denied that there are several articles that are not significant in reducing HbA1c levels or BMI. Some of them have less frequency and duration than other studies. So, it can be estimated that the frequency and duration of walking exercise plays an important role in reducing HbA1c levels and also BMI. Thus, it is hoped that future research will pay attention to the duration and frequency of exercise as well as the level of compliance of respondents who participated in the intervention group and control group.

This is the first systematic review that focuses on the effectiveness of walking exercise on HbA1c and BMI levels in type 2 DM patients. The limitation of this systematic review research is that the number of articles reviewed is still insufficient and the limitations on the type of walking exercise are still varied. Thus, it is hoped that further research will provide inclusion limits on certain types of walking exercises.

CONCLUSION

Walking exercise is one of the physical exercises that is considered to have a positive effect on body health for both diabetics and non-diabetics. Walking exercise can improve the metabolic status of diabetes sufferers by reducing blood glucose levels, HbA1c and BMI. Apart from that, walking exercise can also contribute to improving the quality of life of diabetes sufferers. Every research or article definitely has shortcomings, and this systematic review is no different. A deficiency that might be corrected in the future is a more specific type of walking exercise, such as a walking exercise specifically for a treadmill or a walking exercise that measures the number of steps taken.

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The authors have no conflict of interest to declare.

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AUTHOR CONTRIBUTION

Nurul Fitri: Main author, has ideas related to the topic.

Yulis Setiya Dewi: providing useful input and suggestions to the articles written.

Ira Suarilah: providing useful input and suggestions to the articles written.

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