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EFFECTIVENESS OF FARTLEK TRAINING ON CARDIOVASCULAR FITNESS IN TYPE 2 DIABETES - A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a growing public health concern worldwide, with reduced physical activity and obesity being major contributors. Regular exercise is well recognised for improving glycaemic control and cardiovascular health. However, evidence regarding the role of Fartlek training—a flexible, variable-intensity aerobic exercise—remains limited in diabetic populations.

Aim: To evaluate the effectiveness of Fartlek training on cardiovascular fitness in individuals with type 2 diabetes**.**

Methods: A randomised controlled trial was conducted on 120 participants with T2DM, aged 44–60 years. Participants were randomly assigned to two groups: Group A (Fartlek training) and Group B (conventional walking program). Both groups underwent 20 supervised sessions over five weeks. Cardiovascular fitness was assessed pre- and post-intervention using VO_2max values derived from the 6-minute walk test. Statistical analysis was performed using SPSS v27, with significance set at $p < 0.05$.

Results: Both groups showed significant improvements in VO_2max after the intervention. However, participants in the Fartlek training group demonstrated greater gains, with intergroup comparison showing a statistically significant difference ($p = 0.041$) and a moderate effect size ($r = -0.289$).

Conclusion: Fartlek training proved more effective than conventional walking in improving cardiovascular fitness among individuals with type 2 diabetes. Its adaptable structure and superior outcomes suggest it can serve as a practical and scalable exercise strategy for managing diabetes and reducing cardiovascular risks.

INTRODUCTION

The burden of diabetes is high and increasing globally, and in developing economies like India, it is mainly fueled by the increasing prevalence of overweight/obesity and unhealthy lifestyles. The estimates in 2019 showed that 77 million individuals had diabetes in India, which is expected to rise to over 134 million by 2045. Type 2 diabetes, which constitutes 90% of all cases of diabetes, was earlier considered to be a disease of the affluent "Western" countries, but has now spread globally, and has become a major cause of disability and death, affecting even younger age groups. [1]

A reduction in daily physical activity may lead to obesity and insulin resistance, which are key components of metabolic syndrome. This syndrome predicts an increased risk of developing type 2 diabetes mellitus (T2DM) and cardiovascular diseases, as well [2]

Hyperglycemia is closely associated with the occurrence of diabetic complications, especially for patients with type 2 diabetes mellitus (T2DM), so controlling blood glucose is an important goal in the treatment of T2DM patients. Among the various forms of physical exercise, walking is widely accepted by T2DM patients because of its low cost, safety profile, and convenience. It can be performed with different intensities and speeds, requires no specific skills, and has comparatively minimal adverse effects. [3]

Exercise has significant effects on the metabolism of nutrients. It diminishes the blood glucose levels and plays an important role in the treatment of patients with diabetes. Regular exercise may improve glycemic control, reduce cardiovascular risk factors, play a role in weight loss and, consequently, improve well-being among these patients. [4]

It is well established that patients with a diagnosis of type 2 diabetes have low VO2max values when compared with healthy age-matched controls. Specific pathogenic mechanisms such as hyperglycemia, low capillary density, alterations in oxygen delivery, increased blood viscosity, or the presence of vascular and neuropathic complications may also contribute to the decreased VO2max. [6]

Fartlek, which means "speed play" in Swedish, is a training method that blends continuous training with interval training. Fartlek runs are a very simple form of a long-distance run. Fartlek training is simply defined as periods of fast running intermixed with periods of slower running."[7]

The aerobic, anaerobic, and anaerobic system gets activated due to fluctuations in intensity and pace.[8] Studies have shown that Maximum oxygen consumption is reduced due to obesity, as there is decreased body metabolism. Studies have also suggested that VO2 max is reduced in the obese population. There is a lack of evidence that shows the effect of Fartlek training in the non-athletic young population. Little literature has shown the effect of Fartlek training on maximum oxygen consumption in young obese.[8]

NEED OF STUDY

Exercise is vital for managing type 2 diabetes; however, current protocols vary widely, lacking a standardised approach in terms of intensity and duration. Fartlek training, though well-studied in athletes, remains under-researched in diabetic populations. Its flexible and scalable nature may offer significant metabolic and fitness benefits. This study aims to fill the gap by evaluating the effectiveness of a structured Fartlek training protocol for individuals with type 2 diabetes, to develop a more definitive and applicable exercise model.

AIM AND OBJECTIVES

AIM: To See the Effectiveness of Fartlek Training on Cardiovascular Fitness in Type 2 Diabetes

OBJECTIVE: To evaluate the role of fartlek training on cardiovascular fitness in middle-aged individuals with type II diabetes.

METHODOLOGY

Ethical Approval and Trial Registration

The study protocol was reviewed and approved by the **Institutional Ethics Committee for Human Research, Parul University (PU-IECHR)**. The trial was prospectively registered with the **Clinical Trial Registry-India (CTRI)** under reference number **CTRI/2024/09/074350**. Written informed consent was obtained from all participants before enrolment. This study adopted an interventional, comparative design with two parallel groups undergoing different aerobic training protocols over a period of five consecutive weeks. Participants were randomly assigned to two groups: **Group A (Fartlek Training Group)** and **Group B (Conventional Training Group)**. Each participant was scheduled to attend four supervised sessions per week, resulting in a total of 20 sessions. Both groups followed exercise sessions of equal duration (55 minutes), which included a warm-up, main exercise, and cool-down phase.

Eligible participants included individuals with a pre-diagnosis of type 2 diabetes mellitus (T2DM), both male and female, aged between 44–60 years, willing to participate, and not enrolled in any other clinical study in the past year. Participants were excluded if they had recent musculoskeletal injuries, showed signs of sensory loss or symptoms of diabetic neuropathy, or had a diagnosed cardiovascular or respiratory illness

General Protocol Structure

Each session comprised the following segments:

- **Warm-up**: 5 minutes
- **Main Training Session**: 45 minutes
- **Cool-down**: 5 minutes

Warm-Up Session

The warm-up session was identical for both groups and lasted for 5 minutes. It consisted of mobility exercises targeting the neck, trunk, and limbs to prepare the body for aerobic activity. Each of the following exercises was performed for **10 repetitions:**

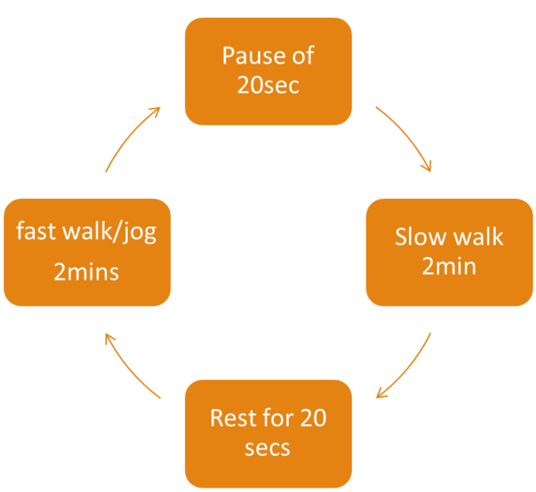
- Neck and trunk tilt
- Neck and trunk tilt side-to-side
- Neck and trunk rotation (left and right)
- Arm circles
- Marching on the spot

Group A: Fartlek Training Protocol

Participants in Group A underwent a progressive Fartlek training program tailored for 5 weeks, with intensity monitored using the **Borg Rating of Perceived Exertion (RPE) Scale**.

TABLE 1: GENERAL PROTOCOL STRUCTURE

WEEK	WARM-UP	WORK PERIOD	NUMBER OF REPETITIONS	ACTIVE RECOVERY PERIOD BETWEEN REPETITIONS	NUMBER OF SETS	RECOVERY BETWEEN SETS	COOL DOWN
1 &2	5 MINS	44MINS	3	240 SEC DECREASE WITH 20 SEC	3	2MIN	5 MINS
3&4	5MINS	33 MINS 30 SECONDS	3	195 SEC DECREASE WITH 15 SEC	3	2MIN	5 MINS
5	5MINS	44 MINS	3	240 SEC DECREASE WITH 20 SEC	3	2MIN	5 MINS



Group B: Conventional Training:

Subjects in the conventional training group were instructed to follow a walking program for a period of five weeks. The program began with 15 minutes of walking per session, with the duration progressively increased by 10 minutes every two weeks, reaching up to 45 minutes per session by the end of the intervention. Each walking session also included a warm-up and cool-down phase lasting 5–10 minutes, similar to the experimental group.

RESULTS

A total of 120 participants diagnosed with type 2 diabetes mellitus were enrolled in the study and evenly divided into two groups: Group A (Conventional Training) and Group B (Fartlek Training), with 60 participants in each group. Amongst them 2 participants were dropped out from Group A and 3 were dropped out from Group B. Baseline demographic characteristics such as age, gender distribution, and duration of diabetes were taken at the time of assessment ensuring homogeneity.

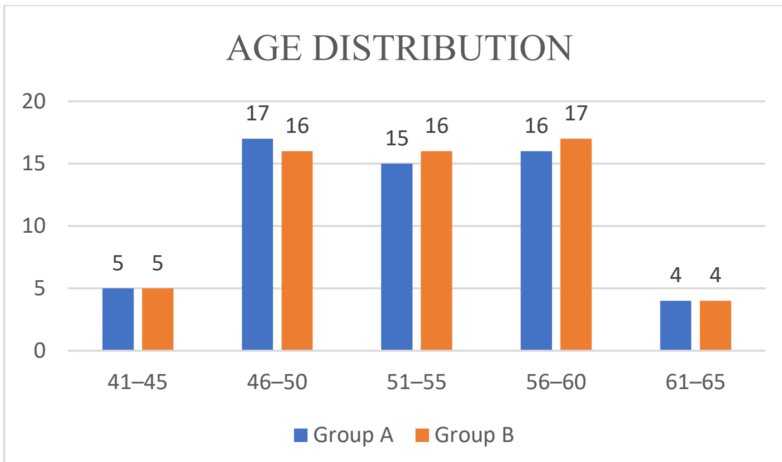
The participants were assessed cardiovascular endurance measured by the 6-minute walk test, The Data was entered in excel sheet and all the statistical analysis were done using SPSS version 27. The data were checked for the normality with the **Shapiro-Wilk test** was used which and **Variables that are normally distributed\, Pre VO2 max** (p = 0.204). **Post VO2 max** (p = 0.095) and **Age** (p = 0.011), **Weight** (p = 0.012), **Duration of DM-2** (p = 0.001),

The effect size was calculated with this formula:

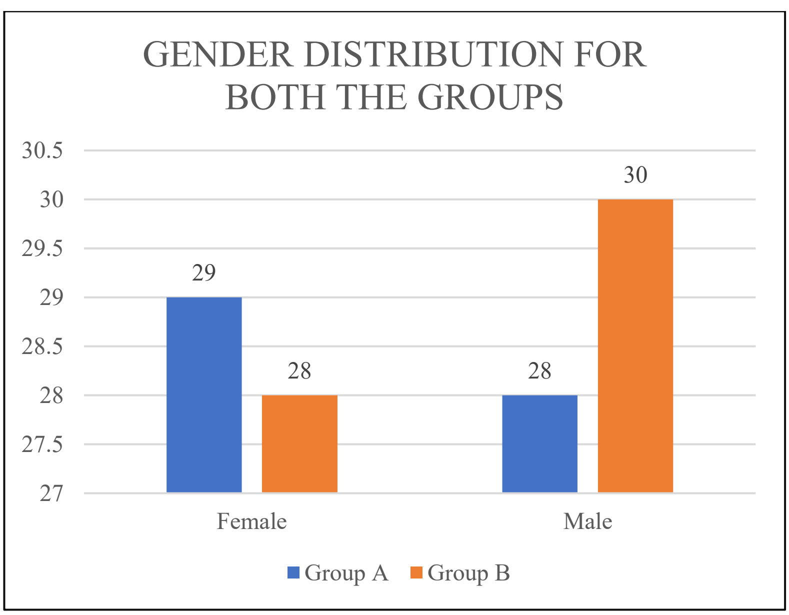
$$r = \frac{|Z|}{\sqrt{N}}$$

Where:

- Z= (from the Mann-Whitney U test results)
- N= (sample size)
- The age distribution of participants across both groups was comparable, with the majority falling within the 46-50 and 56-60 age ranges
- Group A with 17 and 16 participants in these age ranges, respectively Whereas Group B had the highest representation in the 46-50 age group (n = 16), followed closely by 56-60 (n = 17)



GRAPH 1: AGE DISTRIBUTION



GRAPH 2: GENDER DISTRIBUTION

Group	Female	Male
Group A	29	28
Group B	28	30

TABLE 2: GENDER DISTRIBUTION IN BOTH GROUP

Variable	Group A Mean	Group A SD	Group B Mean	Group B SD
Age (years)	51.67	5.14	51.77	5.24
Height (cm)	160.62	7.22	161.14	10.24
Weight (kg)	75.33	11.39	71.35	11.18
Duration of Type-2 DM	5.4386	2.50726	5.0345	2.51288

TABLE 3: BASELINE CHARACTERISTICS OF THE DATA

The above table shows the baseline characteristics of the study participants in Group A (Fartlek training) and Group B (conventional training).

- The average age in both groups was almost the same—51.67 years in Group A and 51.77 years in Group B—showing that participants were well-matched in terms of age. The mean height was also similar between the groups, with Group A at 160.62 cm and Group B at 161.14 cm. In terms of weight, Group A had a slightly higher average (75.33 kg) compared to Group B (71.35 kg).
- The standard deviation values indicate that the variation in age, height, and weight within each group was acceptable. Overall, the data confirms that both groups were comparable at the start of the study, making the outcome comparisons more reliable.

TABLE 4: BASELINE CHARACTERISTICS OF THE DATA

Variable	Group A Mean	Group A SD	Group B Mean	Group B SD

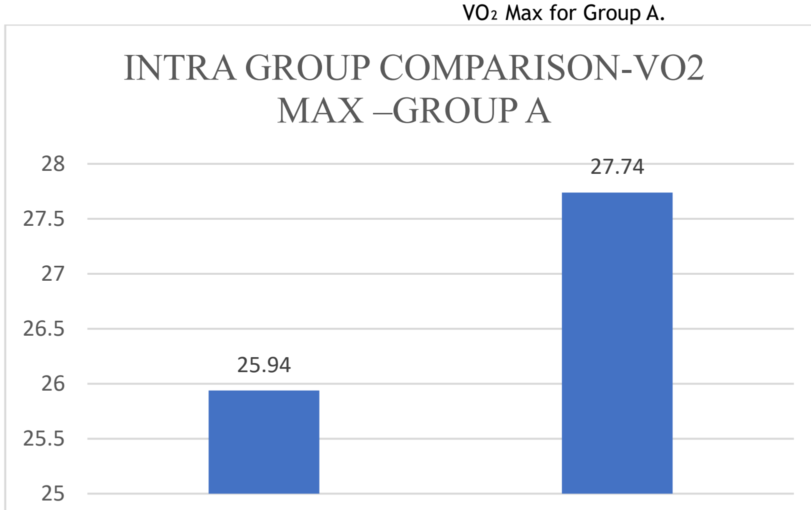
Age (years)	51.67	5.14	51.77	5.24
Height (cm)	160.62	7.22	161.14	10.24
Weight (kg)	75.33	11.39	71.35	11.18
Duration of Type-2 DM	5.4386	2.50726	5.0345	2.51288

INTRA-GROUP COMPARISON OF VO2 MAX -GROUP A

The results of the Related-Samples Wilcoxon Signed Rank Test for VO_2 Max before and after the intervention in Group A indicate a statistically significant improvement.

With 58 participants, the test showed a p-value of 0.000, confirming a highly significant difference between pre- and post-intervention VO_2 Max values.

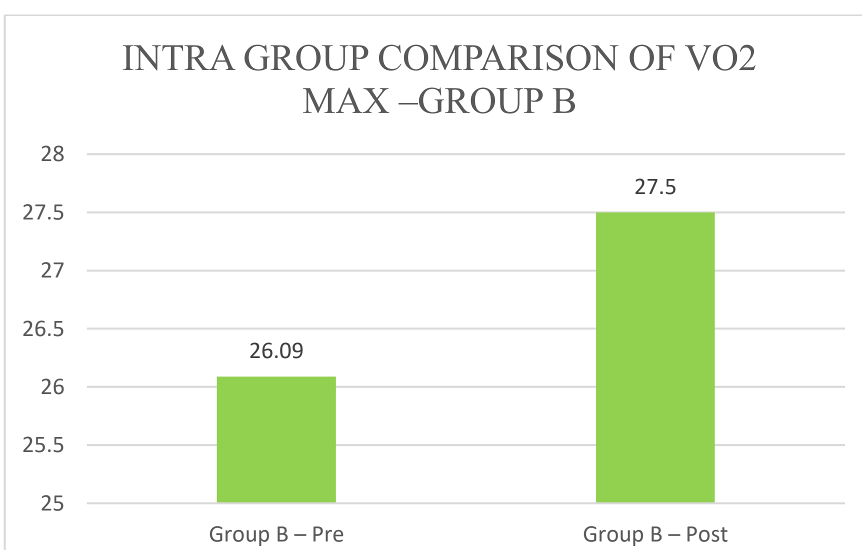
The standardized test statistic of 6.490 reflects a strong positive effect, suggesting that the intervention significantly increased VO_2 Max for Group A.



GRAPH 3: INTRA-GROUP COMPARISON OF VO2 MAX -GROUP A

INTRA-GROUP COMPARISON OF VO2 MAX -GROUP B

With 58 participants, the test produced a p-value of 0.000, indicating that the difference in VO2 Max scores before and after the intervention is significant.



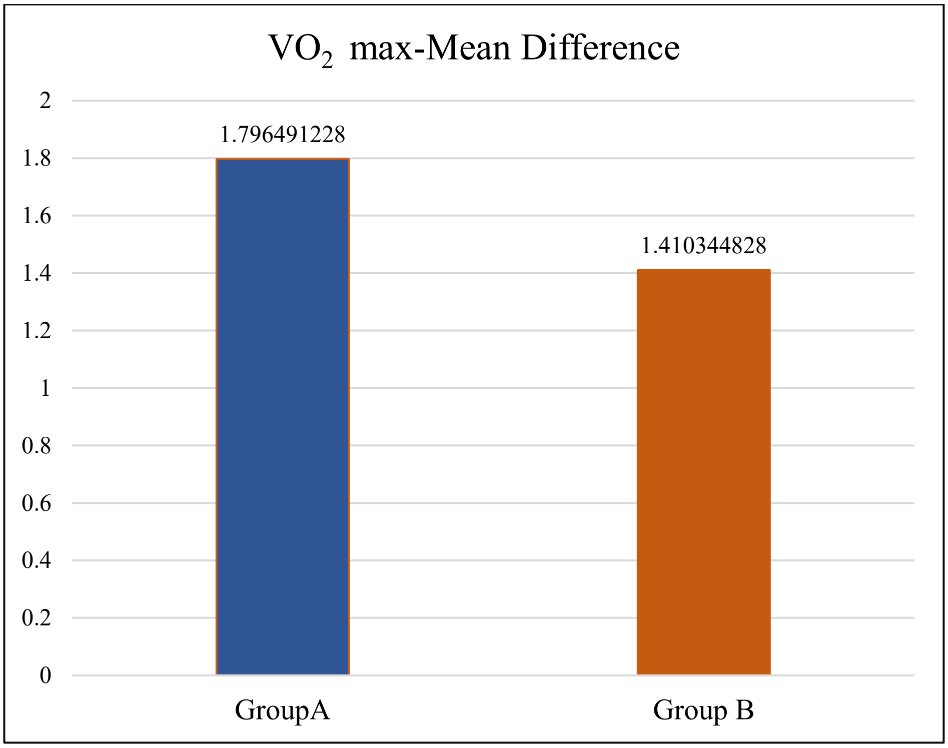
GRAPH 4: INTRA-GROUP COMPARISON OF VO2 MAX -GROUP B

INTER GROUP COMPARISON VO2 MAX- GROUP A AND B

The Mann-Whitney U test for VO_2max yielded a U value of 1288 and a **p-value of 0.041**, indicating a **statistically significant difference** in VO_2max between the two groups.

The **negative Z-value (-2.044)** suggests that **Group A** had better outcomes and showed greater improvement in aerobic capacity compared to Group B.

The **effect size (r = -0.289)** indicates a **moderate effect**, meaning that the difference between the groups is both statistically and practically meaningful.



GRAPH 5: INTER-GROUP COMPARISON OF VO2 MAX- GROUP A & B

DISCUSSION

This study examined the effects of a structured Fartlek training program on cardiovascular fitness in individuals with type 2 diabetes mellitus. After five weeks of training, both the Fartlek and conventional aerobic groups demonstrated significant improvements in VO_2max. Notably, the Fartlek group achieved greater gains, with a moderate effect size, indicating that variable-intensity aerobic protocols may provide superior cardiovascular benefits compared to continuous exercise.

Fartlek training, characterized by alternating bouts of fast and slow running, combines elements of continuous and interval training, thereby engaging both aerobic and anaerobic systems (Billat, 2001). This dual stimulus promotes greater peripheral adaptations, including enhanced capillary density, mitochondrial biogenesis, and improved oxygen utilization in skeletal muscle (Holloszy, 2005). Such physiological mechanisms likely explain the superior improvements in VO_2max observed in our Fartlek training group compared to conventional continuous training.

These findings are consistent with prior studies reporting that interval-based or variable-intensity exercise produces greater improvements in cardiorespiratory fitness than moderate-intensity continuous exercise (MICE). Weston et al. (2014) demonstrated that high-intensity interval training (HIIT) significantly improved VO_2max in patients with metabolic syndrome and T2DM, surpassing the benefits of MICE. Similarly, little et al. (2011) showed that just two weeks of interval training improved insulin sensitivity and muscle oxidative capacity in T2DM patients. Our findings extend this evidence by highlighting the applicability of Fartlek—a less structured, more adaptable variant of interval training—in middle-aged diabetics.

Improvements in **VO_2max** are particularly meaningful for people with type 2 diabetes, as low cardiorespiratory fitness is a well-established predictor of both cardiovascular disease and overall mortality (Kodama et al., 2009). Research shows that even small increases in VO_2max (around 3–5 mL/kg/min) can bring about significant reductions in cardiovascular risk (Blair et al., 1996). In this context, the improvement seen in the Fartlek training group is not just a statistical outcome but a change with real clinical importance. Such gains may help lower disease complications, enhance day-to-day functioning, and ultimately improve quality of life for individuals living with type 2 diabetes.

In individuals with type 2 diabetes, aerobic exercise consistently raises insulin sensitivity and cardiorespiratory fitness (CRF), and increases in CRF are linked to lower cardiovascular and all-cause mortality in this population.(9)

Previous studies have demonstrated that Fartlek-style and interval-based training increase aerobic capacity more quickly and frequently to a greater degree than continuous moderate-intensity training.(10)

The biological plausibility of comparable benefits from Fartlek training in this clinical population is supported by randomized and controlled trials in individuals with type 2 diabetes, which show that interval training paradigms, such as interval walking and low-volume HIIT, improve CRF and several cardiometabolic outcomes.(11,12)

Meta-analytic evidence indicates that HIIT frequently yields superior improvements in CRF compared to moderate-intensity continuous training (MICT) in individuals with prediabetes and type 2 diabetes, although variability in protocols, duration, and participant characteristics affects effect sizes.(13,14)

The results of this study are consistent with past research showing that interval-style training improves metabolism in people with type 2 diabetes. For instance, Mitranun et al. (2014) found that, in comparison to continuous walking, high-intensity interval walking improved aerobic fitness and blood sugar regulation. Similarly, interval walking improved VO_2max, body composition, and insulin sensitivity in this population, according to Karstoft et al. (2013).

Future research must directly compare structured HIIT, Fartlek, and MICT in sufficiently powered randomized controlled trials (RCTs) involving individuals with type 2 diabetes. This should encompass standardized intensity monitoring (such as heart-rate zones or wearable telemetry), evaluate glycemic variability through continuous glucose monitoring, and document long-term adherence and clinical event outcomes.(15)

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