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The effect of non-supervised moderate intensity aerobic physical activity on glycemic control, lipid profile and Body mass index (BMI) of type II diabetic patients in Benghazi.

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Abstract:
Background: *Diabetes mellitus has become a worldwide epidemic. Applying exercise regularly has a positive impact on type II diabetics and considered as a therapeutic non-pharmacological mode for diabetes mellitus (DM).* ***Aims:*** *to study the effects of moderate intensity aerobic physical activity on glycemic control, lipid profile and body mass index (BMI) of type II diabetics.* ***Method:*** *80 cases of type II diabetic patients were recruited. While 54 subjects were involved on non-supervised regular exercise (30 minutes- 5 to 7 days/week) for 12 weeks (EX group), 26 were sedentary (NEX group). Complete history and laboratory investigations including fasting blood sugar (FBS), random blood sugar (RBS), glycated hemoglobin (HbA1c), cholesterol (Ch), Triglyceride (T.G.), low density lipoprotein (LDL), high density lipoprotein (HDL), very low density lipoprotien (VLDL) and BMI were measured for each participant in two time points: base line and after 12 weeks.* ***Results:*** *Base line glycemic indices for EX group (FBS, and HbA1c) were significantly reduced after 12 weeks of exercise (180.4 ±67.9 Vs 124 ±30, 8.38 ±2 Vs 7 ±1.2, respectively; P value = 0.000). There was a significant decrease in Cholesterol, TG, and LDL values post 12 weeks of exercise compared to baseline values (p value= 0.000). Similarly, the results reported a significant decrease in BMI values post exercise compared to pre-exercise measurements (30± 6 Vs 31 ± 6, P value =0.000). No significant changes were documented in glycemic indices, lipid profile and BMI in the control group.* ***Conclusion:*** *The aerobic exercise has a beneficial effect on metabolic control (i.e. hyperglycemia, hyper lipidemic and obesity) for diabetes. Hence, it is recommended as a non-pharmacologic therapeutic modality in the management of type II DM.*

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I. Introduction

There is no doubt that physical activity (PA) has numerous beneficial effects that can be achieved acutely and on more regular basis participation (Duclos et al, 2013). Among these benefits, it is associated with improved quality of life (Fox, 1999), decreased cardiovascular risk factors (Franco et al., 2005), and mortality (Kujala et al., 1998). Furthermore, physical activity plays a major role in the prevention and control of insulin resistance, prediabetes, gestational diabetes mellitus, type II diabetes, and diabetes-related health complications (Colberg et al, 2010).

In fact, physical activity is considered as the cornerstone of lifestyle modification that aid in the prevention and management of type II diabetes and its related morbidities (Colberg et al, 2010, and Duclos et al, 2013). Regarding this aspect, the involvement in both aerobic and resistance training would improve insulin action, at least acutely, and can assist with management of blood glucose levels, lipids, blood pressure, cardiovascular risk, mortality, and quality of life (Voulgari et al, 2013, Colberg et al, 2015).

The American College of Sports Medicine (ACSM) and American Diabetic association joint position statement (Colberg et al, 2010) did recommend the type II diabetes population to perform at least 150 minutes a week of moderate to vigorous aerobic, at least three days of the week, with no more than two consecutive days between exercising. The types of moderate exercises include Brisk walking, running, jumping rope, and walking stairs, all these activities are recommended by the American College of Sport Medicine (ACSM) and the American Diabetes Association (ADA) (July 2010).

In literature, Qiu S. et al (2014) had suggested the non-supervised walking exercise as an effective strategy for decreasing glycosylated hemoglobin (HbA1c). Nearby, Mendes R. et al (2017) stated that a long-term exercise program is an effective strategy in inducing significant benefits on glycemic control, lipid profile (total cholesterol, LDL, HDL, and triglycerides) in type II DM patients. Besides, NajafipourF et al (2017) reported a significant reduction in HbA1c and BMI in exercise group of type II DM compared to control one. Likewise, Nojima H.et al (2017) documented that moderate intensity exercise is associated with reduction in

glycemic parameters. Together, all of previously mentioned positive changes will reduce the risk factors for type II DM and plays a valuable role on its management.

In reality, few diabetic patients do participate in physical activity programs in non-sufficient level (Colberg et al., 2010, and Duclos et al, 2013). Up to date, there is lack of data among the effect of non-supervised physical activity on the glycemic control, lipid profile and BMI among type II diabetic patients in Benghazi - Libya. Hence, this study aims to evaluate the effect of non-supervised moderate intensity physical activity on glycemic indices, lipid profile and BMI of type II DM patients in Benghazi – Libya.

II. Materials And Method

After ethical approval, a written consent was taken from who were agreed to participate. A case control study included randomized 80 diagnosed cases of DM; aged between 18 to 65 years. The exclusion criteria were: chronic diseases (other than DM and hypertension), neuromuscular diseases, pregnancy, history of smoking, regular exercise and diet plan. Physical examination, investigation and ECG were done for all participants before starting the protocol of the study.

54 participants were considered as exercise group (EX), while 26 participants were considered as control cases (NEX). The data was collected from four medical centers at Benghazi (Ibnzahr medical center , Al lithy medical center , Ibn Sina clinic and Al Ekha clinic). A self-prepared health questionnaire which cover the followings: personal data, medical, family, drug history, details about physical activity, precautions before exercise, questions about diet and treatment modifications before and after exercise was filled by each candidate. Moreover, the measurements of indices of blood sugar [fasting blood sugar (FBS), random blood sugar (RBS), glycated hemoglobin (HbA1c)] were taken at two time points: baseline and after twelve weeks of intervention. Besides, the indices of lipid profiles [cholesterol, triglyceride (TG), low density lipoprotein (LDL) high density lipoprotein (HDL), and very low-density lipoprotein (VLDL)] were measured at the same previously stated time points. The laboratory investigations estimated by automatic analysers ACCENT-200 and ACCENT-200 II GEN, and BMI was calculated by using Queenlet index (Weight in kg / Height in meter squared).

Based on their interest, EX group were asked perform a moderate intensity exercise according to their interest, for twelve weeks; for thirty minutes / day for 3 to 5 days a week. This was approved by providing the participants the exercise prescription that determine different types that represents in order to fit the moderate physical activity criteria. The exercise prescription would allow the participants to choose the suitable exercise that can be conducted by them. On the other hand, every participant was asked to fill the required information in the log book. This information includes the following details: type, day, date, and duration of exercise.

All collected data were gathered and analyzed using Statistical package of social sciences SPSS software package (version 18). Quantitive data was expressed to measure if there is significant difference between the values of parameters for EX group before and after exercise, comparing them with NEX group and evaluate the results. Two-tailed P value < 0.05 >0.01 was considered statistically significant, while P value < 0.01 was considered statistically highly significant.

III. Results:

Among sample population, forty-eight of them were males and thirty-two were female. The results (Table 1) showed a highly significant decrease in FBS, RBS and HBA1c values as glycemic indices post exercise for 12 weeks compared to pre exercise measurements (Fasting blood sugar FBS, Random blood sugar RBS and HbA1c): (124 +_ 30 Vs 180+_ 68; 165 +_ 52 Vs 236 +_ 104; and 7 +_ 1.2 Vs 8+_ 2) respectively (P value = 0.000).

Table 1: Glycemic indices changes post 12 weeks of exercise among exercise trial; N= 54 ; values are mean and standard deviation

Parameter	Pre - exercise	Post - exercise	P value
FBS	180+_ 68	124 +_ 30	0.000**
RBS	236 +_ 104	165 +_ 52	0.000**
HbA1c	8+_ 2	7 +_ 1.2	0.000**

P value =<0.05 significant. ** P value = < 0.01 highly significant

Evaluating the lipid indices, showed a high significant decrease (P value =0.001) in cholesterol, TG, LDL and VLDL values post 12 weeks of exercise compared to pre-exercise measurements (183+_35 Vs 195+_43; 145.4 +_54 Vs168+_81; 115+_29 Vs 125+_35 and 29+_11 Vs 34 +_17). On the other hand, the results reported a significant increase in HDL measurements post 12 weeks of exercise (38+_9) compared to base line HDL (37+_11) (P= 0.05). Looking at the BMI values, there was a highly significant decrease (P value = 0.000) in post twelve weeks of exercise compared to pre exercise values (30+_6 Vs 31+_6). Table 2 illustrates the results.

Table 2: Lipid indices and BMI changes post 12 weeks of exercise among exercise trial; N= 54; values are mean and standard deviation

Parameter	Pre - exercise	Post - exercise	P value
Cholesterol	195+_43	183+_35	0.001**
TG	168+_81	145.4	0.001**
LDL	125+_35	115+_29	0.001**
VLDL	34 +_17	29+_11	0.002**
HDL	38+_9	37+_11	0.05*
BMI	31+_6	30+_6	0.000**

P value =<0.05 significant. ** P value = < 0.01 highly significant

In control group, all the glycemic indices reported a non-significant decrease on their measurements post 12 weeks of rest compared to baseline measurements. In addition, the Cholesterol, TG, LDL, VLDL and HDL values showed a non-significant increase in their values post 12 weeks of non-exercise compared to baseline values. Furthermore, the BMI values didn't demonstrate any significant change in NEX group post 12 weeks of rest compared to baseline values. Table 3 summarize all of the measurement pre and post twelve weeks of rest among non-exercise group.

Table 3: Glycemic, lipid indices and BMI changes post 12 weeks of rest among non exercise trial; N= 26; values are mean and standard deviation

Parameter	Baseline	Post 12 weeks rest	P value
FBS	164+_47	148+_53	0.10
RBS	208+_80	180+_58	0.04*
HbA1c	8+_2	8+_1	0.09
Cholesterol	186+_38	189+_34	0.53
TG	156+_130	130+_38	0.24
LDL	118+_33	124 +_28	0.21
VLDL	31+_244	26 +_8	0.25
HDL	37+_12	39 +_14	0.30
BMI	34+_5	33+_6	0.24

P value =<0.05 significant. ** P value = < 0.01 highly significant

Between the two groups, the results showed a significant decrease in FBS values in EX group compared to the decrease in NEX group (p=<0.05). Moreover, it did document a high significant decrease in HbA1c and BMI in EX group compared to the documented changes in NEX group (p=0.01).

IV. Discussion

A sedentary lifestyle should be considered an important modifiable risk factor for type 2 diabetes (Shari et al, 2005). In fact, the physical activity has been considered as one of the cornerstones in the treatment of diabetes mellitus (Laaksonen et al., 2007) Physiologically, physical training would increase glycogen synthase activity, GLUT4 protein expression and lipid storage in muscle which thereby increases fat oxidation capacity (Zakia Ibrahim Belkhair (2018), Colberg et al, 2015). Hence, this would increase the glucose up take via glucose transporter GLUT4 proteins by its translocation from intracellular to the cell surface of the skeletal muscles (Wenrui Wu et al. 2016). Subsequently, training would enhance the responsiveness of skeletal muscles to insulin via an increased expression and/or activity of proteins involved in glucose metabolism and insulin signaling (Perseghin et al., 1996 Slentz et al., 2009). Hence, it is acceptable to state that PA would improve glycemic control through increased insulin sensitivity and glucose tolerance.

The results of this work revealed a high significant (P <0.01) decrease in glycemic indices (FBS, RBS, HbA1c) values for EX group compared to pre-exercise values. Between the trials, there were significant decreases in FBS for EX group compared to change in NEX group. Moreover, there was a highly significant decrease in HbA1c and BMI for EX group compared to the change in NEX group. Collectively, all of these observations indicate the value of exercise as a part of management of diabetes.

Actually, our results are in agreement with Nojima H.et al (2017) who reported that moderate intensity exercise is associated with reduction in glycemic parameters. In addition, Mendes R .et al (2017) concluded that exercise program was effective in inducing significant benefits on glycemic control in middle-aged and older patients with type II DM patients. Moreover, Pahra D.et al., (2017) showed a significant improvement in blood glucose profile and HbA1c after performing moderate-intensity brisk walking exercises in type II DM patients. Besides, Najafipour et al., (2017) documented that long-term exercise training program had a significant effect on HbA1C, and BMI compared with patients in NEX group. As well, Mishra N (2014) reported that FBS and HbA1c were significantly reduced after exercise participation.

Obesity is a common presentation in type II DM. Actually, it is characterized by sympathetic hyperactivity and the significant loss of cardiac parasympathetic influx (Voulgari et al, 2013). Subsequently,

these would be manifested via different pathogenetic mechanisms, including hyperinsulinemia, visceral obesity, subclinical inflammation and increased thrombosis (Voulgari et al, 2013). However, regular physical activity is beneficial for cardiovascular health via a decrease in the risk of cardiovascular disease development, and subsequently its cardiovascular mortality.

The biomedical research findings revealed that physical activity positively affects lipid profile which would subsequently lower the blood pressure, promotes insulin sensitivity, and restores the quality of life in type II DM (Colberg et al., 2010, Nystoriak et al., 2018). In support, Slentz et al., (2009) reported that exercise in sufficient amounts can lead to substantial decreases in body weight, total body fat, and visceral fat. Moreover, the authors documented that physical activity can induce changes in mitochondrial oxidative capacity in skeletal muscle which afterward appear to improve insulin action by reducing the accumulation of incompletely oxidized fatty acids.

In our study, the results showed a high significant (p- value <0.01) decrease in lipid indices (Cholesterol, TG, LDL and VLDL) for the EX group compared to pre-exercise values. On the other hand, the results reported a significant (p-value > 0.01) increase in HDL level post exercise. These observations are in agreement with Mendes R. et al., (2017) who approved that a long-term, community-based, combined exercise program developed with low-cost exercise strategies was effective in inducing significant benefits on glycemic control, lipid profile (total cholesterol, LDL, HDL and triglycerides). Furthermore, Kelley, G. A. , & Kelley , K. S. (2012) observed a statistically significant reduction of about 5% of LDL post eight weeks or more of aerobic exercise on the levels of lipids and lipoproteins in adults with type II DM.

However, there were no significant changes between the values of pre and post 12 weeks of rest in all lipid indices (Cholesterol, LDL, TG, VLDL, and HDL) for NEX group. Similarly, Qiu S. et al., (2014) reported that walking non-significantly changed high-density or low-density lipoprotein cholesterol levels.

Globally, Overweight and obese type II DM patients are increasing in prevalence (Pi-Sunyer, 2014). Physical inactivity and high BMI are considered as independent risk factors in the development of type II DM (Weinstein et al, 2004) and they have been suggested that they might interact (Li Qin et al, 2010). Biochemically, the excessive free fatty acid released by adipose tissue leads to a decrease in insulin sensitivity of muscle, fat and liver. Subsequently, this will (Bjorntorp 1991, Boden 1997, Lewis, et al. 2002 and McGarry. Banting lecture 2001).

Actually, an important documented well-known complication in type II DM is an increased risk of cardiovascular disease (CVD). In this respect, the risk of developing CVD among II DM patients is twice than the non-diabetic population (Emerging Risk Factor Collaboration, 2010). However, physical activity may counteract the diabetogenic impact of obesity by reducing fat mass, increasing fat oxidative capability or through other biological pathways, and obesity may be less detrimental to physically fit individuals with or without diabetes [6, 7 in Li quin paper].

In our study, there was a highly significant decrease (P value = 0.000) in BMI post twelve weeks of exercise compared to pre-exercise values (30 ± 6 Vs 31 ± 6). Furthermore, there was a highly significant decrease in BMI for EX group compared to documented changes in NEX group (p=0.01). The overall findings of our study are in agreement with a previous research published by Shari et al., 2005 who indicated that regular physical activity has beneficial effects on many risk factors for diabetic population, including regulating body weight, enhancing insulin sensitivity and glycemic control, reducing blood pressure, and atherogenic dyslipidemia. Besides, Mendes R. et al, 2017 stated that light physical activity can improve lipid homeostasis and assist in lowering the risk factors for type II DM patients. As authors explained, the positive effects of physical activity are achieved via reducing visceral fat mass, blood cholesterol, and insulin resistance.

Functionally, the results of our work can be implicated in treatment of type II DM patients by encouraging them for moderate exercise as a non-pharmacological mode of management in addition to other modes. Applying physical activity intervention aims to improve the glycemic status, lipid profile and reducing BMI which will indirectly reduce consumption of anti-hyperglycemic drugs, decrease their side effects along with reducing cost, reduce incidence of associated diseases and complications, and improve the quality of life of type II DM patients.

In conclusion, the results of our research support a prescription of moderate intensity aerobic exercise for type II DM population as a non-pharmacologic therapeutic modality to obtain additional benefits on glycemic control, lipid profile and BMI to improve their quality of life.

In reality, these results indicated that aerobic exercises have a beneficial effect on metabolic control (i.e. hyperglycemia, hyperlipidemia, obesity) and aid in diabetes management and help in the prevention or at least delaying the occurrence of related diabetes complications.

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