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Comparison of high intensity interval training and moderate intensity continuous training on blood glucose levels in patients with type 2 diabetes mellitus: A systematic review

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Abstract

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic condition characterized by insulin resistance and elevated blood glucose levels. This condition can lead to various complications such as vascular and nerve damage. Exercise is one of the interventions for T2DM as it can help control blood glucose levels, such as High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT).

Methods: This study is a systematic review of published journals regarding HIIT and MICT exercise in T2DM patients. Six databases were used in this study: PubMed, Science Direct, Research Gate, SAGE Journals, Scopus, and Web of Science, which were then screened to meet the criteria for eligible studies. Out of 9,431 articles, 5 articles were deemed eligible for use in this study. In total, there were 5 qualifying studies, including 3 RCTs and 2 clinical trials.

Results: The effects of HIIT and MICT in reducing blood glucose levels were found to be significant in two studies, while the other two studies showed no significant effect. Bias analysis using RoB2 categorized most of the studies as low risk, although some studies raised concerns.

Conclusion: This study concludes that HIIT interventions show a more significant effect in reducing blood glucose levels compared to MICT. However, further research is needed to determine the optimal type and duration of HIIT to effectively manage blood glucose levels.

Keywords: Type 2 Diabetes Mellitus; Blood Glucose; Hyperglycemia, HIIT; MICT; Insulin Sensitivity; High-Intensity Interval Training; Moderate-Intensity Continuous Training

1. Introduction

Diabetes mellitus is a serious and chronic condition that occurs when blood sugar levels rise due to the body's insufficient production of insulin or the inability to use existing insulin effectively. Type 2 Diabetes Mellitus (T2DM) is the most common type, accounting for about 90% of diabetes cases worldwide. In T2DM, hyperglycemia results from the body's cells being unable to respond completely to insulin, a condition known as insulin resistance8. There are three types of diabetes complications, each with different mechanisms, although several factors are common to all complications. The main factor for all these complications is the elevated blood glucose levels. These three types of complications are macrovascular disease, microvascular disease, and neuropathy.13.

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Regular diet and moderate to high-intensity exercise can improve blood glucose levels within the cells of patients with Type 2 Diabetes Mellitus (T2DM). 15. According to (3), exercise performed without proper management and monitoring of blood glucose levels in individuals with T2DM who are taking diabetes medication risks causing hypoglycemia, Cardiovascular complications (5), and musculoskeletal injuries (2).

The effectiveness of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) compared to other physical exercise modalities. Studies show that both HIIT and MICT have positive effects on blood glucose control in individuals with T2DM (1), are effective in improving cardiovascular fitness (2), and in reducing body fat and managing body weight (10) in individuals with T2DM.

2. Material and methods

This study was conducted with a systematic review. The systematic review was formulated based on the PICOS standard (Population, Intervention, Comparison, Outcome, Study type). The PICO standard was used as a search strategy for journal articles that would be used in the study. Systematic review is carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PICO in this study are:

Population : HIIT and MICT exercise patterns

Intervention : Type 2 diabetes mellitus individuals

Comparison : Blood glucose levels before and after HIIT and MICT exercise pattern interventions

Outcome : Blood glucose levels before and after HIIT and MICT exercise pattern interventions

2.1. Research Population and Sample

The population used in this study is literature that examines HIIT and MICT exercise patterns on blood glucose levels in individuals both men and women who experience type 2 diabetes mellitus. The samples in this study are, The literature can be accessed as a whole (Full Text), The literature is written in Indonesian and English, The literature used was published in 2013-2023, The population in the literature is an individual with type 2 diabetes mellitus and the intervention of HIIT and MICT exercise patterns, The literature provides an overview of blood glucose levels before and after the intervention of HIIT and MICT exercise patterns.

2.2. Location and Time of Research

The study was conducted at the Faculty of Medicine, Universitas Airlangga from July to November 2023.

2.3. Literature Search and Selection

2.3.1. Literature Search

The literature used in this study was searched through several electronic databases, such as PubMed, Science Direct, Research Gate, SAGE Journals, Scopus and Web of Science to find relevant research literature with predetermined inclusion criteria.

2.3.2. Literature Selection

Studies will be selected according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart. The literature identification process starts from entering the literature that appears on electronic databases. Duplicate studies will be removed before going through the screening stage. In the screening process, literature will be screened through the abstract. Unsuitable literature will be removed. The next stage of screening is to read the entire literature. Appropriate literature will be assessed for eligibility. Literature that is not suitable for use in the research will be removed. Furthermore, the literature remaining during the screening process will enter the research stage.

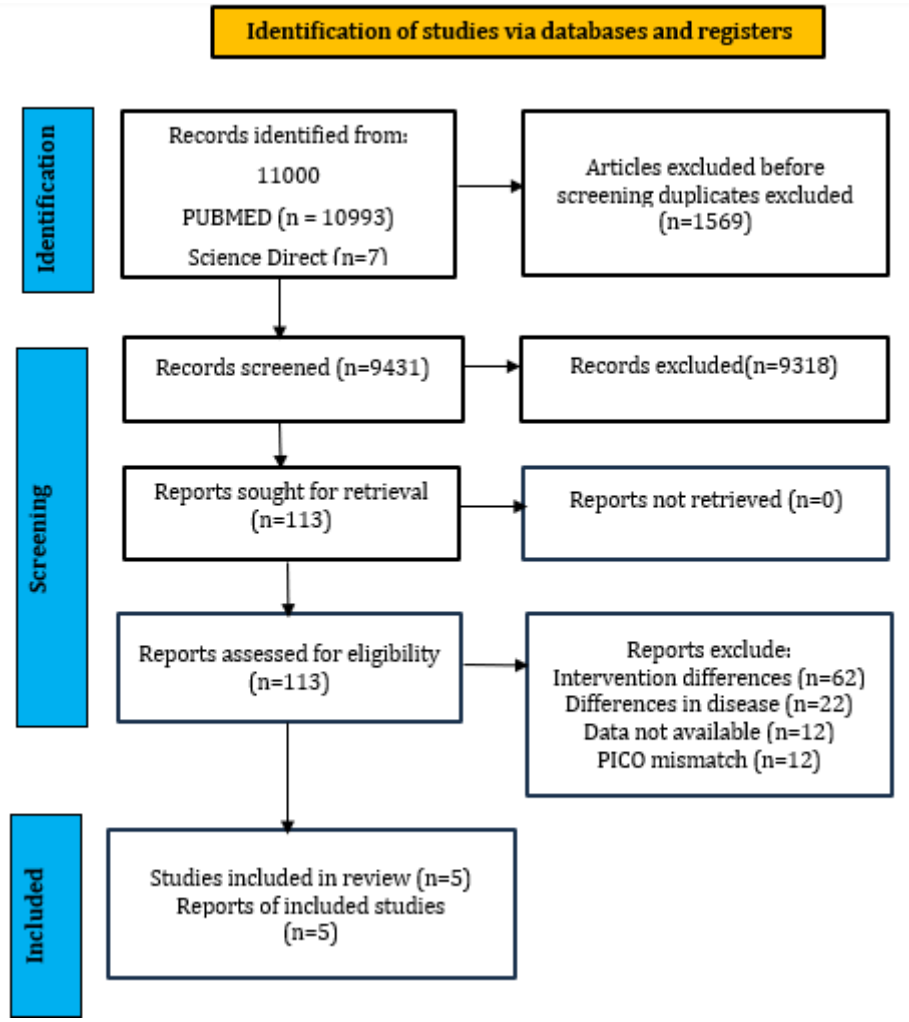

Figure 1 PRISMA flowchart

2.3.3. Quality Assessment

A quality assessment tool for quantitative studies from the Effective Public Health Practice Project (EPHPP) was used to assess the quality of the literature. The six general assessment components used in the literature quality assessment include selection bias, study design, confounders, blinding, data collection, methods, withdrawals and dropouts and two additional research components, namely intervention integrity and analyses. The quality of the literature is assessed based on certain indicators in each component. After the assessment is done, the literature will be divided based on its quality, namely strong, moderate, and weak.

3. Results and discussion

There were four studies that used HIIT and MICT interventions in their research and one study that only used HIIT intervention. All five studies stated the results of the HIIT intervention on blood glucose levels in patients with DM 2 was significant, while in the MICT intervention, three studies stated significant results and one study stated insignificant results because it only experienced a decrease in blood glucose levels by 5.07 mmol/mol with an unreported p value

3.1. Base Data

In this study, three databases were used, namely PUBMED, ScienceDirect, and Scopus. A total of 11,000 studies were found in the five databases used. In the first screening, 9,318 studies were filtered out based on the incompatibility of the title and abstract with this study. In the second screening, 108 studies were excluded based on PICO, different disease types, different interventions not in the form of HIIT and MICT exercise, and incomplete data. Five studies were included in this study. The selected studies were studies that discussed patients with type 2 diabetes mellitus with

interventions in the form of HIIT and/or MICT as well as two clinical trial studies and three randomised clinical trial studies.

The study conducted by (12) examined two groups with HIIT and MICT interventions. These two groups were differentiated based on the interventions performed in the form of different exercise intensities. Other studies that examined groups with HIIT and MICT interventions were studies by (11), (6), and (9). In these four studies, the comparative results of HIIT and MICT can be seen, as well as the significance of blood sugar reduction levels before and after the intervention.

3.2. Effects on HIT Intervention Patterns

In the last decade, HIIT has emerged, which is short bouts of high-intensity activity distinguished by low-intensity passive and active recovery times, with equal or even greater benefits for cardiometabolic health in healthy clinical populations over a shorter period of time. (7) HIIT has the potential to improve glucose control through exercise-induced increases in GLUT4 levels. The HIIT exercise intervention in (12) with a randomised controlled trial study where each individual in the study performed the intervention for 40 minutes per day for three weeks, showed significant results with a decrease in blood glucose from 160.17 ± 30.90 to 84.50 ± 11.00 (p value < 0.001). In study (9), each individual performed a treadmill with a duration of 60 minutes per session for five sessions a week and ran for four months. The results obtained from this study were significant with a decrease in blood glucose levels from 9.0 ± 0.9 to 8.7 ± 1.1 (p value < 0.05). The study by Gasparini and Santos was conducted with two versions of HIIT, long and short, the results of this study were significant in terms of a decrease in blood glucose levels by 32.14 mmol/mol (p value < 0.05) (6). Each intervention was conducted within fifteen minutes per session. The intervention was conducted at a frequency of five times per week with a duration of twelve weeks. The results obtained from this study were significant with a decrease in blood glucose levels from 7.80 ± 0.50 to 6.93 ± 0.33 (p value = 0.001) (11). The study conducted by Cassidy was conducted with a frequency of three sessions per week with a duration of 12 weeks. The intervention carried out in this study was 36 cycling sessions for 12 weeks (three sessions / week on non-consecutive days) at a local gym. The results obtained in this study were significant with a decrease in blood glucose levels by 2.8 mmol/mol, compared to 2 mmol/mol in the control group (P value = 0.03) (4).

Based on the results obtained from the studies (12), (9), (6), (11), and (4) on the decrease in blood glucose levels as an effect of HIIT interventions on individuals incorporated in the study, all expressed similarities, namely the results of a significant decrease with different p values. Judging from the p value of each study, the most significant is the HIIT intervention studied by (12).

3.3. Effects of MICT Intervention Patterns

Moderate-intensity continuous training (MICT) is commonly prescribed for the prevention and treatment of cardiometabolic diseases. However, this method is not suitable for overcoming the time constraints reported by physically inactive individuals. In the MICT exercise intervention in study (12), individuals engaged in the intervention for 40 minutes per day. The intervention ran for three weeks. Significant results were obtained with a decrease in blood glucose from 159.25 ± 24.62 to 90.92 ± 16.17 (p value < 0.0001). In study (9) Each individual performed a treadmill with a duration of 60 minutes per session with a continuous walking method with moderate intensity. This was done five sessions a week and ran for four months. The results obtained from this study were not significant with changes in blood glucose levels from 7.7 ± 0.6 to 7.9 ± 0.7 (P value = NR). MICT intervention by walking continuously at 70% vVO2 peak with a duration of fourteen minutes, with a frequency of two times per week and carried out within a period of two weeks. The results of this study were declared insignificant because it only decreased blood glucose levels by 5.07 mmol/mol (P value = NR) (6). Each intervention was conducted within thirty minutes per session with details of power cycling for three minutes for continuous training (50%-70% VO2 max). The intervention was conducted at a frequency of five times per week with a duration of twelve weeks. The results obtained from this study were significant because there was a decrease in fasting blood glucose levels from 7.60 ± 0.52 to 6.83 ± 0.44 (p value = 0.001) (11).

Based on research conducted by (12), (11), (6), and (9) stated different results, two studies (12) and (11) stated significant results in reducing blood glucose levels, but the results of research (9) and (6) stated insignificant results in reducing blood glucose levels in the individuals studied.

3.4. Comparison of HIIT and MICT

High intensity interval training has been shown to be more beneficial than MICT in individuals with type 2 diabetes mellitus (T2DM). HIIT has been shown to improve insulin sensitivity to a greater extent than MICT. High-intensity exercise intervals followed by rest periods in HIIT can stimulate greater metabolic adaptations, leading to improved

glucose regulation and insulin sensitivity. (1), provide greater improvements in aerobic capacity (VO2 max) compared to MICT (2), time efficient exercise due to shorter exercise duration compared to MICT. HIIT is a safe and effective exercise recommended for patients with DM2 (type 2 diabetes) to improve their functional capacity, body weight, BMI, blood pressure, VO2max and HbA1c (14).

4. Conclusion

In all five studies, it was found that HIIT had a more significant effect when compared to MICT on reducing blood glucose levels in individuals with type 2 diabetes mellitus. HIIT exercise pattern had a significant positive effect in all studies, while MICT exercise pattern had a significant positive effect in two studies and not significant in the other two studies on reducing blood glucose levels in individuals with type 2 diabetes mellitus of the improvement in peripheral insulin sensitivity, improvement in mean blood glucose and HbA1c due to exercise is the synergistic effect between insulin and muscle contraction that stimulates the redistribution of GLUT4 from cytoplasmic vesicles through the sarcolemma, allowing for more glucose uptake by muscle, and increasing peak VO2 after exercise correlates with a decrease in HbAlc. more by the muscle, and increasing peak VO2 after exercise correlates with decreasing HbAlc.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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