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Effect of cardio training and smoking cessation on hemodynamic variables and Body Shape Index in diabetic smokers

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Abstract

Introduction: Diabetes mellitus (DM) is a chronic disease characterized by its severity, debilitating nature and significant economic burden, since it causes life-threatening complications. DM occurrence and frequency are increasing, impacting public health and economic aspects. The aim of the study was to assess the effect of cardio training and smoking cessation on hemodynamic variables and Body Shape Index in diabetic smokers.

Material and methods: The current investigation enrolled 60 male smokers with type 2 diabetes mellitus (T2DM). All patients were evaluated for height, weight, body mass index (BMI), A-shaped body index (ASBI), respiratory rate (RR), systolic (SBP) and diastolic blood pressure (DBP), heart rate (HR), and oxygen saturation (SpO2) at the beginning of the study and following 3 months of the intervention. The participants were randomly allocated into 2 equal-sized groups; Group (A) patients administered Metformin1gm and received cardio training (indoor treadmill brisk walking for 12 weeks, 3 times a week, each session 60 min, with submaximal intensity 50–60% of maximal HR reserve), a smoking cessation program, and nutritional advice; and group (B) patients administered Metformin1gm and received a smoking cessation program and nutritional advice.

Results: The study showed a significant difference in weight and BMI for both groups post-intervention, with a more significant percentage change across group B than group A, with p-value ($p < 0.05$).

Conclusions: Aerobic training is regarded as one of the most effective interventions in the management of type 2 diabetic patients, as it maintains good glycemic and weight control. Moreover, diabetic smokers who quit smoking can benefit from aerobic exercise, as it can probably be the main reason for improving smoking withdrawal symptoms.

Keywords: aerobic exercise, blood circulation, body weight, tobacco

Introduction

Cigarette smoking is a significant modifiable risk factor for developing diabetes mellitus (DM). Furthermore, smoking contributes to developing cancer, heart disease, and chronic obstructive pulmonary disease (COPD), leading to early mortality [1]. Cigarette smoking has particularly complicated and significant consequences on individuals with DM. Smokers with DM experience accelerated macrovascular and microvascular condition development, increasing mortality risk. The coexistence of smoking, DM, and its related consequences, including elevated blood pressure, modified lipid profiles, and cholesterol levels, may contribute to insulin resistance syndrome progression among individuals affected. This increases the susceptibility of patients to subsequent cardiovascular complications [2]. DM encompasses multiple metabolic disorders, due to impairments in insulin production, insulin activity, or a combination of both. Three primary categories of DM exist type 1, type 2, and gestational DM. DM is characterized by persistently elevated blood glucose levels, a condition known as chronic hyperglycemia. This metabolic state is linked to the development of microvascular and macrovascular consequences, such as retinopathy, nephropathy, neuropathy, and cardiovascular and cerebrovascular disease [3].

The global diabetes prevalence in 2021 was estimated to be 10.5% (536.6 million people), rising to 12.2% (783.2 million) in 2045. Global diabetes-related health expenditures were estimated at 966 billion USD in 2021, and are projected to reach 1,054 billion USD by 2045 [4]. Individuals diagnosed with type 2 diabetes mellitus (T2DM) typically exhibit insulin resistance and relative insulin insufficiency, as opposed to absolute insufficiency. The risk of acquiring T2DM is positively correlated to advancing age, obesity, smoking, and insufficient engagement in physical exercise [5]. Insulin resistance plays a major pathophysiological role in T2DM and can lead to other metabolic risk factors, including visceral adiposity, obesity, hypertension, coronary artery disease, glucose intolerance, dyslipidemia, and metabolic abnormalities that define the metabolic disorder or "Insulin Resistance Syndrome" [6].

Managing DM necessitates the integration of various components, including regular physical exercise, adherence to a certain dietary regimen, appropriate pharmaceutical usage, and consistent daily self-care practices, with a particular emphasis on glycemic control [7]. In the treatment and management of DM, aerobic exercise training is regarded as one of the most effective interventions, as exercise training has shown great effects in lowering blood pressure, fasting glucose and glycosylated hemoglobin (HbA1c), augmenting insulin sensitivity, regulating glucose levels, improving lipoprotein profile, and managing weight. Aerobic activity reduces metabolic risk factors for cardiovascular diseases [8]. Aerobic exercise training enhances glucose homeostasis and regulates body weight in T2DM patients, and exercise training must be accompanied by a calorie-restricted diet to achieve the maximum metabolic benefits [9].

People who quit smoking can benefit from aerobic exercise. Exercise training may increase the oxygen supply to the brain, which is probably the main reason for improving smoking withdrawal symptoms [10]. The present advice emphasizes the significance of quitting smoking in individuals with DM to enhance their quality of life and prevent the development and advancement of problems associated with DM [11].

The efficacy of acute aerobic exercise in mitigating hemodynamics in individuals without underlying health conditions has been well documented. Nevertheless, the impact of acute aerobic exercise on hemodynamics in individuals with DM remains insufficiently demonstrated [12]. Therefore, we hypothesized that cardio training and smoking cessation would alleviate selected health problems in diabetic smokers. The aim of the study was to assess the effect of cardio training and smoking cessation on hemodynamic variables and Body Shape Index in diabetic smokers.

Materials and methods

Ethics

The Research Ethical Committee of the Faculty of Physical Therapy at Cairo University has given an approval (P.T.REC/012/003343). Before signing an informed consent form, every patient received a comprehensive explanation of the objectives and methodologies of the study. The study was registers in Clinicaltrails.gov (identifier: NCT05624970).

Participants

Sixty male smoker patients with T2DM were chosen from the diabetic outpatient clinic of Qasr AL-Einy Hospital. The physicians of the hospital carefully examined all patients. Their age was 45–55 years, body mass index (BMI) was 18.5–29.9 kg/m^2, glycated haemoglobin (HbA1c) > 6.5%, and moderate to heavy smoking index, in addition to having been diagnosed as T2DM for over 5 years.

The participants were allocated randomly into two equal groups (Fig. 1): group A administered the medical treatment in the form of Metformin 1gm and received cardio training, a smoking cessation program, and nutritional advice; and group B administered Metformin 1gm and received a smoking cessation program and nutritional advice. The study excluded individuals with heart block and those who were smokers with any unstable medical condition, musculoskeletal or neurological disorders, hepatic diseases, kidney disorders, type 1 DM, uncontrolled hypertension, uncompensated heart failure, unstable angina pectoris, and current myocardial infarction.

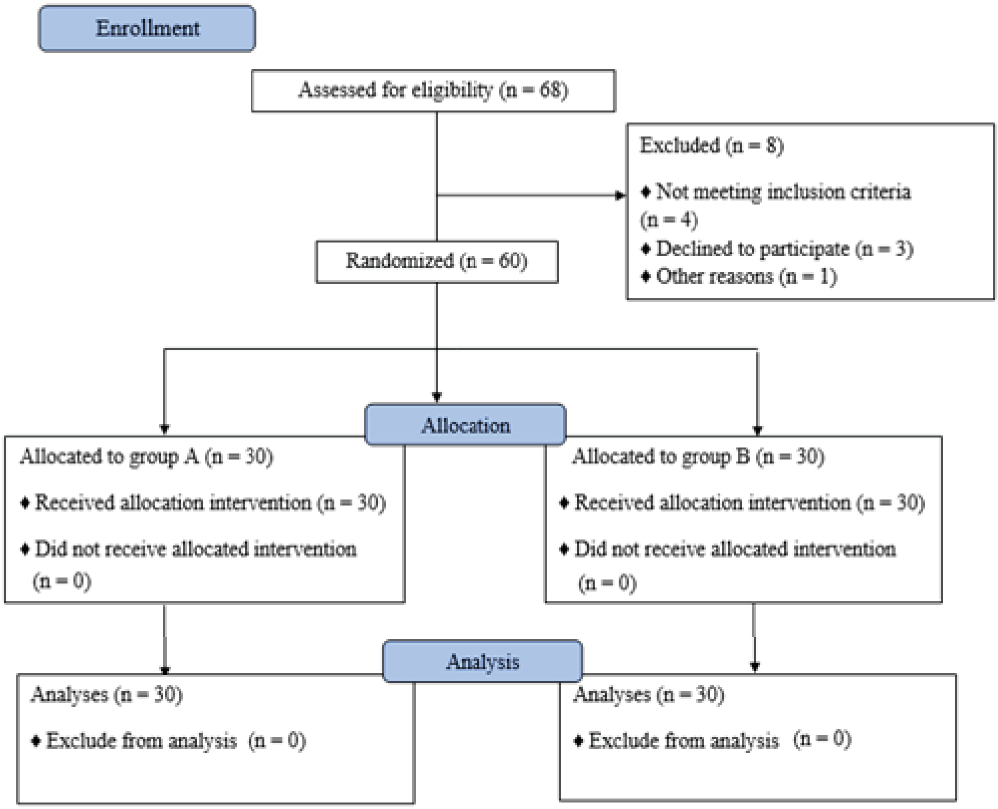

Fig. 1. Study flow chart

Intervention

Cardio training program

Patients completed indoor treadmill brisk walking for 12 weeks, performing this activity 3 times per week, with each session lasting for 60 min, with submaximal intensity (50–60% of maximal HR) utilizing the treadmill. The training routine consisted of three distinct phases: an initial warm-up period (10 min), followed by the main program (cardio exercise-40 min), and concluding with a cool-down period (10 min) [10].

The smoking cessation program consisted of 3 main strategies as follow [13]:

A) Strategies for behavioral techniques:

Individuals should establish a predetermined conclusion to their meal before commencing consumption, as smoking cigarettes signifies meal termination. They were encouraged to do activities after each meal; one good suggestion is walking for 30 min in the morning.

B) Strategies for cognitive approaches:

Participants are advised to employ cognitive strategies to redirect their thoughts to manage and mitigate cravings. For example, training an individual to develop their ability to “STOP” with a given stimulus is possible. Individuals who discontinue a particular endeavor may consider acknowledging their achievement and seeking assistance from their family members and community.

C) Strategies for post-cessation weight gain and depression:

Participants were not advised to initiate a highly restrictive dietary regimen. During the vulnerable phase following smoking cessation, the primary objective is to manage their weight rather than specifically focusing on weight reduction. Patients were encouraged to enhance their level of physical exercise, according to their interests.

Nutritional advice

Participants were advised to adhere to a nutritious dietary regimen, engage in meal pre-planning, increase their water intake, and limit their sodium consumption to a maximum of 2,300 mg daily. It is recommended that individuals prioritize consuming carbohydrates derived from vegetables, fruits, whole grains, legumes, and dairy products, instead of other types of carbohydrates, particularly those supplemented with fats, sugars or sodium, and that they also monitor their carbohydrate consumption for optimal glycemic control [14].

Outcome measures

Height, weight, BMI, waist circumference, A-shaped body index (ASBI), blood pressure systolic (SBP) and diastolic (DBP), respiratory rate (RR), Heart rate (HR), and oxygen saturation (SpO_2) were assessed at the beginning of the study and following 3 months of the intervention.

A weight and height scale (UGM-200 Health scale) was utilized to measure the weight and height of the participant in order to calculate BMI [15] and ABSI [16]. A flexible but not stretchy measuring tape passed around the participant's waist halfway between his lowest rib and the top of the pelvic bone was used to measure waist circumference while standing comfortably [17]. The sphygmomanometer (Mercury sphygmomanometer (ce0197) and Deluxe stethoscope) was used to obtain manual SBP and DBP measurements. The participants were in a resting position during measurements (sitting down and relaxing on a chair) [18]. The HR was measured by counting the beats in a set period (60 s) [19]. RR was measured while the participant was at rest by counting the number of breaths for 60 s [20]. A pulse oximeter (Contec Pulse oximeter CMS50D) was used to measure SpO_2 [21]. The smoking index was measured and calculated using the following formula: cigarettes per day (CPD) × years of tobacco use. We defined heavy smoking as ≥20 CPD and mild smoking as <20 CPD [22].

Statistical analysis

The collected data was analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The presentation of the quantitative data included mean ± standard deviation and ranges. The Independent-Sample t-test was used to assess the significant differences between the two means, while the paired sample t-test was employed to assess the significant differences between associated samples. The confidence interval was 95%, with a corresponding % error margin of 5%. Value of $p < 0.05$ indicated statistically significant.

Results

This study was conducted on sixty male smoker diabetic participants (Tab. 1) There were no statistically significant differences between groups regarding age, smoking index, height, weight, BMI, ABSI, SBP, DBP, HR, RR and SpO_2%.

Table 2 shows a significant ($p < 0.05$) higher mean value of weight and BMI in group B compared with group A.

Table 3 shows a significant ($p < 0.05$) higher mean value of weight and BMI in group B compared with group A. Moreover, group B showed a significantly ($p < 0.05$) greater mean reduction of DBP compared with group A.

Discussion

The purpose of this study was to see how cardio exercise and smoking cessation affected hemodynamic variables and body shape index in diabetic smokers. Our findings were consistent with the findings of a previous study, which found that an 8-week aerobic exercise program effectively reduced SBP, DBP and BMI compared to the control group, who were instructed not to engage in structured physical activity during the eight-week study period [7]. A recent study of aerobic and combined aerobic and resistance protocols used a sample of 30 participants, whose results were analyzed and

Tab. 1. Comparison analysis between group A and B based on parameters

Parameters	Group A (n = 30)	Group B (n = 30)	Test value	p-value
Age [years]	50.33 ± 3.59	50.20 ± 3.31	0.150	0.882
Smoking index	748.13 ± 187.24	784.00 ± 187.98	–0.740	0.462
Height [cm]	174.37 ± 4.77	173.27 ± 5.17	0.857	0.395
Weight [kg]	81.10 ± 5.87	82.37 ± 6.86	–0.769	0.445
BMI [kg/m^2]	26.69 ± 1.63	27.42 ± 1.69	–1.697	0.095
ABSI	0.088 ± 0.003	0.089 ± 0.002	–1.513	0.136
SBP [mmHg]	117.67 ± 9.71	119.6 7± 11.89	–0.714	0.478
DBP [mmHg]	80.00 ± 5.87	81.00 ± 7.12	–0.593	0.555
HR [beat/min]	93.37 ± 4.57	93.93 ± 4.58	–0.480	0.633
RR [breath/min]	28.43 ± 2.50	29.67 ± 2.37	–1.961	0.055
SpO_2%	97.10 ± 0.88	97.07 ± 0.83	0.151	0.881

ABSI – A Body Shape Index, BMI – Body Mass Index, DBP – diastolic blood pressure, HR – heart rate, RR – respiratory rate, SBP – systolic blood pressure, SpO_2 – oxygen saturation.

Tab. 2. A comparison analysis between group A and B based on variable post-intervention

Variable (Post)	Group A (n = 30)	Group B (n = 30)	Test value	p-value
Weight [kg]	82.17 ± 6.01	86.73 ± 7.46	–2.613	0.011*
BMI [kg/m^2]	27.04 ± 1.88	28.89 ± 2.21	–3.503	< 0.001**
ABSI	0.088 ± 0.003	0.089 ± 0.003	–0.725	0.471
SBP [mmHg]	117.00 ± 8.77	118.67 ± 10.08	–0.683	0.497
DBP [mmHg]	78.33 ± 4.61	76.00 ± 5.63	1.756	0.084
HR [beat/min]	93.17 ± 3.52	93.83 ± 3.50	–0.735	0.465
RR [breath/min]	28.10 ± 2.02	28.73 ± 1.68	–1.319	0.192
SpO_2%	97.90 ± 0.48	97.70 ± 0.53	1.523	0.133

ABSI – A Body Shape Index, BMI – Body Mass Index, DBP – diastolic blood pressure, HR – heart rate, RR – respiratory rate, SBP – systolic blood pressure, SpO_2 – oxygen saturation; *$p < 0.05$, **$p < 0.001$.

Tab. 3. A comparison analysis between group A and B based on the amount of change between pre- and post-intervention

Variable	Group A (n = 30)	Group B (n = 30)	Test value	p-value
Weight [kg]	1.07 ± 0.36	4.37 ± 0.58	–4.814	< 0.001**
BMI [kg/m^2]	0.36 ± 0.12	1.48 ± 0.20	–4.771	< 0.001**
ABSI	0.000 ± 0.000	–0.001 ± 0.000	1.286	0.204
SBP [mmHg]	–0.67 ± 0.67	–1.00 ± 0.73	0.336	0.738
DBP [mmHg]	–1.67 ± 0.97	–5.00 ± 1.15	2.217	0.031*
HR [beat/min]	–0.20 ± 0.38	–0.10 ± 0.29	–0.209	0.835
RR [breath/min]	–0.33 ± 0.28	–0.93 ± 0.23	1.639	0.107
SpO_2%	0.80 ± 0.16	0.63 ± 0.14	0.780	0.439

ABSI – A Body Shape Index, BMI – Body Mass Index, DBP – diastolic blood pressure, HR – heart rate, RR – respiratory rate, SBP – systolic blood pressure, SpO_2 – oxygen saturation; *$p < 0.05$, **$p < 0.001$.

categorized into two groups: an aerobic exercise group and a weighted vest group. Both groups exhibited a reduction in SBP and DBP and an increased breathing rate [8], which aligns with the findings of our study. An earlier study by Bhagyalakshmi et al. [23], who investigated the effect of regular supervised integrated aerobic exercise in individuals with T2DM, discovered a modest, progressive, and substantial improvement in mean heart rate variability (HRV) with increasing exercise duration. The autonomic nervous system regulation of heart activity is reflected in HRV.

Garg et al. [24] reported that tissue hypoxia plays a significant role in developing DM-related conditions. The study also found a correlation between obesity, glycation of hemoglobin, and SpO_2 in patients with T2DM. Therefore, physical activity can mitigate chronic hypoxia in individuals with T2DM by enhancing blood flow to the peripheral regions, which is in agreement with this study. The current investigation findings coincided with those of Voulgari et al. [25], who reported in their study on individuals with newly diagnosed T2DM that discontinuing smoking was linked to improved metabolic parameters and decreased blood pressure.

The present research outcomes revealed a statistically significant change in weight and BMI for both groups post-intervention, with the change percentage within Group B higher than that within Group A. That means both groups registered an increase in body weight and BMI after the smoking cessation program, but statistically, the increase in group A is less than that of group B, as patients in group A performed cardio exercise training. To comprehend the impact of smoking cessation on metabolism, it is necessary to get insight into the consequences of smoking and nicotine on body weight and metabolic parameters. The impact of nicotine on glucose metabolism and body weight is mediated by the activation of lipolysis, resulting in heightened energy expenditure and subsequent weight reduction [26]. This study coincided with the results obtained by Bajaj in his study that cigarette smoking can potentially elevate energy expenditure. Furthermore, smoking cigarettes has been observed to cause a rapid elevation in free fatty acid (FFA) levels due to the lipolysis induced by nicotine. [27].

The findings of this study were consistent with the findings of Hsia et al. [28], which indicated that a duration of 6–8 weeks of smoking cessation was associated with enhancements in insulin sensitivity. Furthermore, it can be inferred that individuals who engage in smoking cessation may temporarily exacerbate central fat redistribution within two months. However, this is followed by a more sustained improvement over time, provided the reduced smoking habit is consistently maintained for 24 weeks. Artese et al. [29] stated that smoking cessation improves insulin sensitivity, even with potential weight gain. This finding aligns with the results of the present investigation. On the contrary, the results declared by Campagna et al. [11] found that smoking cessation may be associated with an elevated risk of developing new-onset T2DM. The occurrence of weight gain and an increase in waist circumference resulting from smoking cessation may contribute to the development of insulin resistance.

Finally, this trial is to evaluate the effect of cardio training and smoking cessation in diabetic smokers, and hemodynamic variables and body shape index were evaluated. In addition to being beneficial and simple to implement, 60 patients followed the treatments throughout the research. The current study should be interpreted as a good step in the management of diabetes. However, the results of this study should be treated with caution due to the small sample size and the lack of details regarding the participant's characteristics. Future research ought to utilize a bigger sample size. Moreover, future research could investigate the impact of resisted exercise on smoker-diabetic patients, and also the impact of aerobic exercise versus resisted exercise.

Conclusions

Aerobic training is regarded as one of the most effective interventions in the management of type 2 diabetic patients as it maintains good glycemic and weight control. Furthermore, diabetic smokers who quit smoking can benefit from aerobic exercise, as it can probably be the main reason for improving smoking withdrawal symptoms.

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Conflict of interest
The authors have no conflict of interest to declare.

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