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Impact of aerobic versus resistance exercise training on glucose control and biomarkers of oxidative stress among Saudi patients with type 2 diabetes

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ABSTRACT

Background: *Type 2 diabetes (T2DM) is a chronic and progressive disease that is strongly associated with all-cause and cardiovascular mortality. Oxidative stress plays a key role in both initiation and complications of T2DM. There is limitation in clinical studies have addressed the ideal exercise intensity that efficiently modulates the insulin resistance and abnormal oxidative stress markers among type 2 diabetic patients.*

Objective: *The present study was designed to examine aerobic versus resisted exercise training effects upon insulin resistance and oxidative stress markers among type 2 diabetic patients.*

Material and Methods: *One hundred obese patients with type 2 diabetes mellitus, their age ranged from 45-57 years and their body mass index ranged from 30-36 kg/m2 were equally assigned into 2 groups: The first group received aerobic exercise training in the form of treadmill aerobic exercises where, the second group received resisted exercise training for 12 weeks.*

Results: *The mean values of Homeostasis Model Assessment-Insulin Resistance Index)HOMA-IR(, conjugated dienes (CD) and malondialdehyde (MDA) were significantly decreased, while the mean values of the quantitative insulin-sensitivity check index (QUICKI),glutathione peroxidase (GPx), superoxide dismutase (SOD) and glutathione (GSH) were significantly increased in patients of group (A) as a result of aerobic exercise training and group (B) as a result of resisted exercise training. There were significant differences between mean levels of the investigated parameters in group (A) and group (B) after treatment with more changes in patients received aerobic exercise training.*

Conclusion: *The current study provides evidence that aerobic exercise is more appropriate than resisted exercise training in modulating insulin resistance and oxidative stress among type 2 diabetic patients.*

Keywords: *Aerobic Exercise; Resisted Exercises; Type 2 Diabetes Mellitus; Oxidative Stress.*

Introduction

Diabetes mellitus is a worldwide medical problem affects about 6% world population which is expected to reach more than 550 million 2030 [1]. Many system dysfunctions are associated with diabetes include renal, cardiac, eye, nerve and blood vessels [2]. Hyperglycemia induces oxidative stress and inflammation[3].

Oxidative stress is usually associated with diabetes as a result of abnormal glucose control [4-7].However, oxidative stress is one of the main cause of diabetic complications [8-11]. In the other hand, metabolic control enhance antioxidant defense system in type 2 diabetes patients (T2DM) [12]. Hyperglycemia seems to cause an imbalance between oxidant and antioxidant systems in T2DM patients [13].

Physical activity reduces rate of mortality and morbidity in diabetic individuals [14-16]. Therefore, regular exercise is an effective therapeutic strategy for T2DM [17]. Aerobic exercise improves metabolic control and reduces the cardiovascular disease risk [18]. Physical activity ameliorate insulin resistance and oxidative stress [19-23].

Limited studies available regarding the ideal exercise intensity that efficiently modulates the metabolic control and oxidative stress of T2DM patients, therefore this study was designed to examine aerobic versus resisted exercise training effects upon insulin resistance and oxidative stress markers among T2DM patients.

Materials and Methods

Subjects

One hundred obese T2DM patients, their age mean was 49.71 ± 6.28 year and their body mass index (BMI) mean was 32.87±3.12 Kg/m2. Smoking, renal failure, heart failure, respiratory failure, hepatitis and pregnancy were the exclusion criteria. Participants were assigned into two groups; group (A) received aerobic exercise training on treadmill. While, group (B) received resisted exercise training. Informed written consent was signed by all participants.

Measurements

A. Measurement of insulin and insulin resistance: An insulin kit (Roche Diagnostics, Indianapolis, IN, USA) using a cobas immunoassay analyzer (Roche Diagnostics) was used to measure serum insulin. However, homeostasis model assessment (HOMA-IR). HOMA-IR = [fasting blood glucose (mmol/l) _ fasting insulin (mIU/ml)]/22.5 was used as a formula to assess insulin resistance [24]. While, the quantitative insulin-sensitivity check index (QUICKI) using the formula: QUICKI=1/[log(insulin) + log(glucose)] was used as a formula to assess insulin sensitivity [25].

B. Measurement of oxidative stress markers and anti-oxidant status: Plasma level of malondialdehyde (MDA) was measured by the method described by Esterbauer et al [26]. Glutathione (GSH) level was measured by adopting the method described by Weckbecker and Cory[27], glutathione peroxidase (GPx) and superoxide dismutase (SOD) were was estimated according the method described by Masnini [28].

Procedures

1. Group (A) received aerobic exercise training on treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holand) according to American College of Sports Medicine recommendation [29]. Participants conducted training intensity of 60-80% of maximum heart rate for 30 minutes, 3 sessions/week.

2. Group (B) received resistance exercises on some resistance gym machines (Nautilus Sports/Medical Industries, Independence, VA). Participants conducted training intensity of 60 and 80% of their one maximal repetition weight (1-RM) for 30 minutes, 3 sessions/week [30].

Results

The baseline characteristics of the participants revealed no significant differences between both groups as shown in table (1).

Table (1): *Baseline characteristics of all participants.*

	Group (A)	Group (B)	Significance
Age (year)	48.92 ± 6.15	49.75 ± 5.83	P <0.05
Gender (male/female)	31/19	34/16	P <0.05
BMI (kg/m^2)	32.73 ± 3.14	33.25 ± 3.11	P<0.05
Duration of diabetes (years)	13.87 ± 3.91	12.56 ± 4.12	P<0.05
SBP (mmHg)	145.16 ± 11.18	143.27 ± 10.32	P <0.05
DBP (mmHg)	89.14 ± 6.35	86.92 ± 7.64	P<0.05
Total Cholesterol (mg/dL)	205.37 ± 18.42	200.13 ± 16.25	P <0.05
HDL-C(mg/dL)	41.63 ± 6.71	44.53 ± 7.15	P <0.05
Triglycerides(mg/dL)	148.11 ± 12.57	144.74 ± 10.13	P<0.05
HBA1c (%)	8.61 ± 2.83	8.21 ± 2.54	P<0.05
Glucose (mmol/L)	5.44 ±1.28	5.26 ± 1.14	P <0.05
Insulin (pmol/L)	20.65 ±5.10	18.37 ± 4.88	P<0.05

BMI: Body Mass Index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL-C: High density lipoprotein cholesterol; HBA1c: glycosylated hemoglobin.

The mean values of MDA, SOD and HOMA-IR were significantly decreased, while the mean values of GSH, GPx and QUICKI were significantly increased in patients of group (A) as a result of aerobic exercise training and group (B) as a result of resisted exercise training(Table 2 and 3). However, there were significant differences between mean levels of the investigated parameters in group (A) and group (B) after treatment with more changes in patients received aerobic exercise training (Table 4).

	Mean +SD		T-value	Significance
	Pre	Post		
MDA (nM/mL)	0.30 ± 0.08	0.17 ± 0.05*	7.24	P<0.05
GSH (nM/mL)	3.45 ± 0.74	4.51 ± 0.86*	6.83	P<0.05
GPX (UI/mL)	2.86 ± 0.42	3.62 ± 0.57*	6.92	P <0.05
SOD (UI/mL)	118.25 ± 17.63	98.85 ± 12.13*	7.43	P<0.05
QUICKI	0.123 ± 0.018	0.155 ± 0.024*	6.85	P <0.05
HOMA-IR	5.17 ± 1.65	3.95 ± 1.48*	6.27	P <0.05

MDA: Malondialdehyde; GSH: Glutathione; GPX: Glutathione peroxidase; SOD: Superoxide dismutase; QUICKI: The quantitative insulin-sensitivity check index; HOMA-IR: Homeostasis Model Assessment-Insulin Resistance Index; (*) indicates a significant difference, P < 0.05.

Table (2): *Mean value and significance of MDA, GSH, GPX,SOD, QUICKI and HOMA-IR in group (A) before and at the end of the study.*

	Mean +SD		T-value	Significance
	Pre	Post		
MDA (nM/mL)	0.34 ± 0.07	0.25 ± 0.06	3.67	P<0.05
GSH (nM/mL)	3.21 ± 0.68	3.79 ± 0.72	3.45	P<0.05
GPX (UI/mL)	2.95 ± 0.47	3.36 ± 0.53	3.71	P <0.05
SOD (UI/mL)	121.34 ± 18.12	108.45 ±13.44	4.52	P<0.05
QUICKI	0.120 ± 0.019	0.134 ± 0.023	3.37	P <0.05
HOMA-IR	5.31 ± 1.76*	4.62 ± 1.52	3.54	P <0.05

MDA: Malondialdehyde; GSH: Glutathione; GPX: Glutathione peroxidase; SOD: Superoxide dismutase; QUICKI: The quantitative insulin-sensitivity check index; HOMA-IR: Homeostasis Model Assessment-Insulin Resistance Index; (*) indicates a significant difference, P < 0.05.

Table (3): *Mean value and significance of MDA, GSH, GPX,SOD, QUICKI and HOMA-IR in group (B) before and at the end of the study.*

	Mean +SD		T-value	Significance
	Group (A)	Group (B)		
MDA (nM/mL)	0.17 ± 0.05*	0.25 ± 0.06	3.42	P<0.05
GSH (nM/mL)	4.51 ± 0.86*	3.79 ± 0.72	3.61	P<0.05
GPX (UI/mL)	3.62 ± 0.57*	3.36 ± 0.53	3.55	P <0.05
SOD (UI/mL)	98.85 ±12.13*	108.45 ±13.44	3.91	P<0.05
QUICKI	0.142 ± 0.021*	0.134 ± 0.023	3.43	P <0.05
HOMA-IR	3.95 ± 1.48*	4.62 ± 1.52	3.77	P <0.05

MDA: Malondialdehyde; GSH: Glutathione; GPX: Glutathione peroxidase; SOD: Superoxide dismutase; QUICKI: The quantitative insulin-sensitivity check index; HOMA-IR: Homeostasis Model Assessment-Insulin Resistance Index; (*) indicates a significant difference, P < 0.05.

Table (4): *Mean value and significance of MDA, GSH, GPX,SOD, QUICKI and HOMA-IR in group (A) and group (B) at the end of the study.*

Discussion

Oxidative stress (OS) plays a major role in pathogenesis of T2DM complications [31,32]. Therefore this study was designed to examine aerobic versus resisted exercise training effects upon insulin resistance and oxidative stress markers among T2DM patients.

Concerning insulin resistance, both aerobic exercise and resisted exercise training significantly improved insulin resistance, these results agreed with *Bacchi et al*. stated that 4 months of aerobic and resistance exercises improved insulin sensitivity in T2DM with nonalcoholic fatty liver [33]. However, *Angelico et al*. reported that 5%-10% weight loss of patients with metabolic syndrome modulated insulin resistance [34].

Concerning oxidative stress, results of the present study proved that both aerobic and resistance exercises mean values of MDA, SOD and HOMA-IR were significantly decreased, while the mean values of GSH, GPx and QUICKI were significantly increased in T2DM patients. These results agreed with previous studies that stated that 6 months of aerobic exercise increased GSH in T2DM individuals [35,36]. However, another study reported that 24 weeks of resistance exercise ameliorated oxidative stress in obese individuals [37]. In addition, *Oliveira et al*. confirmed that 4 months of aerobic exercise improved oxidative stress markers among T2DM subjects [38]. However, *Vinetti et al*. found that 12 months of combined aerobic, resistance and flexibility training modulated oxidative stress among T2DM patients[39]. While, *Farinha et al*. mentioned that 3 months of treadmill exercise improved oxidative stress in women with metabolic syndrome [40]. Similarly, *Nojima et al*. stated that 12 months of aerobic exercise improved metabolic control and oxidative stress markers among T2DM patients [41]. Moreover, *Gordon et al*. proved that 3 months of Hatha yoga exercise improved glucose control, blood lipid profile and oxidative stress markers among T2DM patients [42]. The possible mechanisms for modulation of oxidative stress markers following exercise training may include improvement in glucose control[43-46], also improved insulin sensitivity in target tissues is the second possible mechanism for reduction in oxidative stress by aerobic and resistance exercise training [47,48].

Conclusion

Aerobic exercise is more appropriate than resisted exercise training in modulating insulin resistance and oxidative stress among type 2 diabetic patients.

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