

## Efficacy of Aerobic & Resistance Exercises on Type-II Diabetes Mellitus Patients – A Systematic Review

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### ABSTRACT

**Aim:** To determine the efficacy of aerobic & resistance exercise on type-II diabetes mellitus patients.

**Method:** Google Scholar, Pub Med, MEDLINE, CINAHL, SPORT Discus, LILACS, SCIELO, etc. were searched for the studies conducted between 2012 –2022. Literature reviews and randomized control trials were included that investigate the efficacy of aerobic & resistance exercise on type-II diabetes mellitus patients.

**Result:** A combination of aerobic and resistance exercises showed improved results in type II Diabetes Mellitus patients than aerobic and resistance exercises alone or no exercise at all.

**Conclusion:** The results from this systemic review led to the conclusion that when aerobic exercises are combined with resistance exercises or with standard physiotherapy treatment show better results in improving their physical function and decreasing the harmful effects of diabetes mellitus.

**Keywords:** Aerobic exercise, Resistance exercise, Combination exercise, and Diabetes Mellitus

### INTRODUCTION

One of the non-communicable diseases with the fastest rate of growth in the globe is type 2 diabetes mellitus (T2DM). Maintaining a healthy weight, eating nutritious food, and engaging in exercise are all advised for T2DM prevention<sup>(1)</sup> Along with a healthy diet and effective medications, exercise is regarded as a cornerstone of type 2 diabetes mellitus management. Exercise has been shown to significantly improve glycemic management, blood lipid profiles, and other

outcomes in this population; however, the relative benefits of various exercise modalities are less clear. For those with type 2 diabetes, both resistance and aerobic activities are advised as effective treatments. To guide clinical judgment and enable customized exercise prescriptions, it is still necessary to identify the best type of exercise for the disease.<sup>(1,2)</sup>

There is ample evidence to support the recommendation of aerobic (cardio-respiratory) activities in the majority of

T2DM preventive regimens. Large-scale preventative trials like the Diabetes Preventative Program (DPP) revealed improvements in risk factors like weight and insulin sensitivity as well as reductions in T2DM incidence of up to 58%.<sup>(3)</sup> Diabetes patients must engage in aerobic exercise, which has the benefits of being inexpensive and flexible with time. Blood glucose levels can be decreased with aerobic exercise. It is challenging to assess the relative efficacy of different aerobic activities because there aren't enough controlled trials to compare their effects.<sup>(2,3)</sup> For those with type 2 diabetes (T2D), resistance training (RT) is an effective intervention for glucose management and cardiometabolic health.<sup>2</sup> However, the use of RT in patients at risk for T2D to prevent or postpone the onset of T2D, as well as the most beneficial RT program features, is yet unclear. Based on evidence gathered over the past ten years, resistance training (RT) has more recently been recommended for people with type 2 diabetes (T2DM).<sup>(2-4)</sup> RT has been shown to have advantages including improved fasting plasma glucose (FPG), glycosylated hemoglobin (HbA1C), insulin sensitivity, and the maintenance of fat-free mass during energy restriction for weight loss.<sup>(4)</sup>

Current T2DM prevention and management guidelines prescribe at least 150 minutes per week of moderate-vigorous aerobic exercise and two (preferably three) RT sessions per week (at least 60 minutes). Aerobic exercise, which activates large groups of muscles and includes brisk walking, cycling, swimming, and jogging, has historically been the most

researched.<sup>(2,4,5)</sup> 80% of persons with type 2 diabetes, on the other hand, are overweight or obese, and many have mobility issues, peripheral neuropathy, vision impairment, or cardiovascular illness. For some people, achieving the requisite volume and intensity of aerobic exercise may be impossible, and resistance exercise may be more viable.<sup>(3-5)</sup>

Resistance exercise is a type of exercise that employs muscular power to move a weight or work against a resistive load, resulting in isolated, short activity of single muscle groups. It has gained popularity in the recent decade.<sup>(4,5,6)</sup> Many studies have found that combining aerobic and resistance training has additive advantages on glucose management and can yield higher reductions in T2DM incidence than a single exercise modality. Multi-component (diet + aerobic activity + RT) lifestyle therapies, on the other hand, have the potential to become too demanding, thus jeopardizing program adherence. Furthermore, the long-term effectiveness of multi-component programs is unknown.<sup>(6)</sup> As a result, the purpose of this systematic review was to synthesize the data on the efficacy of lifestyle programs that included aerobic exercise + RT components in type II diabetes mellitus populations. This study specifically examines the impact of these therapies on weight loss, glucose management, and exercise outcomes. This goal must be met to verify the evidence supporting existing exercise guidelines for T2DM prevention.<sup>(5)</sup> Current management of T2DM involves lifestyle modification, pharmacotherapy, and in some cases, insulin therapy. While pharmacotherapy is effective in controlling blood glucose

levels, it does not address the root cause of insulin resistance and may have adverse side effects. <sup>(4)</sup> Lifestyle modifications, particularly diet and exercise, are crucial in managing T2DM, yet adherence to these interventions remains a challenge. <sup>(6)</sup>

This systematic review evaluated the efficacy of aerobic and resistance exercises in managing T2DM. It synthesized existing research, providing a clear understanding of evaluating which form of exercise (aerobic, resistance, or combined) is more effective in improving glycemic control and reducing insulin resistance, evidence-based guidelines for exercise prescription tailored to T2DM patients' needs, assessing the impact and long-term benefits of these exercises on the overall quality of life and well-being of T2DM patients.

## MATERIALS AND METHODS

### Literature search strategy

Databases like Google Scholar, Pub Med, MEDLINE, CINAHL, SPORT Discus, LILACS, SCIELO, etc. were searched using combinations of the keywords:

'Combination exercises', and 'Diabetes Mellitus'. This literature search was conducted from January 2012 to July 2022.

### Inclusion and Exclusion Criteria

The inclusion criteria of the present study were: (a) Those articles in which the following keywords are used: aerobic exercises', 'resistance exercises', 'combination exercises', 'Diabetes Mellitus II'. (b) The search was limited to the years 2012-2022 written in the English language. Studies were excluded based on the following criteria: (a) Reviews and studies with only abstracts were excluded.

### Data extraction and analysis

In the first phase, the eligibility of each retrieved record was assessed based on the title and abstract. Then, the full-text articles were screened. In the second phase, all included studies were subsequently re-screened by reading the full-text articles. After double screening, a total of 10 studies were included in this review [Table/Fig-1].

### Description of Included Studies

After the double screening of full-text articles, 10 studies were included in the review as a summary of included articles which is shown in [Table/Fig-2].

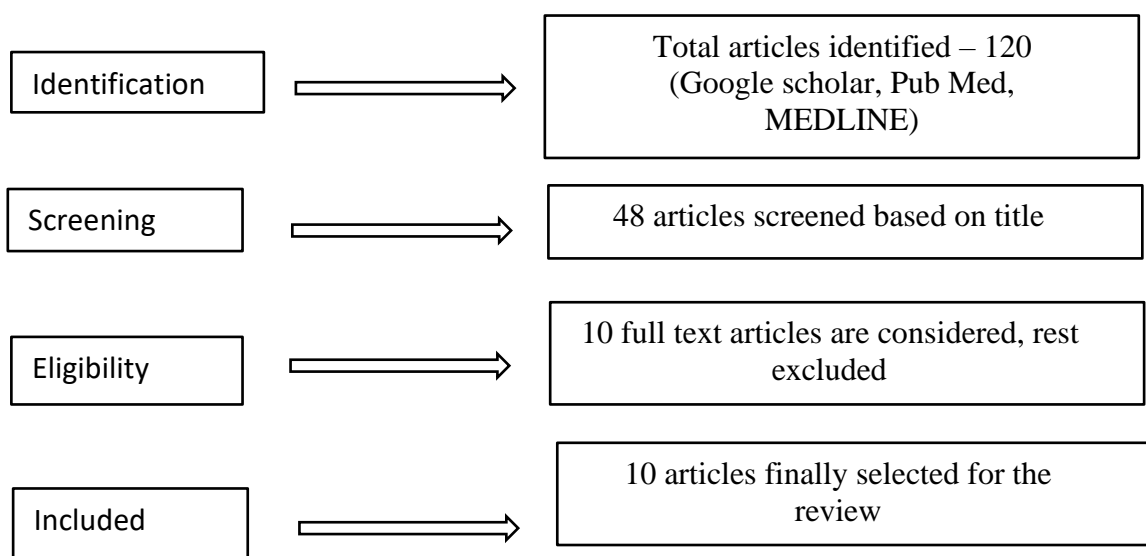


Fig1: The process of selection of studies

AUTHOR	TITLE	SUBJECT	DESIGN	OUTCOME MEASURES	CONCLUSION
Xiaoyun et al. (2022) <sup>3</sup>	The effects of aerobic exercise combined with resistance training on inflammatory factors and heart rate variability in middle-aged and elderly women with type 2 diabetes mellitus.	N=30 Control group- hypoglycemic drugs Exercise group- hypoglycaemic drugs + Aerobic Exercise + Resistance Training	RCTs	Fasting plasma glucose (FBG), 2-Hour plasma glucose (2hPG), Serum inflammatory factors, C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ )	Blood glucose and serum inflammatory markers were significantly lower after combining resistance training with aerobic exercise.
Terauchi et al (2021) <sup>4</sup>	A randomized controlled trial of a structured program combining aerobic and resistance exercise for adults with type 2 diabetes in Japan	N=228 Standard therapy group–Standard exercise protocol Supervised exercise group –aerobic and resistance exercises	RCTs	HbA1c, FBG, Glycol albumin, fasting insulin, homeostatic model assessment of insulin resistance, LDL, HDL, height, body weight, waist circumference, blood pressure, pulse rate, and ECG.	The supervised exercise group showed more improvement in the outcome measures of patients with T2DM.

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AUTHOR	TITLE	SUBJECT	DESIGN	OUTCOME MEASURES	CONCLUSION
Jamshidpouret al (2019) <sup>5</sup>	The effect of aerobic and resistance exercise training on the health-related quality of life, physical function, and muscle strength among haemodialysis patients with type 2 diabetes.	N=28 (diabetic chemo dialysis patients)  Control group–No intervention  Exercise training groups – aerobic + resistance exercise	RCTs	6-Minute Walk test, hand- Held Digital Dynamometer and Short Form Health Survey (SF-36)	The improvement of physical function and lower limb muscular strength in diabetic chemodialysis patients appears to be facilitated by combined aerobic resistance exercise training.
Annibalini et al (2017) <sup>6</sup>	Concurrent aerobic and resistance training has anti-inflammatory effects and increases both plasma and leukocyte levels of IGF-1 in Late Middle-Aged Type 2 Diabetic Patients.	N=16  Intervention group– aerobic and resistance training program  Control group –usual diabetes care advice.	RCTs	Body composition, blood pressure, total cholesterol, plasma levels of adipokines, leptin, RBP4, pro-inflammatory markers IL6, TNF- $\alpha$ , MCP-1, and IGF-1	The metabolic anomalies associated with T2 DM are Improved by concurrent aerobic and resistance exercise, which also has the potential to lessen the negative health consequences of inflammation associated with diabetes.

AUTHOR	TITLE	SUBJECT	DESIGN	OUTCOME MEASURES	CONCLUSION
Aguiaretal (2016) <sup>7</sup>	Efficacy of the Type 2 Diabetes prevention using a lifestyle education program	N=101  Control group–No intervention  Intervention group – aerobic + Resistance training + Diet modification	RCTs	Weight loss, glycated haemoglobin BMI, waist circumference, body fat percentage,  Fasting plasma glucose, aerobic fitness, squat box test for lower body muscular fitness, seated shoulder press for upper body muscular fitness	The intervention group showed improvement in several risk factors for Type 2 diabetes mellitus.
Earnest et al (2015) <sup>8</sup>	Aerobic and strength training in concomitant metabolic syndrome and Type 2 Diabetes	N=262 Aerobic stretching and relaxation Resistance–of strength training exercises Combined treadmill walking + exercise	RCTs	Metabolic syndrome scores	Aerobic and AER + RES training groups showed significant improvement in metabolic syndrome scores.

AUTHOR	TITLE	SUBJECT	DESIGN	OUTCOME MEASURES	CONCLUSION
Liu et al (2015) <sup>9</sup>	Effects of Combined Aerobic and Resistance Training on the Glycolipid Metabolism and Inflammation Levels in type2 diabetes mellitus	N=42  Conventional therapy group–drug therapy + diet control  Intensive therapy group–drug therapy + diet control + Aerobic + resistance training	RCTs	Oral glucose tolerance test, cardiopulmonary exercise testing, qPCR, western blotting, ELISA, blood glucose, postprandial insulin, glycated Haemoglobin level, and insulin resistance	Combined aerobic and resistance training groups showed improvement in glycolipid metabolism and reduced low-grade inflammation in patients with diabetes mellitus patients.
Simpson et al. (2015) <sup>10</sup>	Graded Resistance Exercise and Type 2 Diabetes in Older Adults	N=103  Sham exercise control group–non-progressive, low-intensity training. Power training intervention–power training	RCTs	HbA1c, homeostatic model assessment 2, body composition, adipokines, muscle morphology, metabolism, measures of energy expenditure, fat oxidation, neuro-psychological function, cardiovascular health status, quality of life, dietary intake	Power training could be a workable supplemental treatment for enhancing glycemic control in the rising T2D epidemic in older persons.



AUTHOR	TITLE	SUBJECT	DESIGN	OUTCOME MEASURES	CONCLUSION
Sanghani et al (2013) <sup>11</sup>	Impact of lifestyle modification on Glycaemic Control in Patients with Type 2 diabetes mellitus	N=279 Control group –diet modification Unstructured activity group– supervised exercise training + diet modification Structured exercise Group– aerobic + resistance exercise + diet modification	RCTs	HbA1c, BMIS. B.P., D.B.P., HDL-C, LDL-C, Triglycerides, Total-cholesterol, Waist circumference, Hip circumference e, Total body fat,	Both structured and unstructured training provides benefits, but The structured exercise group was associated with a significant change in the parameters.
Yavari et al. (2012) <sup>12</sup>	Exercise and Type 2 Diabetes	N=80 Four groups (n=20 each) aerobic, resistance, combined training, and control.	RCTs	HbA1c, post-prandial glucose, blood pressure, VO2 max, and muscular percentage.	The combined training group is associated with greater positive changes.

## DISCUSSION

The data analysis indicates that resistance and aerobic exercise are beneficial for increasing muscular strength, glucose tolerance, glycosylated hemoglobin levels, and modest weight loss.<sup>(13–15)</sup> Because the effects of the therapies on muscular fitness and physical activity were not always documented, it was difficult to determine how these changes affected glucose control.<sup>(14-17)</sup>

Research studies differed in how they reported their workout routines; most of them only provided broad descriptions of their regimens.<sup>(17-20)</sup> For instance, "The supervised exercise group has also been

provided with supervised, progressive, individually tailored aerobic exercise programs and circuit-type resistance training sessions for 1 hour twice a week".<sup>(21-25)</sup> Because of this, it might be difficult to determine the exact resistance training exercise modalities that were employed (such as body weight, free weights, isometric, isokinetic, and resistance band exercises) and the necessary volume (load, repetitions, and sets).<sup>(24-27)</sup>

In most trials, exercise sessions for either individuals or groups were under supervision.<sup>(28)</sup> Few healthcare facilities can afford to offer programs for



professional staff monitoring, therefore this has implications for these initiatives' distribution costs, feasibility, and practicability in community and hospital settings. The benefits of exercise were not consistently measured in each study

One notable limitation of earlier research is the dearth of studies assessing physical activity with objective measurements (e.g., pedometers or accelerometers). Compared to control groups, self-reported levels of physical activity rose greater in intervention groups. <sup>(25, 27, and 28)</sup>

Aerobic exercise testing is the most widely used fitness indicator to estimate or measure VO<sub>2</sub> max, and improvement in aerobic fitness was usually observed in the intervention groups. <sup>(28,29)</sup> Without assessing muscular performance, including upper and lower body muscle groups, it is challenging to determine whether the RT program was followed or whether its inclusion in multi-component programs contributes to improvements in glycemic control and muscular fitness in populations with pre-diabetes, as has been demonstrated in adults with type 2 diabetes. <sup>(30-32)</sup>

## CONCLUSION

Research has focused less on the benefits of resistance and aerobic exercise for individuals with Type-II Diabetes Mellitus. Multi-component lifestyle interventions, comprising aerobic and resistance exercise training and dietary modifications, are only moderately effective in improving impaired fasting glucose, improving glucose tolerance, and improving dietary and exercise outcomes in adult populations of at-risk and pre-diabetic adults. In T2DM patients with DCAN, combining aerobic exercise and resistance training enhanced autonomic nerve function, lowered blood glucose and serum inflammatory markers, and raised HbA1c.

## LIMITATION(S)

This meta-analysis only included research that was published in English, which could have led to the exclusion of pertinent studies carried out in other languages. This meta-analysis's studies were done in a range of populations and environments, which can restrict how broadly the results can be applied to other groups or environments.

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