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Effect of Interval versus Continuous Training on Cardiovascular Autonomic Neuropathy in Type II Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus (DM) represents a chronic metabolic condition marked by elevated blood glucose levels, due to defects in the release of insulin, its action, or both. DM is frequently linked to microvascular as well as macrovascular complications. Autonomic neuropathy presents with clinical symptoms such as hypoglycemia inattention, orthostatic low blood pressure, constipation, diarrhea, erection problems, along with neurogenic bladder.

Aim of the study: This study aimed to inspect the impact of interval versus continuous training on cardiovascular autonomic neuropathy (CAN) in type II diabetes mellitus.

Methods: Sixty diabetic patients suffering from autonomic neuropathy, patients had been randomized into two groups equivalent in number, the study group (group A) as well as the control group (group B). Group (A) involved 30 diabetic patients who were treated by high intensity interval training. Group (B) involved 30 diabetic patients who were treated by moderate intensity continuous training. Heart rate variability (HRV) response, beat to beat variation with deep breathing and HRV with standing are the variables that were examined. The variability of blood pressure (VBP), quality of life (QoL), and reaction to standing, as well as hand grip blood pressure (DBP), as well as systolic blood pressure (SBP).

Results: Following the treatment, a statistically significant difference was detected among the study and control groups on quality of life questionnaires, hemoglobin A1c% (HbA1c), blood pressure variability, in addition to heart rate variability.

Conclusion: Practicing of interval training and continuous training had an effect on heart rate variability, blood pressure variability, HbA1c% and quality of life questionnaire but the interval training had more significant effect.

Keywords: Interval continuous training, Autonomic neuropathy, Diabetes mellitus.

INTRODUCTION

Diabetes mellitus (DM) represents a chronic metabolic condition associated with high blood glucose levels as a result of impairment in the release of insulin and its action or both. DM has been linked to microvascular and macrovascular complications, as well as many other conditions, such as metabolic, cellular, along with blood coagulation disturbances, which can lead to complications that influence multiple organs, such as the kidneys, retina, and peripheral nerves **[1]**.

Autonomic neuropathy presents with clinical symptoms such as low glucose levels unawareness, orthostatic low blood pressure, dyshidrosis, constipation, diarrhea, er

ection problems, along with neurogenic bladder **[2]**. Patients who have diabetes and autonomic neuropathy face a significant hazard of serious complications in their treatment. Hypoglycemia ignorance can result in severe as well as possibly life-threatening consequences, particularly in individuals with advanced complications and comorbid medical conditions **[3]**.

Despite the fact that CAN is associated with higher death rates, the only medication that can stop or reverse CAN is controlling blood glucose levels as well as glucose variability **[4]**. According to recent research, CAN is independently associated with severe hypoglycemia in diabetic patients **[5, 6]**. Experimental hypoglycemia results in decreased heart rate variability and impaired baroreflex sensitivity **[7, 8]**.

Globally, the aging population has resulted in an increase in the prevalence of chronic illnesses among elderly individuals. Type II diabetes mellitus (Type II DM) is a frequent metabolic disorder, with prevalence rates expected to double over the next thirty years, presenting significant medical and economic challenges **[9]**.

Type II DM is commonly associated with cardiovascular disease, with approximately 80% of patients with type II DM experiencing complications linked to cardiovascular disease **[10]**.

Quality of Life (QOL) represents a broad term that encompasses various domains related to overall wellbeing, future physical health along with functioning, mental well-being and therapy satisfaction in addition to social functioning **[11]**. The issue of diabetes and its impact on QOL is a significant public health concern for patients, families, employers, as well as healthcare professionals. Diabetes and its complications, treatments, and subsequently patient attitudes adversely affect dimensions of quality of life, including social, physical, emotional well-being, cognitive as well as sexual performance, pain, and overall health perceptions. Diabetes necessitates continuous changes in health behaviors and adherence to prescribed treatment regimens. Numerous

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instruments have been created, validated, and employed to assess the QOL of diabetic patients [(12)].

Cardiovascular autonomic neuropathy (CAN) represent a serious complication of diabetes that is frequently miss-diagnosed and has a substantial impact on cardiovascular morbidity as well as mortality. The Toronto Consensus Panel on Diabetic Neuropathy characterized CAN as a disorder of cardiovascular autonomic control in individuals with confirmed diabetes, following the exclusion of alternative causes [(13)]. Additionally, evidence increasingly indicates that high-intensity interval training (HIIT) offers an efficient substitute to moderate intensity continuous training (MICT). The relationship among exercise intensity and duration is crucial for producing specific adaptations, however the ideal exercise model is still unclear [(14)].

MATERIALS AND METHODS

This study was done to compare the impact of HIIT Versus MICT on CAN in Type II DM.

Patient: This study was carried out on 60 patients suffering from Type II DM, aged from 50 to 60 years old. The patients were chosen from Saudia Elmalek Fahd Hospital and patients were randomized into two groups.

Inclusion Criteria: Sixty men with type II DM ($HbA1_C$ up to 6.5– 9 %). All patients had oral hypoglycemic drugs with controlled diabetes mellitus. Medical treatment has been optimized a minimum of three months before initiation of the study. The patients aged from 50 to 60 years old. All patients didn't participate in any rehabilitation programs before the study.

Exclusion criteria: Uncontroled DM (HbA1c ≥ 9%). Evidence of acute heart failure, uncontrolled angina, and severe arrhythmia within three months preceding study enrollment. Pacemakers. Chronic obstructive pulmonary disease. Other conditions that impede exercise testing due to limitations in lower extremity mobility such as burns and fractures. Pre-existing neuromuscular diseases (for example Myasthenia Gravis). Chronic inflammatory autoimmune disease. Anemic patient. Patient with liver disease. Heavy smoker patient.

Patients were randomized into two groups with group A was given HIIT and group B was given MICT. Both groups received their optimal medical treatment. All patients were evaluated before and after treatment protocol application. All patients received their prescribed medical treatment.

Primary outcome: Cardiovascular Autonomic Neuropathy to heart rate variability response. Beat to beat variation with deep breathing, HRV with standing, blood pressure variability response via DBP, and SBP response to standing had been measured.

Secondary outcome: QOL via QOL diabetic questionnaire and blood glucose levels via HbA1c had been measured.

Material: The study equipment's were divided into two different types: A) Evaluation instruments. B) Treatment instruments.

A) Evaluation instruments:

- **Holter monitor:** The Holter monitor portable electrocardiogram (ECG) (Magic R Series; Maestros, India). It was utilized for continuously recording the electrical activity of the heart for 24 hours or more in the absence of the doctors. A standard or "resting" ECG is among the simplest and quickest assessments for evaluating cardiac function.
- **Standard height and weight sealed:** (Floor type mode; ZT-120, made in China).

B) Treatment instruments:

Treadmill apparatus:

- Electronic treadmill (AC5000M) is used in performance of aerobic exercises and interval training program and had multi programs (continuous interval training and weight loss program).

Procedure: A verbal description regarding the significance of the study procedures, primary objective, along with conceptual framework was provided to every participant.

A. Evaluation procedures:

Preparation: participants in the study were strictly instructed to avoid eating heavy meals, drinking caffeine beverages and exercising at least two hours before the assessment to minimize the potential effect of digestion or thermo regularity activity and to create a stable hemodynamic state. Every individual underwent a medical examination to rule out any previously reported abnormal medical conditions.

Exercise stress test:

A standard 12-lead ECG was administered to the study individuals. According to physician supervision, the participant underwent an exercise stress test on a motorized treadmill following the Bruce protocol. The protocol begun at a velocity of 2.7 km/hr and an inclination of 10%, with both parameters raising every 3 minutes. The main criterion for ending of the exercise stress test was the attainment of 90% of the age-predicted maximum heart rate. The test stopped if the participant experienced light-headedness, chest pain, excessive dyspnea, abnormal blood pressure responses, or abnormal ECG traces. Upon ending of the EST, the attending doctor reviewed and signed off on the ECG trace recorded throughout the procedure. Participants with an abnormal ECG trace or exercise stress test reaction were referred to the relevant medical team for additional investigation. Heart rate at rest and maximum heart rate and the end of the test were measured for each patient participated in the study.

1. Heart rate variability (HRV) response was measured by:

The evaluation of resting heart rate variability was conducted in the morning following a 12-hour overnight fast. An electrocardiogram (ECG) equipment was used to acquire the ECG data. The participants were asked to lie down and breathe spontaneously after a fifteen-minute rest, and the electrocardiogram (ECG) was collected for 5 minutes inside a dimly lit calm room. The Kubios HRV program was used to automatically construct consecutive R-R intervals among QRS complexes, which were then downloaded for study.

To replace artifacts and ectopic beats in R-R interval recordings, the linear interpolation approach was used. Various time-domain linear parameters, which includes the root mean square of successive differences (RMSSD) in addition to standard deviation from normal to normal R-R intervals (SDNN), and frequency-domain parameters, including high frequency (HF) power, low frequency (LF) power, along with the HF/HF power ratio, were computed. There was an evaluation of both HF and LF utilizing normalized units.

2. Beat to beat variation with deep breathing: First the patients were asked to take a normal deep breath (6-8) breaths followed by normal berating. The variation in HR in a cycle of 6-8 breaths was expressed as the mean difference among the maximum as well as minimum HR.

3. HR Response to Standing: Patients were positioned supine upon an examination surface and permitted to rest for 5 minutes. They were instructed to breathe at a rate of approximately 10 breaths each minute, guided by a metronome, before being linked to an ECG machine. The ECG recording was performed, and the resting heart rate was calculated. Subsequently, the patient was directed to stand for three minutes, after which the heart rate was recalculated.

Blood pressure variability response: was measured by:

1. **Hand grip blood pressure:** The patient was instructed to exert maximum isometric contraction on the dynamometer, followed by sustaining 30% of maximum effort for a duration of 5 minutes. Thin the blood pressure was measured pre- and post-exercise.

2. Systolic blood pressure (SBP) response to standing: After recording baseline BP for 3 minute, the patient was slowly changing his position to standing position and a continuous recording of BP continued.

3. Diastolic blood pressure response to standing: The patient was permitted to return to a supine position and the blood pressure was recorded, while in this position. The patient was instructed to stand, while blood pressure measurements are taken at 0 and 1-minute intervals.

Quality of life measurement: was measured by:

1. Quality of life questionnaire: The 12-item General Health Questionnaire (GHQ-12) is used as a screening tool for identifying psychiatric disorders in both community and non-psychiatric clinical environments. The instrument comprises 12 items designed to assess short-term changes in mental health as well as psychological functioning levels. The scale questions if the participant recently experienced a specific symptom or behavior. Items are evaluated using a four-point scale: Lower than usual, no greater than usual, rather more than usual, and much more than usual. This results in a total score of either 36 or 12, based on the chosen scoring method. The predominant scoring methods include bimodal (0-0-1-1) along with scoring styles (0-1-2-3) **[15]**.

2. HbAIc% measurement L: Hemoglobin A1C (BbAlc) test was measured for each patient in the study at the beginning and after receiving the exercise protocol.

Management procedures: The MICT and LVHIIT groups engaged in training sessions three times weekly for a duration of 12 weeks within a community gym environment, under the supervision of gym instructors knowledgeable in the exercise programs as well as study investigators. Before each exercise session, researchers recorded the blood pressure of each participant. Participants with a SBP exceeding 170 mmHg or below 90 mmHg, and/or a DBP exceeding 90 mmHg or below 60 mmHg were prohibited from training. Furthermore, all participants were mandated to assess their blood glucose levels before training. Participants were allowed to train only when their blood glucose levels were regulated to minimize the risk of hypo- in addition to hyper-glycemic episodes.

Group A: Patients received medical treatment and were submitted to receive HIIT.

1. The warm up phase:

This phase involved walking on a flat electronic treadmill, beginning by doing a 5-minute warming up at 30-40% of Maximum Heart Rate (MHR) to prepare for the more intense activities in the subsequent phase of the exercise program, thereby minimizing the risk of muscle injuries.

2. The main exercise phase:

- **Frequency**: HIIT was in 3 supervised sessions per week for 12 weeks on treadmill.

- **Intensity**: After the patients warmed up to 50% of their maximum heart rate for 5 minutes, they did a 4-minute low-intensity exercise at 50% of their maximum heart rate, followed by a 4-minute high-intensity exercise at 80% of their maximum heart rate. This sequence continued for six weeks. From six weeks to twelve weeks, the patients warmed up to 60% of their maximum heart rate, then did a 4-minutes low-intensity exercise at 60% of their maximum heart rate.
- **Duration**: The session lasted 30-40 min and included warming up and cooling down [16].

3. The Cool down Phase:

This phase was executed through slow movements, comparable to those in the warming up phase, for 5 minutes at 30-40% of MHR, serving as a recovery from the more intensive activities of the major exercise phase.

Group B: Patients received medical treatment and were submitted to receive MICT**.**

- **Frequency**: Moderate continuous training was scheduled 3 sessions a week for 12 weeks[16].
- **Intensity**: After a 5-minute warm-up, patients continued training continuously for 20–25 minutes at 60% of MHR, followed by a 5-minute cooling down.
- **Duration**: 30-40 minutes per session.

Ethical approval: Subjects' informed permission and ethics committee approval were both met. Participants were free to stop participating in the research at any moment without penalty. Appendix I shows that the study's ethics committee gave its stamp of approval to the research at Cairo University's Faculty of Physical Therapy.

Statistical analysis

The collected data was statistically analyzed using descriptive statistics (the mean and standard deviation).

- We used the paired t test to find the degree of significance between the pre- and post-PT groups.
- Less than 0.05 is the threshold of significance.

RESULTS

This study was done to compare the impact of HIIT versus MICT on cardiovascular autonomic neuropathy in patients with type II DM. 60 men patients with an age range from 50 to 60 years old were randomly distributed into 2 equal groups. **Group A** included 30 men patients with type II DM and received HIIT program with medical treatment and **Group B** included 30 men patients with type II DM who received MICT program with medical treatment. Regarding age, BMI, HbA1c and duration of disease, there were no significant differences between both groups (Table 1).

Table (1): Comparison mean values of patients general characteristics among both groups

Items	Patients general characteristics			
	Age (Year)	BMI (kg/m^2)	Hb A1c %	Duration of disease (months)
Group A (n=30)	54.90 ±2.31	27.15 ±1.63	7.80 ±0.69	7.80 ±1.24
Group B (n=30)	55.15 ±2.66	27.20 ±1.54	7.90 ±0.64	7.90 ±1.33
t-value	0.317	0.100	0.473	0.246
P-value	0.753	0.921	0.639	0.807
Significance	NS	NS	NS	NS

Data are expressed as mean ±standard deviation (SD) P-value: probability value NS: non-significant

In terms of the mean values of age (P=0.753), body mass index (P=0.921), hemoglobin A1C (P=0.639), and duration of illness (P=0.807) for patients with type II diabetes mellitus, the statistical analysis showed no significant differences (P>0.05) between Group A and Group B.

Table (2): Mixed MANOVA for the impact of treatment on measured variables:

Heart rate at rest (Mean ± SD) (Beat/min)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	81.50 ±1.85	82.85 ±2.62
Post-treatment	74.00 ±2.79	82.20 ±3.00
SDNN (Mean ±SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	35.30 ±2.75	34.00 ±1.83
Post-treatment	43.55 ±3.39	32.80 ±2.35
R MS SD (Mean ± SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	23.75 ±3.07	23.35 ±2.77
Post-treatment	29.40 ±2.78	24.10 ±2.80
HF (Mean ±SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	34.99 ±2.43	35.03 ±2.33
Post-treatment	53.48 ±6.70	35.67 ±2.30
LF (Mean ± SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	58.87 ±5.21	56.96 ±6.55
Post-treatment	57.47 ±6.59	57.29 ±6.64
Changes of heart rate to standing (Mean ± SD) (Beat/min)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	83.65 ±2.47	82.35 ±2.25
Post-treatment	75.90 ±2.42	76.95 ±1.84
SBP response to standing (Mean ± SD) (mmHg)		
Items	SBP (Supine)	SBP (Standing)
Group A (n=30)	124.85 ±5.40	117.85 ±3.95
Group B (n=30)	125.25 ±5.02	115.50 ±4.58
DBP response to standing (Mean ± SD) (mmHg)		
Items	DBP (Supine)	DBP (Standing)
Group A (n=30)	76.65 ±3.74	69.90 ±3.59
Group B (n=30)	78.15 ±1.59	71.25 ±2.02
SBP response to hand grip (Mean ±S D) (mmHg)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	116.95 ±3.84	119.05 ±3.37
Post-treatment	126.35 ±3.40	127.65 ±2.68
DBP response to hand grip (Mean ± SD) (mmHg)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	74.80 ±3.03	76.65 ±2.47
Post-treatment	82.85 ±4.54	84.25 ±2.51
Hb A1C % (Mean ± SD) (%)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	7.90 ±0.64	7.80 ±0.69
Post-treatment	6.09 ±0.42	6.06 ±0.39
Factor I (anxiety-depression) (Mean ± SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	10.15 ±2.13	10.20 ±2.35
Factor II (social dysfunction) (Mean ± SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	11.40 ±2.98	11.35 ±2.88
Post-treatment	3.95 ±0.68	4.40 ±0.68
Factor III (loss of confidence) (Mean ± SD)		
Items	Group A (n=30)	Group B (n=30)
Pre-treatment	4.95 ±0.88	5.05 ±0.88
Post-treatment	1.60 ±0.59	2.15 ±0.58

Data are expressed as mean ±standard deviation (SD) P-value: probability value NS: non-significant

DISCUSSION

This study done to compare the impact of HIIT versus MICT on cardiovascular autonomic neuropathy in patients suffering from type II DM. In the current study, 60 patients with type II DM with autonomic neuropathy with an age range from 50 to 60 years old participated in our study.

Disease called diabetic autonomic neuropathy (DAN) represents a prevalent and severe complication of diabetes. Regardless of its correlation with higher cardiovascular mortality risk and various symptoms and impairments, the importance of DAN remains under recognized. DNA represents a prevalent subtype of diabetic neuropathy, linked to heightened morbidity and mortality, particularly in individuals with poorly controlled diabetes over a prolonged period. DAN remains asymptomatic during the initial stages, making detection and diagnosis challenging [16].

The subsequent autonomic function tests were involved Autonomic Neuropathy to heart rate variability response, beat to beat variation with deep breathing, HRV with standing, Blood pressure variability response via hand grip blood pressure (DBP, mm Hg) and SBP response to standing and QOL via QOL diabetic questionnaire and blood glucose levels via HbA1c had been measured in our study.

A substantial body of evidence supports the efficacy of HIIT as a cardiovascular exercise strategy for enhancing cardiorespiratory functioning along with minimizing cardiovascular disease risk factors. The recent study's findings indicated substantial enhancements in HRV measures following 12 weeks of HIIT, independent of important weight losses. Significant reductions were observed in resting heart rate and glycated hemoglobin levels. The research indicated that the enhancement in SDDN, that represents the overall HRV, exhibited a positive correlation with the observed changes. The rise in SDNN following training signifies an enhancement in overall HRV. The significant rise in SDNN, RMSSD, along with HF collectively indicates enhanced parasympathetic modulation and elevated vagal activity during rest, whereas the marked decline in the LF/HF ratio suggests a reduction in sympathovagal balance [17,18]. The results align with a new study conducted by **Pagkalos *et al.*** [19] who reported enhancements in HRV (SDNN, RMSSD, HF power) following 16 weeks of HIIT in individuals having metabolic syndrome. A significant enhancement in HRV was observed after a 12-week HIIT program in patients with type II DM. A study by **Pichot *et al.*** [20] detected a significant improvement in SDNN, RMSSD, as well as HF by 18.8%, 35% and 47.5% respectively, after 6 months of aerobic exercise training from 70–85% HRR in patients suffering from type II DM and autonomic neuropathy. A comparable enhancement in HF power was observed following 2 weeks of HIIT in sedentary middle-aged men.

Conversely, **Currie *et al.*** [21] found that a 12-week HIIT protocol had no effect on HRV outcomes in patients suffering from coronary artery disease. **Figueroa *et al.*** [22] found that HRV in subjects with Type II DM didn't show improvement after 16 weeks of endurance training.

No consensus is seen currently regarding the mechanism through which exercise influences cardiac autonomic function. The rise in plasma volume after HIIT is hypothesized to influence parasympathetic activity in addition to enhancing HRV. A different mechanism suggests that the repetitive shearing forces applied to the vessel walls during HIIT promote the endothelium to produce greater nitric oxide that subsequently modulates cardiac vagal activity [23]. Furthermore, the enhancement in HRV may result from changes in the sinus node, as indicated by the notable reduction in rest HR observed in the present study [18]. Previous research has reported the same bradycardia at rest as a result of exercise training in patients having type II DM [24]. The muscles engaged during HIIT may indirectly influence autonomic activity regulation via afferent signals coming from muscular chemoreceptors [25]. Moreover, research indicates that HIIT enhances carotid artery dispensability, resulting in improved baroreceptor reflex activity [26]. Prior research indicates that enhancements in baroreceptor reflex sensitivity are reflected by rises in LF power [27]. **Mika *et al.***[28] demonstrated that extremely restricted glycemic control mitigates the progression of advanced cardiac autonomic dysfunction, suggesting that enhancements in HRV measures may result from enhanced glycemic regulation. Insufficient glycemic control as well as hyperglycemia lead to dysfunction in autonomic nerve fibers that innervate the cardiovascular system, attributed to the build-up of advanced products of glycation within these cells.

Despite significant reductions in HbA1c following HIIT in this study, no correlation was found between HRV, as indicated by SDNN, and HbA1c levels. **Hollekim-Strand *et al.*** [29] noted similar reductions in HbA1c among diabetic subjects following HIIT. These enhancements were attributed to excessive glucose uptake in skeletal muscle, resulting from AMP-activated kinase activation through enhanced GLUT4 translocation [30].

This study found that improvements in HRV occurred without significant weight loss, despite existing literature suggesting a correlation between weight loss and positive changes in HRV. Furthermore, alterations in all parameters of HRV have a significant correlation with the decrease in BMI among overweight as well as obese adults having type II DM [31].

The utilization of the GHQ-12 indicated that the three factors—anxiety, depression, social dysfunction, as well as loss of confidence—collectively enhance psychological well-being, as evidenced by the pre- and post-treatment mean score differences in patients with type II DM in addition to autonomic neuropathy. Comparative results from our study indicated that HIIT exercises were more efficient than moderate-intensity continuous exercise but interval and continues training in both exercise groups had a positive effect and showed an improvement of QOL in diabetic patients having autonomic neuropathy. We utilized the twelve items GHQ-12, our finding confirmed the study of **Veglio *et al.*** [32] indicating all three factors were improved after using structured program of aerobic and resistance exercise.

This study found that resting HR in diabetic patients had a significantly elevation, potentially attributable to destruction to the parasympathetic nervous system. This finding aligns with numerous studies that have reported similar results. The lack of significant weight loss in this study, despite enhanced HRV, aligns with recent findings indicating a weak correlation between BMI and HRV parameters in obese individuals. A significant decline in BMI was anticipated following 12 weeks of HIIT. However, the observed non-significant decline may be attributed to the pre-test characteristics of the individuals, as most participants were classified with mild obesity. The lack of difference in BMI may result from a rise in lean body mass coupled with a decline in fat mass. The current study did not provide confirmation, as differences in body fat percentage haven't been measured. The efficacy of HIIT in promoting weight reduction and enhancing body composition is well-established. Body composition changes are influenced by various factors, which involves exercise intensity, frequency, diet, as well as lifestyle.

LIMITATIONS

This study had several limitations. The selection of a single-sex sample was beneficial as it mitigated potential differences in HRV responses among genders. A limitation of this study was the absence of measurement of body fat percentage, which could aid in interpreting the enhancement in HRV parameters and its potential relationship to changes in body fat independent of weight reduction. An important limitation was the absence of measurement for the non-linear HRV indices. Additionally, the assessment of HRV solely via a 5-minute ECG recording may represent a limitation. Nonetheless, this brief recording duration may provide greater reliability compared to the 24-hour HRV recording that is influenced by circadian rhythms along with fluctuations in physical activity. Finally, HRV parameters were assessed solely during spontaneous breathing, excluding measurements taken during paced breathing.

CONCLUSION

Exercise training significantly enhanced HRV in patients with type II DM, associated with declined sympathetic activity and rise in parasympathetic activity. Interval training exhibited the most significant advantages regarding HRV parameters. Supervised training enhanced the majority of HRV parameters, independent of training duration as well as frequency. Patients who obtained the greatest benefit from exercise program were those with a longer duration since the diagnosis of type II DM. Enhancements in BMI, HbA1c, as well as blood pressure following exercise training were associated with enhancements in HRV.

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