EFFECT OF LOW-INTENSITY INTERVAL TRAINING ON BLOOD GLUCOSE LEVEL AMONG PATIENTS OF TYPE-II DIABETES MELLITUS IN SELECTED ENDOCRINE CLINICS ZARIA METROPOLIS, NIGERIA

Nafeesah Bello Wurno[1], Yahaya Abdullahi[2], Suleiman Usman Omeiza[2] & Labaran M. Shuaibu[3]

[1]Department of Physical and Health Education, Federal University of Education Zaria-Nigeria
[2]Department of Human Kinetics and Health Education, Ahmadu Bello University Zaria-Nigeria
[3]School of Health Sciences, Maryam Abacha American University of Nigeria, Kano

Abstract

This study investigated the efficacy of a structured low-intensity interval training (LIIT) program on blood glucose levels in patients diagnosed with Type II Diabetes Mellitus (T2DM) within selected endocrine clinics in Zaria, Nigeria. Employing a one-group repeated measures pre-test/post-test design, the research purposively sampled fifteen (15) paticipants from 108 patient with age limit of 28-56 year and above of T2DM patients who met predefined inclusion criteria and demonstrated readiness for physical activity. The intervention spanned nine weeks, with training sessions held three times weekly (Thursday, Friday, and Saturday) between 4:00 PM and 5:30 PM. Each session was carefully structured to last between 30 and 45 minutes, incorporating essential warm-up and cool-down phases. The intensity of the LIIT progressively increased, starting at 20% of maximum heart rate (HR_{max}) for the initial three weeks, advancing to 30% HR_{max} for weeks 4-6, and culminating at 40% HR_{max} for weeks 7-9. Blood glucose levels were meticulously monitored at four distinct time points: baseline (week 0), week 3, week 6, and week 9, utilizing a glucometer kit, with treadmill exercise serving as the primary mode of intervention delivery. Data were subjected to descriptive statistical analysis, and hypotheses were rigorously tested using a one-way analysis of variance (ANOVA) with repeated measures, at a predetermined significance level of $P<0.05$. The findings unequivocally demonstrated a statistically significant reduction in blood glucose levels observed from the 3rd, 6th, and 9th weeks of the intervention ($P<0.000$). This compelling evidence leads to the conclusion that a 3-to-9-week low-intensity interval training regimen is highly effective in decreasing blood glucose levels among Type II Diabetes Mellitus patients attending endocrine clinics in Zaria, Nigeria. Consequently, it is strongly recommended that LIIT be integrated and sustained as a practical and beneficial approach for the ongoing management of blood glucose in this patient population within the Zaria metropolis.

Keywords: **Blood glucose level, Endocrine Clinic, Interval training, Low intensity interval training, Type-II diabetes mellitus**

Introduction

Type 2 Diabetes Mellitus (T2DM) is a chronic disease with a growing global prevalence, affecting a large portion of the population and significantly impacting overall health (Yach et al., 2006). The World Economic Forum's Global Risk Report estimated a substantial increase in diabetes cases, from 108 million in the 1980s to 422 million by 2014, with cases continuing to rise (da Rocha Fernandes et al., 2016). Bennett et al. (2018) projected a 72% increase in diabetes prevalence between 2010 and 2030, with an estimated 642 million people affected by 2040 (Chin et al., 2021). These epidemic places a heavy burden on health systems, with treatment costs for individuals aged 20-79 reaching $776 million (Cho et al., 2018).

In Nigeria, the reported prevalence of T2DM among adults is 1.7% (Adeloye et al., 2017). However, these figures, based on data from other countries, are widely believed to be an underestimation of the true burden (Uloko et al., 2018). Glucose, a primary energy source for cells, is transported with the help of insulin (Mukhtar et al., 2020). Normal fasting blood glucose levels are typically between 70 and 99 mg/dL (Awuchi et al., 2020). High blood glucose, or hyperglycaemia, occurs when the body does not produce enough insulin or cells do not respond to it properly. Untreated hyperglycaemia can lead to serious complications, including nerve, kidney, and eye damage (Awuchi et al., 2020).

Weight reduction and exercise are crucial for managing T2DM. The American Diabetes Association (2013) and American College of Sports Medicine (2014) recommend at least 150 minutes of moderate-to-vigorous physical activity per week. Even a single session of high- or low-intensity exercise can improve endothelial function and lower glycaemic levels within 24 hours (Francois et al., 2016). Low-intensity exercise, in particular, has been shown to improve insulin sensitivity and glycaemic control (Howden et al., 2018). The rise in insulin sensitivity is linked to a decrease in abdominal fat and enhanced glucose metabolism (Bartlett et al., 2013).

T2DM is characterized by reduced insulin production, which impairs the regulation of blood glucose (Boukabous et al., 2019). Long-term hyperglycaemia can lead to serious complications such as cardiovascular diseases, kidney disease, and neuropathy (Awuchi et al., 2020). Health professionals are vital in providing patients with the necessary information for effective self-management (Marcotte-Chénard et al., 2021).

A study by Chaturvedi et al. (2021) examined the effect of Low-Intensity Interval Training (LIIT) on glycated hemoglobin (HbA1c) in 40 women with T2DM. The study found that regular LIIT significantly improved HbA1c levels compared to a control group, indicating its effectiveness as an alternative to aerobic training for glycaemic control. Similarly, another study by Chaturvedi et al. (2021) demonstrated that LIIT can improve glucose regulation and cardiovascular well-being.

Regular physical activity improves overall health, boosts cardiorespiratory fitness, and helps manage complications like T2DM and obesity (Collin, 2021). Exercise enhances insulin sensitivity for up to 48 hours and improves glycaemic regulation. The benefits of exercise depend on its intensity, duration, and type. Interval training, especially at high speeds, can maximize improvements in $VO2_{max}$ and mitochondrial density (Chori et al., 2022). Low-intensity exercise during recovery periods can also help excrete lactate after strenuous activity (Brooks et al., 2022). A study by Podvigina et al. (2022) concluded that LIIT enhances glycaemic regulation and pancreatic beta-cell function in T2DM patients, reinforcing the role of physical activity in glucose homeostasis for both healthy and diabetic individuals.

Methodology

One group repeated trials research design was used, which the participants were measured more than two (2) times repeatedly over a period of time on the same dependant variable as suggested by Cho et al. (2020). In this design, one group response outcomes were measured on the same experimental unit at different condition (Rachel et al., 2023). The sample size for this study consisted of fifteen (15) female Patients which were drawn from 108 population for the study with T2DM. To arrive at this sample size for this study, the purposive sampling technique was used, this was because the participants met certain criteria set for the study (Campbell et al., 2020). Participants with age limit of 28-56 and above years constitute the study, and a one group pretest and posttest repeated analysis measure of variance was used. The baseline was used as a pre-training measure, while the measurement of the 3rd week, 6th week and 9th week measurements were the experimental manipulations for nine (9) weeks. The design was to measure how the treatment affected each individual. An ethical approval was sought from the Ahmadu Bello University Committee on Use of Human Research Subjects (ABUCUHSR/2023/025), similarly, a letter of introduction from the Department of Human Kinetics and Health Education, Faculty of Education Ahmadu Bello University Zaria was issued to the Chief Medical Directors of the Selected Endocrine Clinics Zaria Metropolis, Nigeria, for approval to use its clinic for the requirement of participants for the study, and also for the permission to use its gymnasium for the training.

Training Procedure

Glucose level was measured using a kit called glucometer, which was applied by pricking a finger with a lancet, using a lancing pen, the deposit of blood sample on a test strip was inserted in the meter. The readings on the test strip were displayed in units of mg/dL or mmol/L. participants undergoing interval training on a treadmill which were T2DM patients for nine (9) weeks. The pre-training participants were asked to follow general lifestyle recommendation, including brisk walking at least three (3) times for a minimum of thirty (30-40) minutes as a placebo. The data collected served as the baseline. As for the control, the subjects that undergone training, training session commenced shortly after the participants' physical characteristics were measured in order to obtain their body composition which were used as a guideline for the exercise prescription, such as frequency, intensity, duration and mode of activity. The participants were exposed to 9-week low-intensity training at frequency of 2 - 3 days per week. At the beginning of the training programme, the intensity was 20% HR_{max} 1 – 3rd week, 30% HR_{max} 8th week, and 40% HR_{max} 9th week.The time assigned for each training session was 30 minutes. The programme was of low intensity considering the fitness level of the participants. As recommended by Kilhede (2020), the intensity of low intensity training should start with walking at a working heart rate of 20% of estimated HR_{max} (108 bmp) at 0 – 3rd week, increased to 30% HR_{max} (117 bmp) at 4th - 6th week progressively to 40% HR_{max} (126 bmp) at 7th - 9th week. But for this study the rate of increment will be individual based due to their health conditions.

Instruments

The test were performed on a Trim line 7800 Treadmill USA were the interval training exercise. The Blood glucose level was measured using Glucometer kit, VivaChek™ Eco BGMS blood glucose meter (VivaChek Biotech (Hangzhou) Co., Ltd.) with strips and lancets needles. A Stopwatch: Six stopwatches digital port-spring model 015. Manufactured by a jewel sports company, Britain was used for monitoring the duration of the intervals training exercise. (Jackson, 2017).

Results

To examine sub-hypothesis, a repeated one-way analysis of variance (ANOVA) test was conducted on the blood glucose level (GL) of the participants. The results of this analysis are presented in Table 1.

Table 1: Effects of low-intensity interval training on the GL of participants

Source		type-III Sum of Squares	df	Mean Square	F	Sig.
GL	Sphericity Assumed	74.597	3	24.866	48.136	.000
	Greenhouse-Geisser	74.597	1.141	65.395	48.136	.000
	Huynh-Feldt	74.597	1.175	63.482	48.136	.000
	Lower-bound	74.597	1.000	74.597	48.136	.000
Error (GL)	Sphericity Assumed	21.696	42	.517		
	Greenhouse-Geisser	21.696	15.970	1.359		
	Huynh-Feldt	21.696	16.451	1.319		
	Lower-bound	21.696	14.000	1.550		

Table 1 displays the results of the repeated one-way analysis of variance (ANOVA) that investigated the effects of low-intensity interval training on the blood glucose level (GL) of the participants. The obtained results, $F(3, 42) = 48.136$, indicated the effect of the training programme on the GL of the participants. Furthermore, table 4.8 revealed the Mean and the Standard deviation of the Low-intensity interval training on the (GL). However a Bonferroni pairwise comparison post hoc test was conducted and the results of the findings revealed that the Mean and Standard deviation of (GL) of the participants was significantly decreased from 11.47 ± 0.96 at baseline to 10.63 ± 0.96 at the 3rd week, furthermore, the training programme led to a further significant decreased in the average GL of the participants to 9.23 ± 0.68 at 6th week at $p = 0.002$, and was subsequently decreased significantly to 8.65 ± 0.67 at 9th week, $p < 0.000$. An observation of this results revealed that low-intensity interval training slightly reduces the blood glucose levels of the participants at the 3rd week of low-intensity interval training and more significantly at the 9th week of low-intensity interval training. Consequently, the null hypothesis, which states that there is no significant effect of low-intensity interval training on the blood glucose level among patients with type-II diabetes mellitus (T2DM) in the selected endocrine clinics of Zaria Metropolis, Nigeria, is rejected because, the P-calculated ($P=0.000$) was less than the statistical level of significance $P>0.05$.

The variation of participant's GL during the course of the study is as presented in Figure 1.

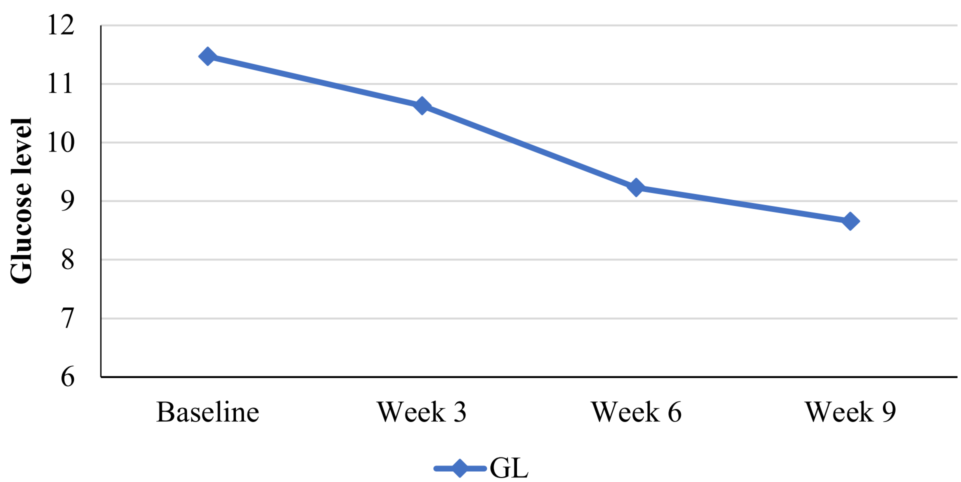

Figure 1: Variation of participant's GL during low-intensity interval training

Discussion

The finding of this study revealed that Low-intensity interval training significantly decreased the blood glucose level among type 11 diabetes mellitus patients. The results of the findings coincided with those of Feng, et al.,2019; Laursen and Buchheit (2019), who found and reported that low-intensity interval training of 30 minutes enhanced glucose metabolism. However, low-intensity interval training reduced insulin resistance because of a reduction in blood glucose levels among the experimental group. Similarly, Boukabous, et al., 2019); Sugandh, et al.,(2022) stressed that moderate-intensity continuous training has a lesser effect on fasting insulin level than low-intensity interval training, with a reduction of 31% and 9%, respectively. The pancreas produces two hormones: insulin and glucagon, which help to assert blood glucose levels. Exercise reduces the insulin requirements of T2DM patients by 30–5 percent, and insulin sensitivity improves, which lasts for one or two days before reaching pre-exercise levels. Thus, T2DM patients need to exercise regularly to maintain enhanced insulin sensitivity. However, Yannon (2022) shows that there are improvements in long-term glucose control due to regular exercise in T2DM patients. The results of the findings supported the findings of Gibala, *et. al.,* (2014), who suggested that low-intensity interval training (low-intensity interval training) can increase glucose regulation and cardiovascular well-being in individuals with T2DM at p = 0.002 in a pre-test post-test group design among a sample size of 45 participants.

However, it should be noted that exercise and regular physical activity have a great influence on health; they also promote overall health and individual state of mind for all ages with better changes in energy balance, psychological well-being, and immune function. However, it was concluded that low-intensity interval training should be used to regulate blood glucose levels and insulin resistance, as well as promote and control T2DM. The study also agreed with Mahmoudi, *et. al.,* (2018), who showed that 8 weeks of HIIT led to a significant decrease in blood plasma glucose. Sports activities increase the number of glucose carriers and, as a result, increase the entrance of sugars into muscles. The consumption of sugars during sports activities has an insulin-like effect and sends a lot of glucose into the cell to spend on energy production. In this study, blood glucose levels in the diabetic group were significantly lower than in patients who received metformin, which suggested that intense physical activity may be a good alternative to medication to reduce glucose. Similarly, to the findings of Rynder *et al*. (2014), who stated that acute high-intensity exercise compared with the no-exercise control group was significantly different from the control HIE (0.6, P≤.5) and moderate-intensity exercise with MIE (0.4) effectively improved the late-phase postprandial glucose and insulin responses to an oral glucose tolerance test, Both MIE and HIE are beneficial for improving postprandial insulin sensitivity, measured 1 hour after the cessation of exercise. Although the differences between exercise conditions did not reach statistical significance, they suggested that HIE conveys greater postprandial benefits compared with an isocaloric bout of MIE.

Conclusion

These findings therefore indicate that low-intensity interval training is an effective approach for managing blood glucose level in individuals with type-II diabetes mellitus. The study further highlighted the importance of exercise in the prevention and management of diabetes-related health complications and emphasizes the need for proper guidance and techniques in exercise programmes for individuals with type-II diabetes mellitus. It was concluded that there was significant decreased in the blood glucose level among type-II diabetes mellitus patients who participated in the programme.

Recommendation

Based on the findings of the study, it was recommended that Low-intensity interval training should be sustained to regulate the blood glucose level among type 11 diabetes mellitus patients in Zaria clinics. Exercise and sports scientist, physiotherapist should recommend moderate and low intensity training to help patients with type-II diabetes mellitus in Zaria Metropolis. |

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