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A HEMATOBIOCHEMICAL EVALUATION TO COMPARE THE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING AND AEROBIC EXERCISE TO CONTROL DIABETES MELLITIS AND ITS COMPLICATIONS

¹Muneeb Iqbal²Imtiaz Rabani³Salman Malik⁴Amir Saeed⁵Muhammad Akhtar⁶Shumaila Ehsan⁷Iqra Mubeen⁸Saifullah Khalid

ABSTRACT

Background: Diabetes has become a very common disease all over the world since last few decades and is now perceived as a global health disorder. Diabetes mellitus is identified on the basis of constant high concentration of blood glucose level and it mainly occurs due to deficiency of the pancreatic hormone insulin. High-intensity interval training (HIIT) is an improved form of interval trainings, and exercise strategies which alternate the periods of small intense anaerobic exercise by less-intense regaining periods. The study aimed to compare the hematological parameters associated with diabetes and muscle activity between healthy humans and diabetic type-1 patients when subjected to HIIT and regular aerobic exercises.

Method: A convenience sample of total 60 participants was taken it comprised of thirty healthy individuals taken from the department of Physical Therapy, University of Sargodha, Lahore campus and thirty diabetic type-1 individuals of age 15-30 years taken from Akhuwat health services clinic Township, Lahore. Participants were divided into four groups of fifteen individuals each. Group one was the diabetic HIIT (DH) group with diabetic type-1 patients subjected to HIIT. Group two was the diabetic aerobic (DA) group with diabetic type-1 patients subjected to regular aerobic exercises. Group three was control High intensity interval training (HH) that consisted of fifteen healthy individuals to be subjected to High intensity interval training exercises (HIIT). Group four (HA) was the control aerobic group with fifteen healthy individuals of average lifestyles subjected to regular aerobic exercises.

Results: Aerobic exercise was found to be more effective in reducing glucose level, lowering exogenous insulin and glycated hemoglobin, however HIIT proved to be more effective in lowering blood cholesterol level and decrease LDL level and increase HDL level.

Conclusion: It was concluded that aerobic exercise program in comparison to high intensity interval training showed better results in lowering blood glucose levels and HbA1c levels. So we may suggest aerobic exercise program along with drugs as a synergic therapy to control diabetes and its complications.

Keywords: Sprint interval trainings (SIT), High-intensity intermittent exercises (HIIE), Diabetes mellitus, Aerobic exercise, Glycated hemoglobin, Low density lipoproteins, High density lipoproteins

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CORRESPONDING AUTHOR

¹Muneeb Iqbal

University of Veterinary and
Animal Sciences,
Shaykh Abdul Qadir Jilani Rd,
Lahore 54000, Pakistan.

²Physiology department, University of Veterinary and Animal Sciences, Shaykh Abdul Qadir Jilani Rd, Lahore 54000, Pakistan.

³Principal Multan Institute of health sciences, Multan, Pakistan.

⁴Head of Department, Sheikh zaid Hospital, Lahore, Pakistan.

⁵Head of Department, Social Security Hospital, Gujranwala, Pakistan.

⁶School of Physiotherapy, King Edward medical University

⁷Research Officer, Multan Institute of health sciences, Multan, Pakistan.

⁸Senior lecturer, Institutional Address: Institute of Physical Medicine and Rehabilitation Dow University of Health Sciences, Karachi, Pakistan.

INTRODUCTION

Diabetes mellitus has become a severe metabolic disorder worldwide. Diabetes mellitus is a metabolic disease associated with decreased production of insulin due to a disturbance in the normal function of the pancreas, which results in hyperglycemia [1]. It has several etiologies as it is not a single disease but a group of metabolic diseases, which results in high blood glucose level. During the last fifteen years the incidence of diabetes mellitus has increased intensely in several countries of the world and now this disease is considered as a global public health problem. It is believed that from 2009 to 2031 there will be a rise of 68% diabetic patients in the developing countries and up to 21% in developed countries [2]. Physical exercise is some bodily activity which improves or maintains overall health physical fitness and wellness. It is done for several reasons like strengthening of muscles, improving cardiovascular system, enhancing athletic skills, reducing weight or for the maintenance of overall health and also for enjoyment [3] frequent and consistent physical exercises strengthen immune system, and also help to avoid disease of affluence like cardiovascular disease, heart disease obesity and diabetes [4].

High-intensity interval training (HIIT), also known as sprint interval trainings (SIT) or high-intensity intermittent exercises (HIIE), are an improved form of interval trainings, and exercise strategies which alternate the periods of small intense anaerobic exercise by less-intense regaining periods. HIIT sessions can usually fluctuate from 3–30 minutes. HIIT can be of moderate-level intensity or slow like walking it varies from person to person and depends upon one's cardiovascular development. High intensity trainings (HIIT) are strengthening type trainings which became prevalent in the 1980s. The chief principles of HIIT are: short exercise (1-4 sets of simple exercises in one hour training session or shorter), strenuous exercise and infrequent workouts (not more than three times a week usually twice or can be only once) [5].

Trapp et al. (2008) revealed that high-intensity interval trainings beneficially effects health of both diabetic and healthy people [6]. It was observed that if HIIT was performed four times a week for seven weeks matched to similar frequency of aerobic exercises, there was a substantial decrease in trunk fat, subcutaneous leg fat, total body fat and as well as in insulin resistance in case of young women [7]. According to Little et al. (2011) HIIT quickly improves glucose control and also induces variations in the skeletal muscles which are related to enhanced metabolic health in type-2 diabetes patients [8]. Adams et al. (2013) exhibited that very short-lived HIIT recovers blood glucose in 1 to 4 days by post exercises in both healthy and diabetic patients [9]. HIIT is not likely to induce hypoglycemia during and instantly after exercise. Mitranun et al. (2014) exhibited that both interval and continuous trainings were proved effective in enhancing glycaemic control, endothelium dependent vasodilatation and aerobic fitness but interval trainings seem to confer better improvements as compared

to continuous training programs[10].

Different patterns of exercises like aerobic and HIIT affect differently to blood parameters and play important role in improving glucose metabolism and lowering harmful lipids in the human body. The objective of the present study is to compare hematological parameters associated with diabetes and muscle activity between healthy humans and diabetic type-1 patients when subjected to HIIT and regular aerobic exercises.

MATERIALS AND METHODS

A convenience sample of thirty healthy and thirty diabetic type-1 individuals of age 15-30 years were included in this study. These patients were taken from Akhuwat health services clinic Township, Lahore and healthy individuals were taken from the department of Physical Therapy, University of Sargodha, Lahore campus. They were divided into four groups of fifteen individuals. Group one was the diabetic HIIT (DH) group with diabetic type-1 patients subjected to HIIT. Group two was the diabetic aerobic (DA) group with fifteen diabetic type-1 patients subjected to regular aerobic exercises. Group three was control High intensity interval training (HH) that consisted of fifteen healthy individuals to be subjected to High intensity interval training exercises (HIIT). Group four (HA) was the control aerobic group with fifteen healthy individuals of average lifestyles subjected to regular aerobic exercises. Group one and three i.e. DH and HH groups were exercised 20 minutes, 4-5 days/week for a total duration of 6 weeks. Exercise consisted of a 5 minutes warm up, 20 seconds of ultra-high intensity exercise (treadmill, stationary bike, eclipter, jumping rope, punching bag, weights) followed by 10 seconds of rest, repeated continuously for 4 minutes, 5 intervals, and ending with a 2 minute cool down period [11] whereas group 2 and 4 i.e. DA and HA groups were exercised aerobically (brisk walking, jogging, skipping) for half an hour daily for 5 days a week for a total duration of 6 weeks [12]. Blood samples from all groups in fasting/basal state were collected in dry glass centrifuge tubes at the start of trial and then at the end of the trial and were allowed to coagulate at room temperature. The tubes were then centrifuged at 4000rpm for ten minutes to obtain clear, non-hemolysed supernatants sera that were be separated using clean dry disposable plastic syringes and then stored at -20°C for biological analysis. Thebiochemical analysis of serum creatin kinase to check muscle damage, fasting blood sugar test and HbA1c test to evaluate effect of HIIT and aerobic exercises on blood glucose consumption and total cholesterol, serum LDL, HDL and triglycerides to evaluate lipid profile was done by using commercially available kits.

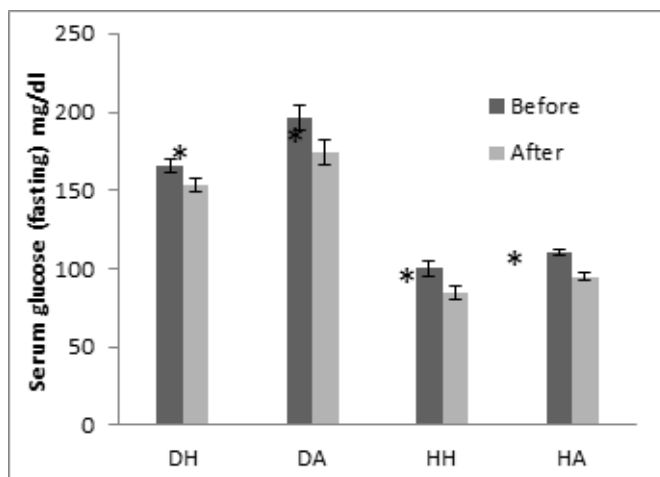
RESULTS

The Data of this study were analyzed by paired sample T test for individual parameters using statistical package for social science (SPSS, 16) whereas presented charts were made with the help of Microsoft excel. Data were presented as means \pm S.E. $P < 0.05$ was considered significant. During the course of the study it was seen that both aerobic and

high intensity interval training exercise programs reduced the glucose level significantly ($p < 0.05$) but aerobic exercise gave highly significant results (Graph1.1). there was decreased exogenous insulin resistance for the peripheral tissues by giving high intensity interval training and aerobic exercises but here aerobic exercises were more effective than the high intensity interval training and this can be shown by decreased insulin dose of the patients suffering from type-1 diabetes. Aerobic exercises lowered Glycated haemoglobin as compared to HIIT that produced no significance decrease in HbA1c level with $p < 0.05$ (Graph1.2) Serum high-density lipids are increased more after high intensity interval training but less after aerobic exercises. HIIT gave much better results in lowering blood total cholesterol and LDL as compared to aerobic exercise program (Graph1.3 and 1.4). According to present study, HIIT is very beneficial in lowering serum LDL levels as compared to aerobic exercises both in diabetic and healthy individuals. While comparing the levels of creatine kinase the aerobic exercise program did not increase the enzyme level significantly ($p < 0.05$) when compared with the control group but in high intensity interval training the enzyme level was increased to extreme high levels (Graph1.5)

DISCUSSION

The present study is in agreement with previous studies about middle- aged patients with type-2 diabetes in which after exercise glucose level is markedly reduced. This is possibly due to a decreased insulin resistance and increased glycogen synthesis [13]. In the present study both aerobic and HIIT exercise programs reduced the glucose level significantly ($p < 0.05$) but aerobic exercise gave highly significant results (Graph1.1)

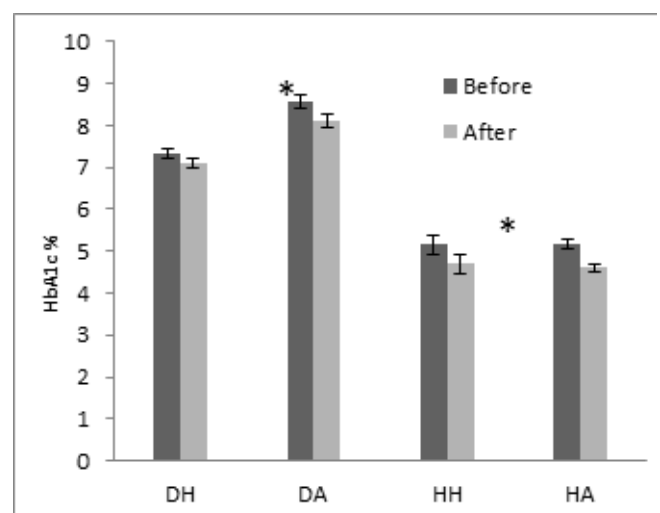


Graph 1: Effect of HIIT and aerobic exercises on serum glucose (fasting) in diabetic type-1 and healthy individuals (DH= Diabetic HIIT, DA= Diabetic aerobic, HH= Healthy HIIT, HA= Healthy aerobic)

The possible reason may be the long duration of activity in aerobic exercise without any interruption and decreased exogenous insulin resistance due to increased activity level of the body. In the study conducted by Jurimae et al. they observed no changes in insulin concentrations after 6,000 meters rowing ergometer test in highly trained male row-

ers; glucose levels were significantly increased after the exercise and decreased after the first 30 minutes of recovery. This showed that glucose increases due to the action of cortisol during exercise but after that the glucose is utilized in the peripheral tissue by the action of insulin, which reduces the glucose level during recovery period. In another study,[1] reported that after 45 minutes of sub-maximal aerobic exercise with 65% of maximal oxygen consumption, overweight males showed an increase in insulin sensitivity and a significant decrease in insulin concentration, only immediately after exercise [19]. The present study showed that there was decreased exogenous insulin resistance for the peripheral tissues by giving high intensity interval training and aerobic exercises but here aerobic exercises were more effective than the high intensity interval training and this can be shown by decreased insulin dose of the patients suffering from type-1 diabetes. This is in agreement with a study encoded by Borghouts and Keizer in which HIIT exercise improved insulin resistance. The possible mechanism is due to a high uptake of glucose through skeletal muscles due to increased muscular activity and enhanced glucose transport through GLUT4 [14].

Aerobic exercises lowered Glycated haemoglobin as compared to HIIT that produced no significance decrease in HbA1c level with $p < 0.05$ (Graph1.2) This decrease with aerobic exercise may be due to low glucose level in blood, when the glucose level was maintained and there was not enough extra glucose to bind with the hemoglobin so that glycated hemoglobin level was decreased. These results contradicts with the study enclosed by Smutok et al. in which he proposed that both exercise modalities showed results that were successful at normalizing glucose levels and decreased the glycated hemoglobin and there is no difference between two treatments when compared with the control group [20]

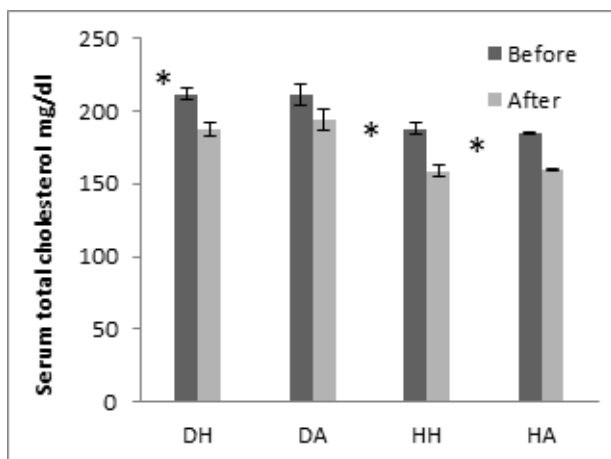


Graph 1.2: Effect of HIIT and aerobic exercises on HbA1c in diabetic type-1 and healthy individuals (DH= Diabetic HIIT, DA= Diabetic aerobic, HH= Healthy HIIT, HA= Healthy aerobic)

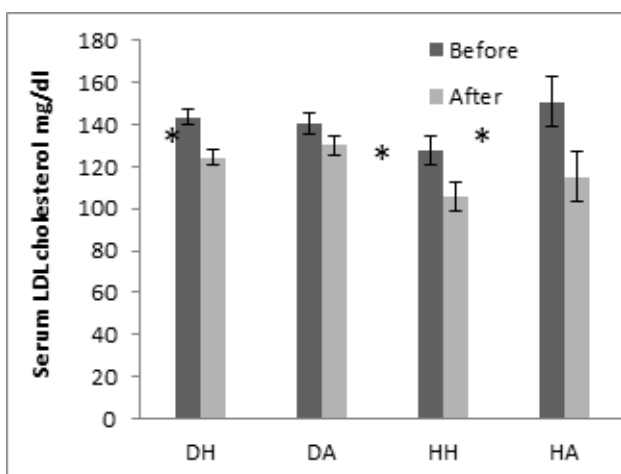
Serum high-density lipids are increased more after high intensity interval training but less after aerobic exercises.

The possible reason is due to the intense muscular activity of body in HIIT reduced the hepatic synthesis of harmful lipids and decreased cholesterol reabsorption from the gut. Present study results are in accordance with the study of Williams et al. that demonstrated an increase in high density lipid (HDL) level in the treatment group which was given high intensity interval training exercises, the findings indicates that subjects may exercise at high intensity. Although there is some suggestion that men with low HDL levels are less likely to respond to training than men with higher HDL levels, our data support this concept [21].

HIIT gave much better results in lowering blood total cholesterol and LDL as compared to aerobic exercise program (Graph 1.3 and 1.4). And these results was exactly in accordance with previous studies that suggest short-term low volume high intensity trainings are time-efficient approach to increase body composition and also enhance muscles oxidative capacity in obese women, however fed-versus fasted-state trainings does not modify this response [22].



Graph 1.3: Effect of HIIT and aerobic exercises on serum total cholesterol in diabetic type-1 and healthy individuals (DH= Diabetic HIIT, DA= Diabetic aerobic, HH= Healthy HIIT, HA= Healthy aerobic)

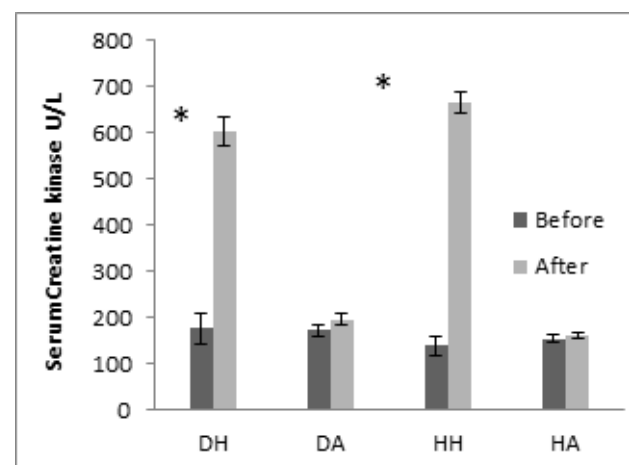


Graph 1.4: Effect of HIIT and aerobic exercises on serum LDL cholesterol in diabetic type-1 and healthy individuals (DH= Diabetic HIIT, DA= Diabetic aerobic, HH= Healthy HIIT, HA= Healthy aerobic)

High intensity interval training scan represent a more time efficient substitute to aerobic exercises and can also en-

hance fat oxidation in overweight sedentary men[16]. By using analysis of high-energy kinetics in vivo in reaction to HIIT gives indication that different aspect of human skeletal metabolism responds in a different way to this kind of training [17]. So, HIIT may be included in recommendations for obese persons, persons suffering with hyperlipidaemia and those who are at high risk of coronary artery atherosclerosis. Similar studies showed that after giving resistance exercise program the diabetic patients showed mark reduction in serum low density lipids level in spite of any variation in the lipid profile of the patients this is possibly due to low hepatic synthesis of low density lipid (LDL cholesterol) or may be due to high lipid utilization [18]. According to present study, HIIT is very beneficial in lowering serum LDL levels as compared to aerobic exercises both in diabetic and healthy individuals.

While comparing the levels of creatine kinase which is normally an indication of muscle damage, the aerobic exercise program did not increase the enzyme level significantly ($p < 0.05$) when compared with the control group but in high intensity interval training the enzyme level was increased to extreme high levels (Graph 1.5) at the start of trial and remained significantly high throughout the trial period but its value was lowered at the end of trial in comparison to the beginning of trial.



Graph 1.5: Effect of HIIT and aerobic exercises on serum Creatine Kinase in diabetic type-1 and healthy individuals (DH= Diabetic HIIT, DA= Diabetic aerobic, HH= Healthy HIIT, HA= Healthy aerobic)

This showed that high intensity interval training damages the muscles so aerobic exercise is safer than the high intensity interval training. Comparatively low level of enzyme at the end of trial may be due to adaptation of the body to sudden stress and activation of regulatory mechanisms of the body. Similar results were shown by a study conducted by Liu et al. in which both the treatments were compared and high intensity interval training caused more muscle damage [23].

CONCLUSION

At the end of research hematological evaluation of diabetic and healthy individuals showed that lifestyle modification played a very important role in controlling diabetes and its

complications. In present study life style modification was based on regular exercise program and we compared the effect of two exercise programs i.e. high intensity interval training and aerobic exercise. Group 2 (DA) showed significant improvement and hence was concluded that exercise program has better results in lowering blood glucose levels and HbA1c levels. So we can give aerobic exercise program along with drugs as a synergistic therapy to control diabetes and its complications.

Abbreviations

HIIT: High-intensity interval training

LDL: low density lipoproteins

HDL: high density lipoproteins

HbA1c: Glycated haemoglobin

DH: Diabetic HIIT

DA: Diabetic aerobic

HH: Healthy HIIT

HA: Healthy aerobic

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