



## RESEARCH ARTICLE

### EFFECT OF AEROBIC EXERCISE vs. PROGRESSIVE RESISTED EXERCISE ON GLYCOSYLATED HAEMOGLOBIN (HbA<sub>1c</sub>) 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 (HbA<sub>1c</sub>) 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. HbA<sub>1c</sub>, 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  $F_{\text{cal}} = 1.65$  ( $p = 0.19$ ) for HbA<sub>1c</sub>,  $F_{\text{cal}} = 1.91$  ( $p = 0.15$ ) for FBS,  $F_{\text{cal}} = 5.79$  ( $p = 0.003$ ) for BMI,  $F_{\text{cal}} = 4.54$  ( $p = 0.01$ ) for WC,  $F_{\text{cal}} = 26.62$  ( $p < 0.0001$ ) for SBP and  $F_{\text{cal}} = 110.65$  ( $p < 0.0001$ ) 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.

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#### 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 (Treserras and Balady, 2009). The diagnostic criteria for T2DM based on the HbA<sub>1c</sub> are interpreted as follows (Harrison *et al.*, 2012):

**Table 1. Diagnostic criteria for diabetes based on glycosylated haemoglobin (HbA<sub>1c</sub>)**

HbA <sub>1c</sub> value (%)	Interpretation
5.7 – 6.4	Excellent Control
6.5 – 8.0	Good Control
> 8.0	Poor Control

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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; Tresieras *et al.*, 2009). So, the objective of the study was to compare the effect of aerobic exercise, progressive resisted exercise with control group on HbA<sub>1c</sub>, 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

- a. HbA<sub>1c</sub> Test Value
- b. Fasting Blood Sugar by Glucometer
- c. Weight by digital weighing machine
- d. Height by stadiometer
- e. Waist circumference by measure tape
- f. Systolic & Diastolic Blood Pressure by Sphygmomanometer

### Inclusion Criteria

- Age:  $\geq 50$  years
- HbA<sub>1c</sub> 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 HbA<sub>1c</sub> >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 pre-test 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 8<sup>th</sup> 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% HR<sub>max</sub> 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  $p = 0.05$ .

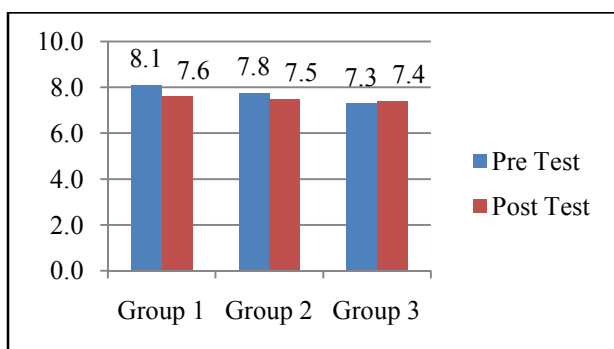
**RESULTS**

**Table 2. Demographics**

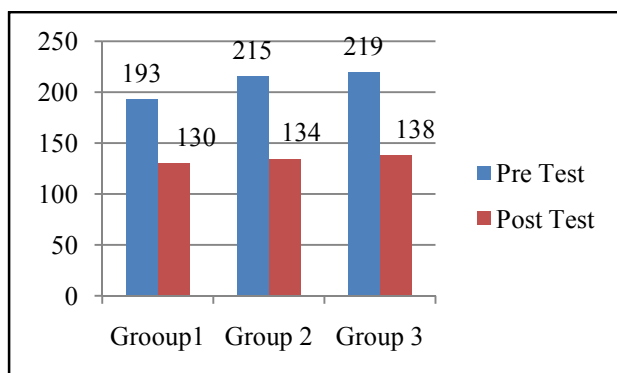
Age	
Group 1 (Mean ± SD)	55.76 ± 3.34 years
Group 2 (Mean ± SD)	56.96 ± 2.58 years
Group 3 (Mean ± SD)	57.32 ± 3.65 years
Gender	
Group 1	Male – 90, Female – 60
Group 2	Male – 85, Female – 65
Group 3	Male – 95, Female – 55
Occupation	
Group 1	Housewife-50 Job-45 Business-30 Retired-25
Group 2	Housewife-55 Job-50 Business-25 Retired-20
Group 3	Housewife-45 Job-65 Business-20 Retired-20
Drug dosage	
Group 1	Metformin: 1.25 ± 0.50 gram Pioglitazone: 25.45 ± 4.71 mg
Group 2	Metformin: 1.15 ± 0.60 gram Pioglitazone: 26.50 ± 4.11 mg
Group 3	Metformin: 1.35 ± 0.60 gram Pioglitazone: 28.54 ± 3.71 mg
Duration of onset of T2DM	
Group 1	4.42±1.79 years
Group 2	4.33±1.86 years
Group 3	4.12±1.93years

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

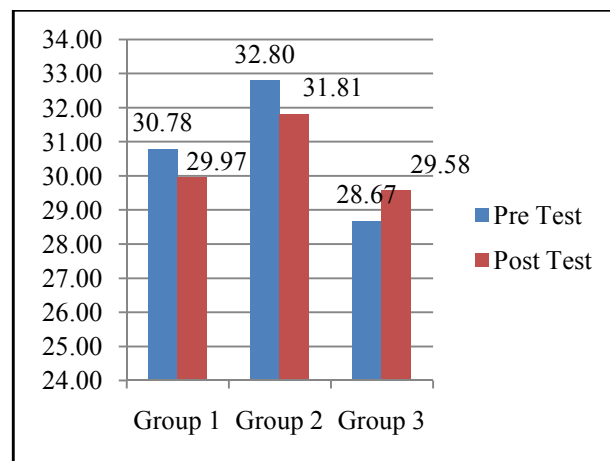
Outcome Measures	HbA <sub>1c</sub>	FBS	BMI	WC	SBP	DBP
F Value	1.65	1.91	5.78	4.54	26.61	110.65
p Value	0.19	0.15	0.003	0.01	<0.0001	<0.0001
F Critical	3.02	3.02	3.02	3.02	3.02	3.02



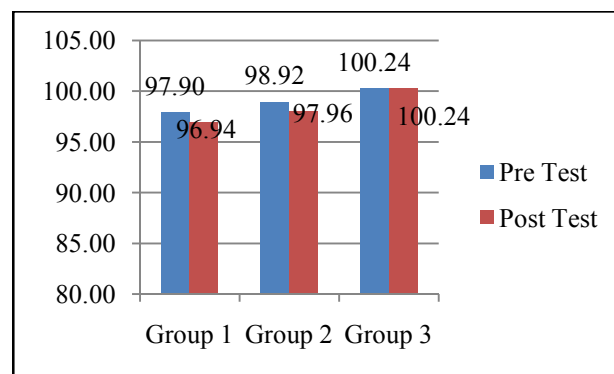
**Graph 1. Pre & post comparison of HbA<sub>1c</sub> test in all three groups**



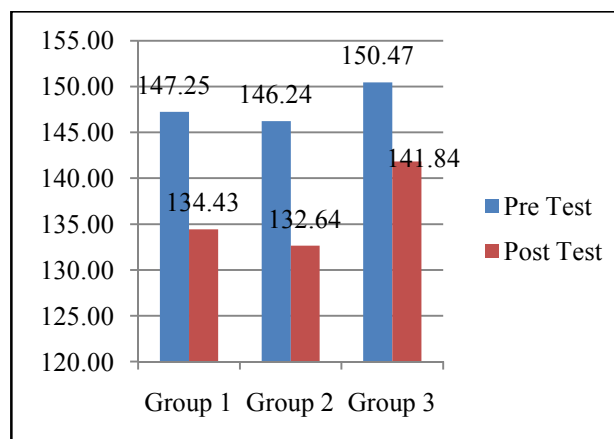
**Graph 2. Pre & post comparison of FBS in all three groups**



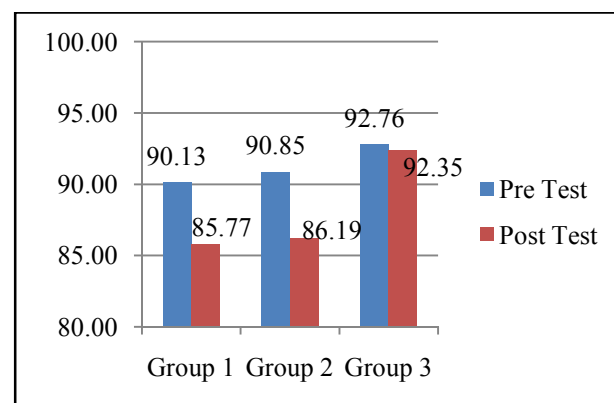
**Graph 3. Pre & post comparison of BMI in all three groups**



**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, HbA<sub>1c</sub> 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 HbA<sub>1c</sub> and FBS values.

### Acknowledgement

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