Effect of aerobic exercise vs. progressive resisted exercise on glycosylated haemoglobin (HbA1c) in persons with type 2 diabetes mellitus

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ABSTRACT

Introduction: The burden of type 2 diabetes mellitus varies remarkably throughout the region of the world and is a serious public health problem in both developed and developing countries. Despite the advancement in knowledge and the increasingly effective therapeutic strategies for type 2 diabetes mellitus management, sustainable control rates at the population level are still elusive.

Objective: To compare effect of aerobic exercise and progressive resisted exercise on glycosylated haemoglobin (HbA1c) persons with type 2 diabetes mellitus.

Methodology: 450 participants (M - 275, F - 175) were enrolled in study. Group 1 participants have performed aerobic exercise for 8 weeks, Group 2 participants have performed progressive resisted exercise for 8 weeks, Group 3 participants were in control group. HbA1c, Fasting blood glucose (FBS), body mass index (BMI), waist circumference (WC), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were outcome measures for the study.

Results: ANOVA tests were applied found Fcal = 1.65 (p = 0.19) for HbA1c, Fcal = 1.91 (p =0.15) for FBS, Fcal = 5.79 (p = 0.003) for BMI, Fcal = 4.54 (p = 0.01) for WC, Fcal = 26.62 (p < 0.0001) for SBP and Fcal = 110.65 (p < 0.0001) for DBP.

Conclusion: Aerobic exercise and progressive resisted exercise should be part of the management of type 2 diabetes mellitus as an adjunct therapy.

Key words: Progressive resisted exercises, Aerobic exercise, Type 2 diabetes mellitus, Glycosylated haemoglobin.

INTRODUCTION

Type 2 Diabetes mellitus (T2DM) is a group of metabolic disorders characterized by hyperglycemia. The epidemic of T2DM is ever increasing in developed and developing countries in spite of the enormous facilities available to control its growth (Satpute et al., 2009). India had 69.2 million people living with diabetes (8.7%) as per the 2015 data. Of these, it remained undiagnosed in more than 36 million people (http://www.searo.who.int/india/mediacentre/events/2016/en). Most of patients with this form of diabetes are obese, and obesity itself causes some degree of insulin resistance. This form frequently goes undiagnosed for many years because the hyperglycemia develops gradually and at earlier stage is often not so severe enough for the patients to notice any of the classic symptoms of diabetes. Diabetes is a widespread disorder and the management of diabetes required a multidisciplinary approach in which exercise is a key element (Subramaniyam et al., 2012). Endurance exercise programs have been traditionally recommended for older patients with T2DM and have associated with weight loss, improved glucose tolerance, and cardiovascular fitness (Ligtenberg et al., 1997). Recent position statements from both the American Diabetes Association (Albright et al., 2000) and the American College of Sports medicine (Colado et al., 2010) also recommend the use of resisted training as a part of well-rounded exercise program for older individuals. In spite of the reported beneficial effects of aerobic exercise on cardiovascular and metabolic parameters, adoption of aerobic activities may be difficult for some patients with T2DM, especially those who are elder and obese (Willey and Singh, 2003). In the last decade, there has been increasing interest in the role of resistance exercise in the management of diabetes as it appears to improve insulin sensitivity (Tresierras and Balady, 2009). The diagnostic criteria for T2DM based on the HbA1c are interpreted as follows (Harrison et al., 2012):

<table>
<thead>
<tr>
<th>HbA1c value (%)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7 – 6.4</td>
<td>Excellent Control</td>
</tr>
<tr>
<td>6.5 – 8.0</td>
<td>Good Control</td>
</tr>
<tr>
<td>&gt; 8.0</td>
<td>Poor Control</td>
</tr>
</tbody>
</table>

Table 1. Diagnostic criteria for diabetes based on glycosylated haemoglobin (HbA1c)
Contradicting and inconsistent findings were reported in the literature regarding the aerobic exercise and progressive resisted exercise for their superiority of one over the other (Willey and Singh, 2003; Tresierras et al., 2009). So, the objective of the study was to compare the effect of aerobic exercise, progressive resisted exercise with control group on HbA1c, FBS, BMI, Waist Circumference (WC), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in community dwelling individuals with T2DM.

MATERIALS AND METHODS

The study was approved by the Intuitional Review Board. Participants were recruited from the various rural communities of Anand district of Gujarat, India. All the participants of Type 2 Diabetes Mellitus are screened and those who have met the inclusion criteria are invited for study. All screened individuals are initially participated in an orientation session to receive information on the aims, inclusion and exclusion criteria, procedures and risks of the study. A written informed consent was then obtained from all the participants.

Study Design: Pre – post Quasi Experimental Study

Study Setting: Community setting

Study sampling method: Nonrandom convenient sampling method

Sample size: n = 450 patients of Type II Diabetes Mellitus

Group: 1: 150 = Aerobic Exercise Group
Group: 2: 150 = Progressive Resisted Exercise Group
Group: 3: 150 = Control Group

Outcome Measures

- HbA1c Test Value
- Fasting Blood Sugar by Glucometer
- Weight by digital weighing machine
- Height by stadiometer
- Waist circumference by measure tape
- Systolic & Diastolic Blood Pressure by Sphygmomanometer

Inclusion Criteria

- Age: ≥ 50 years
- HbA1c Values: 8.0 – 10.0 %.
- Able to walk continuously for at least 20 minutes and climb one flight stairs
- Has sedentary life style (never participated in a structured exercise programme or recreational physical activity or sports)

Exclusion Criteria

- Uncontrolled diabetes mellitus with HbA1c >10%
- Congestive cardiac failure
- Unstable angina
- Acute myocardial infarction within last year
- Proliferative diabetic retinopathy
- Uncontrolled hypertension
- Advanced arthritis which limits mobility or participation in prescribed exercises
- Respiratory co-morbidities
- Significant proteinuria or chronic renal insufficiency
- Prescribed low caloric diet or drugs for treatment of obesity
- Inability to monitor glucose level or to comply with exercise programme

Procedure: According to the above mentioned criteria, 450 participants (Male: 275, Female: 175) were enrolled and finished the study procedure.

Study Protocol: Before doing exercise baseline data for all outcome measures were taken for each participant. After pretest measurement, the training program was carried out 3 times per week over a period of 8 weeks. The exercise intervention was structured and supervised by physiotherapist. All pharmacological management of each participant was not changed. They are constantly on their prescribed drugs. At the end of 8th week all outcome measures were measured.

For Group 1 and Group 2 Interventions:

Warm up and cool down: 3 minutes of stretches of quadriceps, hamstrings, calf, biceps, triceps and back, with each muscle group stretched twice, holding each stretch for 15 seconds and 5 minutes of unloaded cycling.

Exercise Regimen for Group 1 – Aerobic Exercise

Intensity: 65 – 70% HRmax as determined by modified Bruce protocol test

Duration: 50 minutes

- 10 minutes on upright bicycle
- 20 minutes on the treadmill
- 20 minutes on elliptical cycle

Type: Treadmill, stationary upright bicycle, cross trainer (elliptical cycle)

Exercise Regimen for Group 2 – Progressive Resisted Exercise

Intensity: 65 – 70% of 1 RM

Duration: 1 set of 10 repetitions for each of the 9 resistive exercise combined in a circuit (Seated leg press, straight leg raise, hamstrings curls, biceps curls, triceps curls, lateral raises, front raises, hip abduction, hip extension), 3 rounds of the circuit combined in a maximum of 50 minutes

Type: Quadriceps (multiple exerciser machine and straight leg raise); Hamstrings (multiple exerciser machine); Biceps, triceps, anterior and middle deltoids (using free weights); Hip abductors and extensors (multiple exerciser machine)

Data Analysis

Data analysis was done using Microsoft Excel 2007. Demographics were compiled for mean, standard deviation and frequency distribution. ANOVA test were applied for comparing all the outcome measures results of all 3 groups with level of significance p = 0.05.
RESULTS

Table 2. Demographics

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Gender</th>
<th>Occupation</th>
<th>Drug dosage</th>
<th>Duration of onset of T2DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Mean ± SD)</td>
<td>55.76 ± 3.34 years</td>
<td>Male 90, Female 60</td>
<td>Housewife-50</td>
<td>Metformin: 1.25 ± 0.50 gram</td>
<td>4.42±1.79 years</td>
</tr>
<tr>
<td>Group 2 (Mean ± SD)</td>
<td>56.96 ± 2.58 years</td>
<td>Male 85, Female 65</td>
<td>Job-50</td>
<td>Metformin: 1.15 ± 0.60 gram</td>
<td>4.33±1.86 years</td>
</tr>
<tr>
<td>Group 3 (Mean ± SD)</td>
<td>57.32 ± 3.65 years</td>
<td>Male 95, Female 55</td>
<td>Business-45</td>
<td>Metformin: 1.35 ± 0.60 gram</td>
<td>4.12±1.93 years</td>
</tr>
</tbody>
</table>

Table 3. ANOVA test values for all outcome measures for all three groups

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>HbA1c</th>
<th>F Value</th>
<th>p Value</th>
<th>F Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.65</td>
<td>0.19</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.91</td>
<td>0.15</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.78</td>
<td>0.003</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.54</td>
<td>0.01</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26.61</td>
<td>&lt;0.0001</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>110.65</td>
<td>&lt;0.0001</td>
<td>3.02</td>
</tr>
</tbody>
</table>

Graph 1. Pre & post comparison of HbA1c test in all three groups

Graph 2. Pre & post comparison of FBS in all three groups

Graph 3. Pre & post comparison of BMI in all three groups

Graph 4. Pre & post comparison of WC in all three groups

Graph 5. Pre & post comparison of SBP in all three groups

Graph 6. Pre & post comparison of DBP in all three groups
**DISCUSSION**

The finding our study was that there was significant difference found in BMI, Waist Circumference, SBP and DBP in both Group 1 and Group 2 compared to control group. However, Hba1c and FBS values were not significantly rather minimally reduced in Group 1 and Group 2. Same result found in Cindy LW NG et al study in 2010 showed that glucose clearance is higher in Aerobic exercise group than PRE group, which may indicate better preserved insulin sensitivity and glucose uptake by body in individuals with T2DM. Membrane permeability to glucose increases with muscular contraction, possible attributable to increase in number of glucose transporters associated with plasma membrane. Thus, acute bouts of exercise decrease insulin resistance and increases insulin sensitivity thus reducing cell’s requirement for insulin. This decrease in insulin resistance and increase in insulin sensitivity may primarily be response of each individual to a bout of exercise rather than the result of long term changes associated with training (Colberg et al., 2010). Muscle contraction and relaxation improves blood supply to the muscles, which enhances the insulin receptor expression and increases the glucose uptake by muscles and thus reducing blood Glucose (Subramaniyam et al., 2012). The dietary patterns of the participants and pharmacological therapy effects have not been changed in the study.

**Conclusion**

Aerobic exercise and progressive resisted exercise should be part of the management of type 2 diabetes mellitus as an adjunct therapy. It may help in improving more in BMI, WC, SBP, DBP values than Hba1c and FBS values.

**Acknowledgement**

We would like to thank all our participants without whom this study would not have been possible and materialized. We would like to thank acknowledge all the colleagues of the institute and teachers for their support in data collections and data analysis as well as constant motivation.

**REFERENCES**

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