Effects of Aerobic Exercise on Insulin Sensitivity and Glycaemic Control in Type 2 Diabetic Males

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Abstract: **The purpose of present study was to find out the effect of aerobic exercise to change the insulin sensitivity and glycaemic control in type 2 diabetic males. The purpose of this study, eighteen type 2 diabetic males were randomly selected subject from working in various faculties of Annamalai University, India and volunteered to participate in this study. The selected subjects were age, height and weight ranged was 45 ± 7 years, 164 ± 9 cm and 75 ± 13 kg respectively. The Selected subjects were divided into two groups and each group contained nine subjects. This study was consisted of Group I experimental group underwent aerobic exercise and Group II act as control group. The duration of aerobic exercise was given from about 30 to 45 minutes per day. The program included warming-up phase for 5 minutes of stretching exercises, 30 minutes run, stationary run, short kick, knee-ups, syncopated leap, alternate leap, jumping jacks, lateral pendulum, marching, the grapevine maneuver and heel touch at 40-65% of maximum heart rate and cooling down phase for 5 minutes of stretching, three times a week for 8 weeks. The data were analyzed using the SPSS statistical package. The data collected from the two groups before and after the training period were statistically examined to find out the significant improvement using the analysis of covariance. *P* values of <0.05 were considered statistically significant. After 8 weeks, significant change was observed in glycosylated hemoglobin, fasting glucose and fasting insulin level (p<0.05). The result of study shows that aerobic exercise have significantly decreased on glycosylated hemoglobin, fasting glucose and fasting insulin level in type 2 diabetic males. This study supports the value of an exercise program in the management of type 2 diabetes.**

Keywords: **Type 2 Diabetes, Glycosylated Hemoglobin, Fasting Glucose and Fasting Insulin.**

INTRODUCTION

The prevalence of type 2 diabetes is rising rapidly worldwide. In September 2012, the World Health Organization reported a global prevalence exceeding 300 million people, predicting a further 60–70% increase by the year 2030 (WHO, 2012). One of the largest absolute increases is expected to occur in India, with the International Diabetes Federation estimating that India alone will have 100 million people with diabetes by 2030 (IDF,2011).

Type 2 diabetes is a chronic metabolic disease which its prevalence is increasing rapidly throughout the world. It has been estimated that the number of diabetic patients will reach about 333 million people by 2025; 90-95% of patients will have type 2 diabetic. Chronic diabetic hyperglycemia is associated with the long-term complications of various organs, especially damage to eyes, kidneys, nerves, heart and blood vessels.

Increased food consumption and decreased physical activity represent major contributors to the growing Indian type 2 diabetes epidemic, reflecting ongoing economic transitions and widespread embrace of a Western lifestyle. But type 2 diabetes risks also has a substantial genetic component and evidence indicates that Indians may be more susceptible to developing insulin resistance and type 2 diabetes compared with European ancestry individuals of equivalent age and BMI, suggesting the possibility of population-specific genetic or epigenetic risk factors. (Chandalia M et al, 1999)

Physical activity is important in the management of type 2 diabetes mellitus. The overall goals in degree of control and lifestyle modification must be realistic. The general practitioner can have an important positive effect on patient lifestyle. Similarly the general practitioner can ensure that management is individualized to the person's cultural, educational and financial status. (Patel A MacMahon S, et al, 2008)

Carbohydrate foods which are rich in fibre and have a low energy density are the basis of the eating plan and it is recommended that they contribute up to 50% of the total energy intake. Meals containing carbohydrate are spread evenly through the day. Both the quantity of carbohydrate and the quality of carbohydrate will affect blood glucose levels. The amount of carbohydrate has a larger effect on glycaemia than the quality. Increasing physical activity improves metabolic control in people with diabetes. (Duckworth W et al, 2009)

Lifestyle intervention program that combine regular exercise, dietary modulation and/or oral blood-glucose lowering medication have proven an effective therapeutic strategy in type 2 diabetes. Continuous endurance-type exercise training has been shown to lower blood HbA1c, increase insulin sensitivity, improve the risk profile for

cardiovascular disease and reduce adipose-tissue mass in patients with type 2 diabetes (Boule NG et al, 2001). In addition, exercise training represents the only interventional strategy that has consistently been shown to improve whole body and skeletal muscle oxidative capacity. In accordance, recently published standards of medical care for type 2 diabetes underline the importance of exercise prescription. (Sigal RJ, et al, 2006)

Regular exercise has been shown to improve blood glucose control, reduce cardiovascular risk, contribute to weight loss, and improve well being. Furthermore, regular exercise may prevent Type 2 Diabetes Mellitus in high-risk individuals. Moderate-intensity to vigorous-intensity exercises of ≥150 mins per week has been proven to confer significant benefits in the prevention of Type 2 Diabetes Mellitus onset (Knowler WC et al, 2002). Structured exercise interventions of at least 8 weeks' duration have been shown to lower A1C by an average of 0.66% in people with Type 2 Diabetes Mellitus, even with no significant change in body mass index. While higher levels of exercise intensity are associated with greater improvements in A1C and fitness, milder forms of physical activities, like yoga and tai chi, may also benefit control of blood glucose. (Boule NG et al, 2003)

Diabetes mellitus is a worldwide health problem predisposing to markedly increased cardiovascular mortality and morbidity. Lipid abnormalities significantly contribute to the increased risk of cardiovascular disease and other morbidity in diabetics. (George P, Ludvik B, 2000)

Physical exercise along with diet and medication is considered as one of the cornerstones of type2 diabetes management and preventing and treating obesity. Aerobic training is a beneficial training method for decreasing hyperglycemia, which is more efficient than resistance training in improving body composition because of the relationship between weight loss and energy expenditure. American Diabetes Association recommended 150 min aerobic physical activity with moderate intensity or 90 min vigorous aerobic exercise per week for diabetic patients in order for them to improve glycemic control, maintain body weight and decrease risk of cardiovascular diseases. (Marwick TH et al, 2009)

The present study was clinical influence of aerobic exercise training to change the insulin sensitivity and glycaemic control in type 2 diabetic males.

METHODOLOGY

The purpose of this study, eighteen type 2 diabetic males were randomly selected subject from working in various faculties of Annamalai University, India and volunteered to participate in this study. Written informed consent for all procedures was obtained from all participants prior to entering the study. The criteria for the invitation were being willing to participate, clinically healthy, no menstrual irregularities, not using medication and no beta-blockers, sedentary life style and no apparent occupational or leisure time responsibilities that impede their participation. The following measurements were made at baseline prior to the start of the exercise program and at after completion of the eight weeks training program. The selected subjects were age, height and weight ranged was 45 ± 7 years, 164 ± 9 cm and 75 ± 13 kg respectively.

The Selected subjects were divided into two groups and each group contained nine subjects. This study was consisted of Group I experimental group underwent aerobic exercise and Group II act as control group. The duration of aerobic exercise was given from about 30 to 45 minutes per day. The program included warming-up phase for 5 minutes of stretching exercises, 30 minutes run, stationary run, short kick, knee-ups, syncopated leap, alternate leap, jumping jacks, lateral pendulum, marching, the grapevine maneuver and heel touch at 40-65% of maximum heart rate and cooling down phase for 5 minutes of stretching, three times a week for 8 weeks. Stretching exercises were performed for the arms, leg, back and stomach. A target heart rate range between 40-65% of age adjusted maximum heart rate intensity was calculated by each walker from her age and walking supine resting heart rate. Heart rate was measured with an electronic heart rate meter.

In order to evaluate halting levels of glycosylated hemoglobin, glucose, and insulin, 10 cc blood was drawn from anti-cubital vein in a time less than 1 min following bandaging with tourniquet in a sitting position after 12 hours of fasting in the beginning of the trial (pre-test) and at the end of the eighth week (post-test). All samples were drawn at 8 A.M. the subjects were asked to avoid any physical activity during 24 hours before blood drawing except for daily routine activities.

Concentrations of glycosylated hemoglobin, insulin, and glucose were measured through immunoturbidimetric method (using quantifying kit made by Pars Azmoon Company-Iran with internal measurement degree of 1.36 and sensitivity of 3%), ELISA method (using insulin kit made by Diametra Company- Italy with internal measurement degree of 2% and sensitivity degree of 2 micIU/mL, and GOD Photometric Method (using glucose kit made by Pars Azmoon Company-Iran with internal measurement degree of 1.28 and sensitivity of 5 mg/dl) respectively.

The data were collected at prior to and immediately after the training program. The data were analyzed using the SPSS statistical package (SPSS 13 for

Windows; SPSS, Chicago, USA). Mean and standard deviation was used as descriptive statistic. The data collected from the two groups before and after the training period were statistically examined to find out the significant improvement using the analysis of covariance. *P* values of <0.05 were considered statistically significant.

RESULTS

The analysis of covariance for pre and post test data on HbA1c (%), fasting glucose and fasting insulin of aerobic training group and control group were presented in Table-I.

Table I

Variables	Test	Exercise Group	Control Group	Degree of Freedom	Means Squares	'f' ratio
HbA1c (%)	Pre	8.76±0.68	8.69±0.73	1 and 16	0.02	0.04
	Post	7.91±0.23	8.66±0.57	1 and 16	2.59	13.84*
Fasting Glucose (mmol/l)	Pre	10.39±0.54	10.01±0.78	1 and 16	0.67	1.48
	Post	9.89±0.61	10.34±0.69	1 and 16	1.12	2.58
Fasting Insulin (pmol/l)	Pre	63.56±1.42	62.89±2.15	1 and 16	2.04	0.61
	Post	58.36±0.72	62.94±1.84	1 and 16	1.96	48.06*

Means ± SD *Significant at .05 level of confidence

The table value for significance at .05 level of confidence for df 1 and 16 was 4.49. Table 1 shows the biochemical characteristics of the study subjects (pre, post study), there were significant differences aerobic exercise group in glycosylated hemoglobin, fasting glucose and fasting insulin level compare with the control group. After 8 weeks, significant change was observed in glycosylated hemoglobin, fasting glucose and fasting insulin level ($p<0.05$). The result of study shows that aerobic exercise have significantly decreased on glycosylated hemoglobin, fasting glucose and fasting insulin level in type 2 diabetic males.

DISCUSSION

The main trouble in type 2 diabetes is not necessarily the deficiency of insulin. Indeed, the trouble is usually in target tissues, especially in muscles. Since carbohydrate cannot pass into target cells in type 2 diabetic patients, blood sugar exceeds normal level and as a result, pancreas is stimulated and thus, higher insulin level is formed by beta cells to blood. The process causes higher fasting blood sugar causing hypoglycemia or yperglycemia.(Bonen N, 1995)

Exercise training can be considered a type of stress that is known to induce a number of metabolic changes. Indeed exercise stimulates insulin in the liver and muscles to take in excess glucose (Frank B et al,1999).Beneficial effect of physical activity on insulin sensitivity that is separate from any influence of physical activity on body composition. In fact, it appears that the enhanced insulin action in physically trained individuals involves not only muscle tissue but also liver and adipose tissue (Ehrsam et al, 2009). A meta-analysis of 43 randomized controlled trials by the Cochrane Collaboration found that exercising alone led to limited weight loss (Amorim AR et al, 2007).

At the present study our finding revealed that 8 weeks walking exercise was of sufficient duration and intensity to result in significant improvements in the all components of body composition in obese exercise group. Moreover decrease in serum insulin and FBS in exercise group accounts for the responses of insulin and fasting glucose to walking exercise compare with the control group. Janssen et al but reported that The improvement in the metabolic profile such a fasting and insulin was not enhanced by the addition of 16 week aerobic exercise in 38 premenopausal healthy obese women compare with the control groups. They findings reinforce the importance of diminished visceral fat in the treatment of insulin resistance. (Janssen et al, 2002)

Insignificant change of glycosylated hemoglobin in pre-test, mid-test, and post-test is consistent with previous studies. Lack of decreased glycosylated hemoglobin in mid-test is attributable to long-term assessment of blood sugar level by HbA1c. Besides, insignificant increase in glycosylated hemoglobin may be a consequence of improper nutrition and glycaemia or inconsistency of controlling systems of body with the exercise. (Fritz T et al, 2006)

CONCLUSION

The aerobic exercise training improved insulin sensitivity and glycaemic control and in type 2 diabetic males' subjects. Therefore, aerobic exercise is a recommended treatment for middle aged patients with type 2 diabetes. Of course it must be individually adjusted to the biochemical limitations of each patient. This study supports the value of an exercise program in the management of type 2 diabetes. The aerobic exercise used in this study produced significant benefits on reducing such as glycosylated hemoglobin, fasting glucose and fasting insulin level on short term period. Type 2 diabetes mellitus was declined in aerobic exercises because of the merits found. Aerobic exercise was trained in middle age groups and is enough to positively influence the metabolic health indicators of type 2 diabetes men.

REFERENCES

1. Amorim AR, Linne YM, Lourenco PMC. (2007) Diet or exercise, or both, for weight reduction in women after childbirth. Cochrane Database of Systematic Reviews, Issue 3. Art. No.: CD005627.
2. Ashour M, Salem S, Hassaneen H, El-Gadban H, Basu TK (1999) Antioxidant status and insulin dependent diabetes mellitus. Journal of Clinical Biochemical Nutrition, 26:99-107.
3. Bonen N (1995) "Benefits of exercise for type 2 diabetetics" Can Journal Applied Physiology; 20: 261-79.
4. Boule NG, Haddad E, Kenny GP, Wells GA, Sigal RJ (2001) Effect of exercise on glycemic control and body mass in type 2 diabetes mellitus, JAMA; 286:1218–1227
5. Boule NG, Kenny GP, Haddad E, Wells GA, Sigal RJ.(2003) Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in Type 2 diabetes mellitus. Diabetologia; 46:1071–81.
6. Chandalia M, Abate N, Garg A, Stray-Gundersen J, Grundy SM. (1999) Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. J Clin Endocrinol Metab; 84: 2329–2335.
7. Duckworth W, Abraira C, Moritz T, et al. (2009) Glucose control and vascular complications in veterans with type 2 diabetes. New England Journal of Medicine; 360:129-139.
8. Fritz T, Wandell P, Aberg H, Engfeldt P. (2006) walking for exercise – dose three times per week influence risk factorin type 2 diabetes? Diabetes Res Clinicl Practice; 71: 21-7.
9. Ehrsam et al. (2009) Exercise prescription for the overweight and the obese: how to quantify and yet keep it simple.Br. J. Sports. Medicine; 43:951-953.
10. Frank B et al .(1999) Walking compared with Vigorous Physical Activity and Risk of Type 2 Diabetes in Women, The Journal of the American Medical Association; 282(15).
11. George P, Ludvik B: Lipids and diabetes. J Clin Basic Cardiol 2000, 3:159-162.
12. International Diabetes Federation (2011) Diabetes Atlas, 5th ed. Brussels, Belgium, International Diabetes Federation.
13. Janssen et al. (2002) Effects of an Energy-Restrictive Diet with or Without Exercise on Abdominal Fat, Intramuscular Fat and Metabolic Risk Factors in Obese Women. American Diabetic Association; 25(3):431-438.
14. Knowler WC, Barrett-Connor E, Nathan DM (2002) Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin, New England Journal of Medicine; 346:393–403.
15. Marwick TH, Hordern MD, Miller T, Chyun DA, Bertoni AG, Blumenthal RS (2009) Overweight, obesity, and blood pressure: the effects of modest weight reduction. Circulation; 119: 3244–3262.
16. McEneny J (2000) Very low density lipoprotein subfractions in Type II diabetes mellitus: alterations in composition and susceptibility to oxidation. Diabetologia, 43:485-493.
17. Patel A MacMahon S, et al. (2008) Intensive blood glucose control and vascular outcomes in patients with type 2 diasbetes. New England Journal of Medicine; 358:2560-2572.
18. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD (2006) Physical activity/exercise and type 2 diabetes. Diabetes Care 29:1433–1438
19. World Health Organization (2012) Diabetes Fact Sheet -312.

