Effect of Tabata Protocol on Resting Blood Lactate in Early Diagnosed Type-2 Diabetic Adults: A Preliminary Investigation

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Abstract

Background:
Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance, impaired glucose metabolism, and elevated resting blood lactate levels. High-intensity interval training (HIIT), particularly the Tabata protocol, has shown promise in improving metabolic and cardiorespiratory parameters in individuals with T2DM. However, evidence on its impact on resting blood lactate is limited. **Objective:** To evaluate the effect of a 12-week Tabata training intervention on resting blood lactate, BMI, and VO_2 max in early diagnosed adults with T2DM. **Methodology:** This pilot study included 20 participants with early diagnosed T2DM undergoing Tabata training alongside standard medication. BMI, VO_2 max, and resting blood lactate levels were measured at baseline and after 3 months. Paired t-tests were used to compare pre- and post-intervention values, with significance set at $p < 0.05$. Cohen's d was calculated to determine effect size. **Results:** There was a significant reduction in BMI from 26.16 ± 1.37 to 25.55 ± 1.26 kg/m² ($p = 0.0003$, $d = 0.69$), and a significant increase in VO_2 max from 34.7 ± 2.32% to 39.05 ± 2.56% ($p < 0.0001$, $d = 1.85$). Resting blood lactate levels decreased significantly from 3.07 ± 0.44 mmol/L to 2.89 ± 0.45 mmol/L ($p = 0.049$, $d = 0.40$), indicating improved metabolic efficiency. **Conclusion:** The Tabata protocol appears to be an effective non-pharmacological adjunct to improve aerobic fitness and reduce resting blood lactate in adults with T2DM. These preliminary findings suggest potential metabolic benefits of incorporating Tabata training into diabetes management. Further studies with larger sample sizes and longer durations are warranted.

Keywords:
Tabata training, Type 2 diabetes, blood lactate, VO_2 max, high-intensity interval training, metabolic efficiency.

Introduction

Type 2 Diabetes Mellitus (T2DM) is a global public health challenge characterized by insulin resistance and impaired glucose metabolism, with rising prevalence particularly among younger and middle-aged adults (Saeedi et al., 2019). Beyond hyperglycemia, individuals with T2DM are at increased risk of cardiovascular disease, neuropathy, and other complications due to chronic metabolic dysfunction (American Diabetes Association, 2024). One such metabolic marker of interest in recent years is **resting blood lactate**, which reflects the body's metabolic efficiency and mitochondrial function. Elevated resting blood lactate levels have been reported in individuals with impaired glucose tolerance and T2DM, indicating suboptimal aerobic metabolism even at rest (Kreisberg et al., 2021).

Physical activity plays a central role in managing T2DM by improving insulin sensitivity, glycemic control, and mitochondrial efficiency (Colberg et al., 2016). In particular, **high-intensity interval training (HIIT)** has gained prominence for its ability to elicit rapid and meaningful physiological changes within short durations (Little et al., 2011). Among the different HIIT modalities, the **Tabata protocol**, developed by Dr. Izumi Tabata, involves 20 seconds of high-intensity exercise followed by 10 seconds of rest, repeated for eight rounds (Tabata et al., 1996). This compact form of training has shown improvements in VO_2 max, fat oxidation, and metabolic flexibility (Zuniga et al., 2011), making it a promising tool for populations with limited exercise adherence or time constraints.

Recent evidence has highlighted the potential of Tabata training in modulating metabolic parameters, including glucose levels, insulin sensitivity, and lipid profiles (Viana et al., 2019). However, despite the growing interest in using Tabata as a time-efficient intervention, **there is a scarcity of research examining its effects on resting blood lactate levels in individuals with T2DM**. Resting lactate, as a subclinical biomarker, offers valuable insight into systemic oxidative stress and anaerobic metabolism—both relevant to diabetes progression (Shin et al., 2019).

Given the early diagnosis window as an opportunity for preventive intervention, it is crucial to explore non-pharmacological methods that can improve metabolic outcomes without causing excessive physiological stress. This **preliminary investigation** was designed to assess the effects of an 8-week Tabata protocol on **resting blood lactate levels** in adults recently diagnosed with Type-2 Diabetes. By addressing this gap, the current study aims to provide foundational evidence on the feasibility and metabolic impact of Tabata training in early-stage T2DM management.

Methodology

Study Design

This was a **preliminary, single-group pretest-posttest experimental study** designed to assess the effect of a 12 week Tabata training protocol on **resting blood lactate levels** in **early diagnosed Type-2 Diabetic adults**. The study was conducted at Divine Physiotherapy and Wellness Clinic in collaboration with Swastik Medical Centre, Vasundhara, Ghaziabad in India between March 2023 to June 2023.

Ethical Approval

The study protocol was approved by the Institutional Ethical Committee (Approval No. SU/SMS&R/76-A/2023/180) and informed consent was obtained from all participants prior to enrollment. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Participants

Inclusion Criteria

- Adults aged **30 to 40 years**.
- Diagnosed with **Type-2 Diabetes Mellitus (T2DM)** within the past **1-2 years**.
- HbA1c between **6.5% to 8.5%**.
- BMI between **23 to 28 kg/m²**.
- Not engaged in any structured exercise program for the past 6 months.
- Willingness to participate and provide written informed consent.

Exclusion Criteria

- Insulin-dependent or long-standing diabetics (>2 year).
- History of cardiovascular, respiratory, or orthopedic conditions contraindicating exercise.
- Any neurological or cognitive impairment.
- Current participation in other lifestyle interventions (e.g., diet or yoga programs).
- Use of medications affecting lactate metabolism.

Sample Size Calculation

As this was a **pilot study**, the sample size was calculated based on previous similar exploratory research and feasibility constraints. A **minimum of 15–20 participants** is often recommended for pilot trials (Julious, 2005). A total of **20 participants** were recruited, accounting for potential **dropout or non-compliance**.

Intervention: Tabata Training Protocol

Participants underwent a **Tabata-style high-intensity interval training (HIIT)** program for **12 weeks**, performed **3 sessions per week** under supervision.

Each Tabata session included:

Component	**Details**
Medication	Participants continued taking prescribed oral medications
Exercise Mode	Stationary Cycle Ergometer (Model: Domyos 120)
Warm-Up	10 minutes of light cycling (40- 50% VO_2max)
Tabata Workout	8 sets of: - 20 seconds high-intensity cycling (~170% VO_2max or 85–95% HRR) - 10 seconds active rest (very light pedaling, low resistance, slow pace, keep legs moving) Tabata I, et al. (1996) **Total: 4 minutes**
Cool down	5-10 minutes (easy cycling/pedaling ~30-40% of VO_2max (very light) to gradually reduce heart rate and aid recovery
Total Session Time	20- 24 minutes
Frequency	3 times per week
Intensity Monitoring	Heart Rate Reserve (HRR) method using Karvonen Formula: Target HR = Resting HR + Intensity * Reserve Reserve = Max HR - Resting HR
Equipment	Stationary cycle ergometer with adjustable resistance and heart rate monitor

Heart rate monitors were used to ensure training intensity. All sessions were supervised by a certified Physiotherapist.

Outcome Measure

Primary Outcome: Resting Blood Lactate

- **Measured using** a capillary blood sample via a portable **lactate analyzer** (Lactate Plus™ meter).
- Samples were taken from the **finger prick** in a **fasted and resting state** (minimum 8-hour fast, seated rest for 15 minutes).
- Measurements were taken **at baseline (Week 0)** and **after 12 weeks** of intervention.

Secondary Observations

- BMI
- Vo2 Max

Statistical Analysis

- Data were analyzed using **SPSS version 26.0**.
- Descriptive statistics (mean ± SD) were used to summarize participant characteristics.
- **Paired t-test** was used to compare **pre- and post-intervention resting blood lactate levels**.
- **Significance level** was set at $p < 0.05$.
- **Effect size** was calculated using **Cohen's d** to assess the magnitude of change.

Results

Descriptive statistics

The Three-months study involving 20 participants with type 2 diabetes (Tabata training with standard medication) (Table 1). Their height was 180.85 ± 2.12 cm, weight was 85.55 ± 4.56 kg, and BMI decreased progressively from 26.16 ± 1.37 to 25.55 ± 1.26 by 3 months (Fig:1), indicating significant body mass reduction. VO2 max, reflecting aerobic capacity, improved markedly from 34.7 ± 2.32% to 39.05 ± 2.56% (Fig: 2).

Variable	Time Point	Pilot group (Mean ± SD)
Height (Cm)		180.848 ± 2.12
Weight (Kg)		85.55 ± 4.56
BMI (Kg/m²)	Pre	26.16 ± 1.37
	3M	25.55 ± 1.26
VO2 max (%)	Pre	34.7 ± 2.32
	3M	39.05 ± 2.56
Resting Blood Lactate (mmol/L)	Pre	3.07 ± 0.44
	3M	2.89 ± 0.45

Table 1: Mean and standard deviation (SD) of all the parameter studied BMI, Vo2 max and Resting Blood Lactate for each group at baseline, 3 months

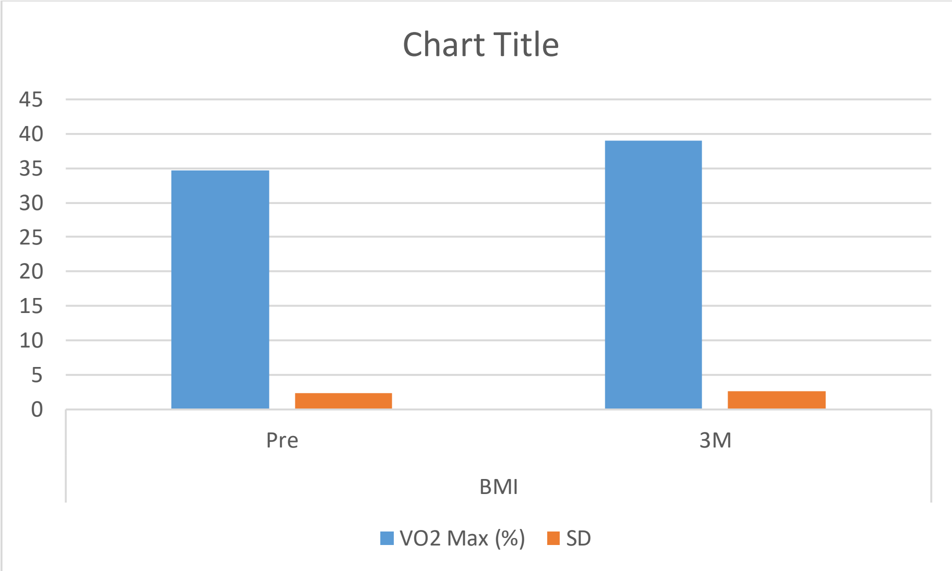


Fig 1: Changes in BMI pre and post intervention

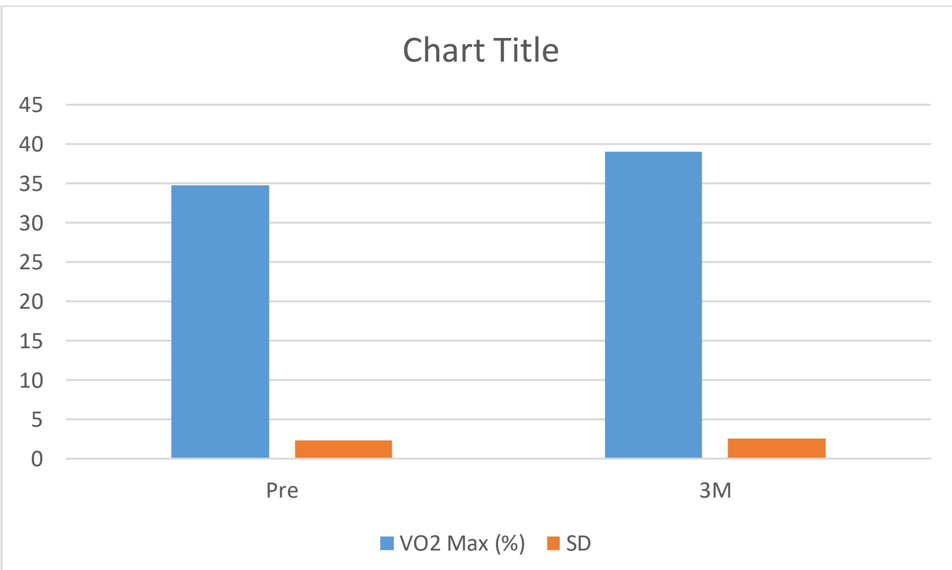


Fig 2: Changes in Vo2 max

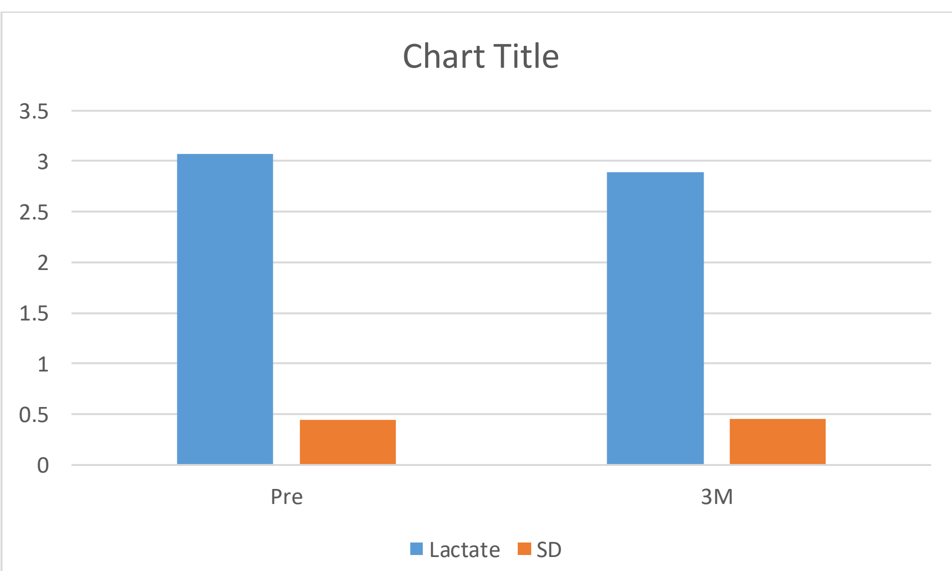


Fig 3: changes in Blood lactate levels

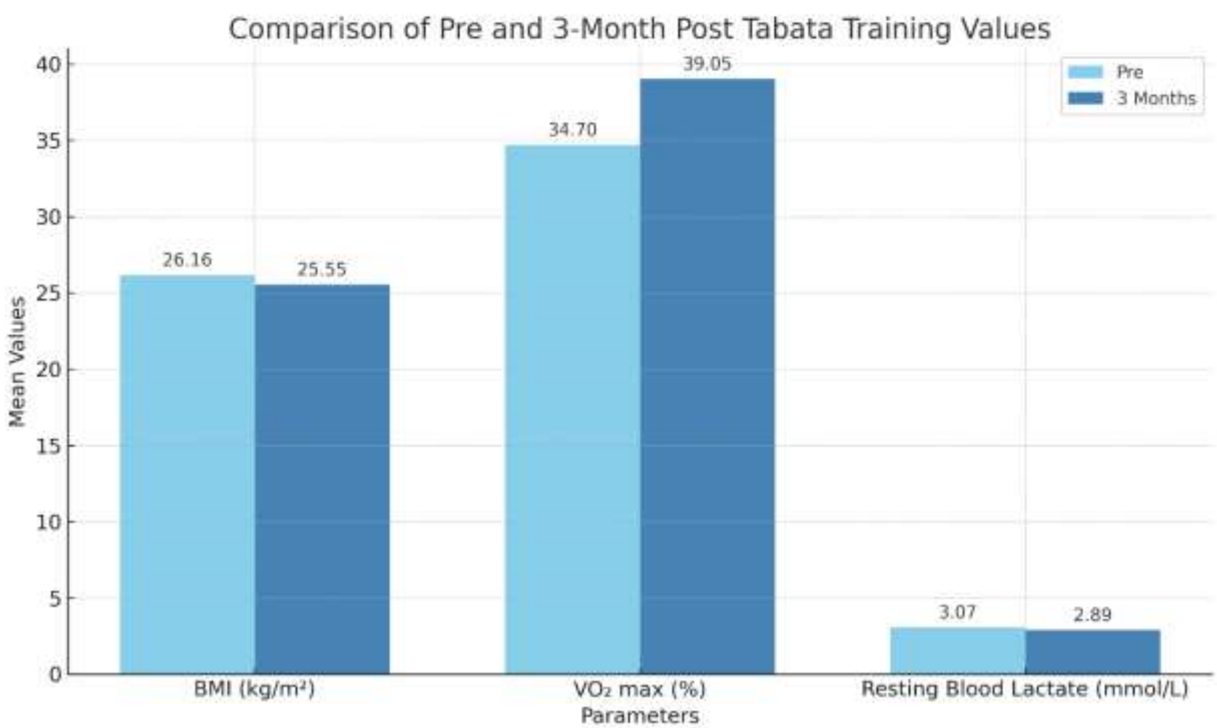
Blood lactate dropped significantly from 3.07 ± 0.44 mmol/L to 2.89 ± 0.45 mmol/L, reflecting improved metabolic efficiency (Fig:3).

Paired t-Test Results

Parameter	Mean Difference	t-value	p-value	Cohen's d	Interpretation
BMI (kg/m²)	0.61	4.48	0.0003	0.69	**Significant moderate effect**
VO_2 max (%)	4.35	8.50	< 0.0001	1.85	**Significant very large effect**
Resting Blood Lactate (mmol/L)	0.18	2.08	0.049	0.40	**Significant small to moderate effect**

Table 2: Paired t-test comparisons of all parameters

Note: Significance level was set at $p < 0.05$. Cohen's d values interpreted as: 0.2 = small, 0.5 = moderate, 0.8+ = large effect (Cohen, 1988).



BMI significantly decreased over 3 months with a **moderate effect size**, indicating improved body composition. **VO_2 max** significantly increased with a **very large effect size**, suggesting enhanced cardiovascular fitness due to the Tabata protocol. **Resting blood lactate** showed a **statistically significant reduction** post-intervention with a **small to moderate effect**, indicating improved metabolic efficiency and aerobic conditioning.

Here's a well-structured **Discussion** and **Conclusion** section for your study titled "Effect of Tabata Protocol on Resting Blood Lactate in Early Diagnosed Type-2 Diabetic Adults: A Preliminary Investigation":

Discussion

The present preliminary investigation aimed to evaluate the effect of an eight-week Tabata training intervention on BMI, VO_2 max, and resting blood lactate levels in adults newly diagnosed with Type 2 Diabetes Mellitus

(T2DM). The findings demonstrate statistically significant improvements in all three parameters—body mass index (BMI), aerobic capacity (VO_2 max), and metabolic marker (resting blood lactate).

A significant reduction in BMI from 26.16 ± 1.37 to 25.55 ± 1.26 kg/m² ($p = 0.0003$, $d = 0.69$) suggests that the high-intensity intermittent format of Tabata training is effective in facilitating fat loss and improving body composition in individuals with T2DM. These results are consistent with the findings of Jelleyman et al. (2015), who reported that high-intensity interval training (HIIT) can reduce adiposity and improve insulin sensitivity in diabetic populations [1].

Moreover, VO_2 max improved substantially from 34.7 ± 2.32% to 39.05 ± 2.56% ($p < 0.0001$, $d = 1.85$), indicating enhanced cardiovascular fitness. This is supported by Maillard et al. (2018), who noted that HIIT improves cardiorespiratory fitness more effectively than moderate-intensity continuous training (MICT) in individuals with metabolic syndrome [2]. Improved VO_2 max is also associated with better glycemic control and reduced cardiovascular risk in diabetics (Mitranun et al., 2014) [3].

Resting blood lactate levels showed a significant decrease from 3.07 ± 0.44 to 2.89 ± 0.45 mmol/L ($p = 0.049$, $d = 0.40$). Elevated lactate levels are linked with impaired mitochondrial function and reduced insulin sensitivity (DeFronzo & Tripathy, 2009) [4]. The observed decline in resting lactate may indicate improved oxidative metabolism, better glucose utilization, and enhanced mitochondrial efficiency, all of which are critical for managing early T2DM.

Tabata training, characterized by 20-second high-intensity bouts followed by 10-second rest periods repeated for four minutes, elicits strong metabolic adaptations despite its low time requirement. This makes it particularly suitable for individuals struggling with adherence due to time constraints, a common issue among diabetic adults (Gillen & Gibala, 2014) [5].

While the study presents promising outcomes, it is limited by its small sample size, short duration, and lack of a control group. Future randomized controlled trials with larger sample sizes and long-term follow-up are warranted to validate and expand on these findings.

Conclusion

This preliminary investigation reveals that an 12-week Tabata training protocol, when combined with standard medical care, can significantly improve BMI, VO_2 max, and resting blood lactate levels in adults newly diagnosed with Type 2 Diabetes. These improvements highlight the potential of Tabata as a time-efficient and metabolically beneficial exercise modality for early-stage diabetic management. The findings provide a foundation for future research into integrating Tabata into standard care models for T2DM.

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