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A Comparative Study of Moderate versus High Intensity Exercise Training for Short Duration on Strength and Physical Function in Type II Diabetes Patients: A Randomized Clinical Trial

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Abstract: ***Background: The purpose of the study was to compare between moderate v/s high intensity exercise training for short duration on physical fitness and physical function in people with Type 2 diabetes. It is a well-known fact that exercise training consisting of aerobic as well as resistance training have beneficial effects in Diabetes. However there is paucity of data, whether short duration training has similar benefits. Methods Sample size estimation after pilot study yielded a sample of 30. The subjects were allotted into two groups' moderate intensity (20) and high intensity (20) group. Resistance training consisted of seated isolated knee extension with weight cuffs. Aerobic training consisted of cycling on static cycle. Statistical analysis: Pre and Post values of muscle strength, aerobic capacity in both the groups was done by paired T – Test. Unpaired T-test was used to compare the post values of muscle strength, aerobic capacity between groups. This test was used to compare pre and post values of Patient specific functional scale Wilcoxon sign rank test was used. Mann Whitney's u test was used to compare post values of Patient specific functional scale. Conclusion: There was significant improvement in both the groups when training was done for shorter duration.***

Keywords: Exercise training, Diabetes mellitus, Resistance training, Functional activities

1. Introduction

The term diabetes mellitus describes a metabolic disorder of multiple etiologies characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both. [1] The condition is classified into type1 and type2 diabetes mellitus.Type2 diabetes mellitus is characterized by hyperglycemia that results from insulin resistance and impaired insulin secretion. It is one of the most important health problems requiring critical and immediate care. The prevalence of Type2 diabetes mellitus has grown rapidly worldwide. According to International Diabetes Federation,246 million people are currently affected by diabetes and it is estimated that the value will reach to 380 million by 2025.Major predisposing factors for the condition are unhealthy diet and less physical activity.

Type2 diabetes mellitus has multiple complications like angina, uncontrolled hypertension, coronary artery disease etc. Patients with type-2 diabetes demonstrated lower functional exercise capacity than healthy. This is predominantly due to reduced aerobic capacity and muscle strength.[3,4]Studies have also suggested that this reduced physical function in individuals with Type2 diabetes have caused, increase in risk of mortality and physical disability. General clinical management for diabetes mellitus includes pharmacological and lifestyle interventions. Pharmacological treatment involves oral blood-glucose controlling medications as well as administrations of insulin through injection. Lifestyle intervention mainly includes regular exercise and dietary modifications. These two interventions have proven an effective therapeutic strategy in Diabetes mellitus.[5] It is well established fact that regular exercise maintains and even improves aerobic capacity as well as muscle strength in diabetes mellitus patients. Thereby, it helps in improving physical function.

Exercise prescription Type2 diabetes mellitus patients helps in reducing hyperglycemia, along with other complication of the illness.[6] Meta-analysis of small-sized studies shows that, not only the glycemic control but also the cardio-respiratory fitness and other CVD risk factors can be improved by supervised exercise program. Thus, combined aerobic and resistance exercise is proved to be more effective than either one alone to improve physical function (7).

There are previous studies that discussed regarding long term exercise intervention comparing high and moderate intensities in people with Type2 diabetes. As there is paucity in data regarding short term exercise intervention comparing moderate and high intensity exercise training program on physical function, this study was attempted to find effects of moderate and high intensity of combined aerobic and resistance training on physical function in Indian population with type 2 diabetes.

2. Review of Literature

2.1 Effect of High versus low intensity supervised aerobic and resistance training on modifiable cardiovascular risk factors in type 2 diabetes; The Italian diabetes and exercise

study.

2.2 Background-while current recommendations on exercise type and volume have strong experimental bases, there is no clear evidence from large sized studies indicating whether increasing training intensity provides additional benefits to subjects with type2 diabetes. Conclusion-Data from the large IDES cohort indicate that, in low-fitness individuals such as sedentary subjects with type 2 diabetes, increasing exercise intensity is not harmful, but does not provide additional benefits on cardiovascular risk factors.

2.3 The effect of 8 weeks aerobic exercise on insulin resistance in type 2 diabetes: A randomized clinical trial (Global journal of health science)

2.4 Background - This study assessed the effects of aerobic exercises on insulin resistance in type 2 diabetes.

2.5 Conclusion-The aerobic protocol used in this study has been effective in lowering plasma glucose, insulin levels, and insulin resistance.

2.6 Exploring the variability in acute glycemic responses to exercise in type 2 diabetes-clinical study (Journal of diabetes research)

2.7 Background-To explore the factors associated with exercise-induced acute capillary glucose (cap BG) changes in individuals with type 2 diabetes (T2D).

2.8 Conclusion-The greater reduction in cap BG seen in individuals with higher pre exercise cap BG may suggest the importance of exercise in the population with elevated glycemia.

3. Statement of Problem

It is a well-known fact that exercise training in the form of aerobic as well as resistance has beneficial effects. It helps in improving the functional capacity of the patients. Unfortunately, abstinence rate is high due to boredom and delayed effects of training. Patients tend to quit exercising well in advance. Hence introduction of short term training if yielding similar benefits are introduced it will help in improving patients functional capacity.

Methodology

Study design-Randomized clinical trial
Type-Experimental study
Study setting: Terna Hospital & research Centre
Material used: Pen, pencil, questionnaires, consent form, cycle ergometer, cuff weights patient specific functional scale sheet
Age- 30-60 years

Null Hypothesis:
There will be no significant difference in effects of moderate and high intensity exercise training for shorter duration.

Alternative hypothesis:
There will be no significant difference in effects of moderate and high intensity exercise training for shorter duration.

Outcome measures-Muscle strength-kilograms in 1RM, Exercise capacity-six minute walk test distance, physical function-patient specific functional scale.

Sample size: 30 on the basis of following formula & pilot study.

$$\frac{(S1)^2 + (S2)^2 \times (1.96 + 0.84)^2}{(X1 - X2)^2}$$

For comparative study of quantitative data
S1=standard deviation of physical function of group A, S2=standard deviation of physical function of group B, $(X1-X2)^2$=marginal mean difference between group A and B

Inclusion criteria-People who met ADA diagnostic criteria for type2 diabetes plus a casual plasma glucose level of 200mg/dL or greater were allocated to receive moderate or high intensity exercise training.

Exclusion criteria-People having complications of diabetes such as angina, uncontrolled hypertension, proliferative retinopathy, severe peripheral neuropathy, history of coronary artery disease, hypoglycemia<70mg/dl, hyperglycemia>300mg/dl.

4. Procedure

4.1 Overview

The investigation was a randomized clinical trial of the effects of moderate versus high intensity exercise training on physical fitness and physical function in people with Type 2 Diabetes. Participants were randomly allocated to either a Group A (Moderate-intensity) or a Group B (High-intensity) exercise training group. Both groups underwent combined aerobic training and resistance training at different intensities.

4.2 Settings and Participants

Absolute contraindications of diabetes for exercise such as injecting alcohol 3 hours prior to exercise were excluded from study. Also people involved in resistance training or aerobic training within 3 months of the beginning of this investigation were excluded. Participants were required to sign a written informed and explained consent form (appendix).

4.3 Randomization and Interventions

Random allocation was performed. As each participant entered this trial, he or she randomly allocated to either Group A (Moderate intensity) or Group B (High intensity). For all the participants, exercise training consisted of a prescribed exercise program involving combine resistance training and aerobic training. Resistance training consisted of seated isolated knee extension with weight - cuffs. Aerobic training consisted of cycling on static cycle. For prescribing the intensities of exercise training, we followed the AHA recommendations for moderate and high intensities of exercise training for people with Type 2 Diabetes, with Group A receiving moderate intensity and the Group B receiving high intensity. Dosage parameters for exercise training include intensity, frequency, and duration.

4.4 Intensity

For Group A in resistance training was 50% of 1RM in kg, and for Group B it was 75% of 1RM in kg. Intensity for Group A in aerobic training was 30-40% of THR and for Group B was 50-65% of THR.

4.5 Frequency

Total duration of training was 3 weeks, in which 4 days per week exercise training was given.3 day aerobic training and 1 day resistance training.

4.6 Duration

Resistance training was given for 15 minutes per session and aerobic training was given for 20 minutes per session.

Form of exercise-*Resistance training* was given by weight cuffs as a resistance for quadriceps muscle as it is a large group of muscle. So seated knee extension with weight cuffs was given.4 sets of 8reps were given for knee extension. *Aerobic exercise* consisted of cycling for 20 minutes of training period. During exercise heart rate was monitored to ensure maximum safe exercise limit to adjust the work load target heart rate range (THRR) was used THRR=220-ageinyears*(30-45%) HRR(Heart rate reserve). If heart rate of patient exceeded than upper limit of THRR then intensity was reduced and if it was less than the lower limit than intensity was increased.

5. Statistical Analysis

5.1 Paired T test

This test was used to compare pre and post values of muscle strength, aerobic capacity, in same Group A (Moderate intensity) and to compare pre and post values of muscle strength, aerobic capacity, in same Group B (High intensity).

5.2 Unpaired T test

This test was used to compare the post values of muscle strength, aerobic capacity and of two different group i.e. Group A (Moderate intensity) and Group B (High intensity)

5.3 Wilcoxon signed-rank test

This test was used to compare pre and post values of Patient specific functional scale in Group A (Moderate intensity) and in Group B (High intensity).

5.4 Mann Whitney's u test

This test was used to compare post values of Patient specific functional scale of Group A and Group B.

Table showing protocol followed

GroupB	*GroupA*	*Parameter*	*Type of training*
75% of 1RM	50% of 1RM	Intensity	Resistance
4 sets of 8 reps	4 sets of 8 reps	Volume	
1 d/wk	1 d/wk	Frequency	
3Weeks (12sessions)	3 weeks(12 sessions)	Duration	
50%-60% of THR	30%-45% of THR	Intensity	Aerobic
20min	20min	Volume	
3d/wk	3d/wk	Frequency	
3weeks(12 sessions)	3weeks(12sessions)	Duration	

Table showing baseline characteristics

Group B	*Group A*	*Variable*
6-Sep	9-Jun	Sex(men/women)
42(18)	47(7)	Age, yrs
106(15.7)	111.7(23.5)	Body mass, kg
Medication use(no. of participant's)		
5	6	Metformin
3	3	Insulin
5	6	Glimepride
3(1)	2(2)	Muscle strength (kilograms)
400(29)	383(23)	Exercise capacity (6MWD)
5(1)	4(0.4)	Physical function (Patient specific functional scale)

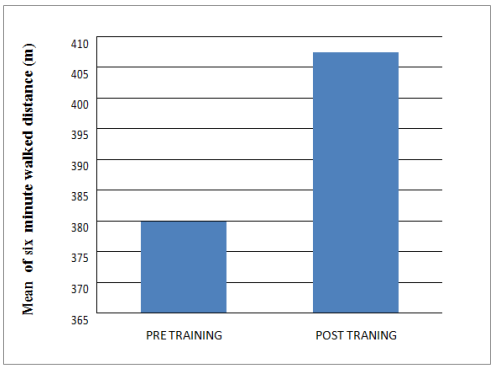
6. Data Analysis & interpretation

6.1 Comparison of exercise capacity at high intensity

Standard Deviation	*Mean*	*SR NO.*
16.333	380.0	PRETRAINING
16.335	407.4	POST TRAINING

Inference- There is increase in exercise capacity at high intensity exercise training with P value of<0.0001, considered extremely significant.

6.2 Comparison of exercise capacity at moderate intensity



Standard Deviation	*Mean*	*SR NO.*
24.6	378.7	PRETRAINING
24.0	405.5	POST TRAINING

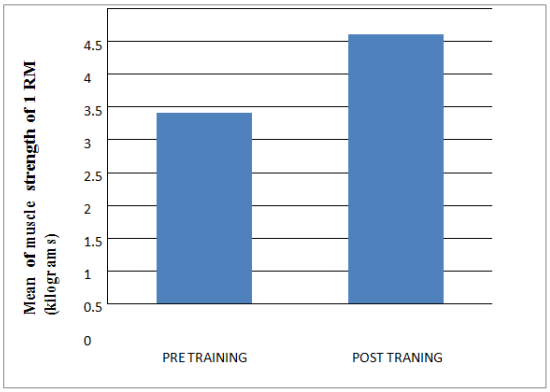
Inference- There is increase in exercise capacity at moderate intensity exercise training with P value of <0.0001, considered extremely significant.

6.3 Comparison of muscle strength at high intensity.

Standard Deviation	*Mean*	*SR NO.*
0.62	2.5	PRETRAINING
0.76	3.5	POST TRAINING

Inference-There is increase in muscle strength at high intensity exercise training with P value of <0.0001, considered extremely significant.

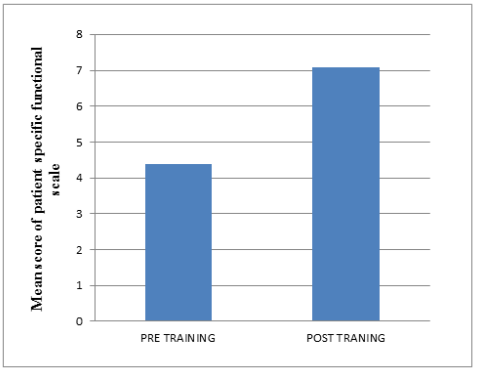
6.4 Comparison of muscle strength at moderate intensity



Standard Deviation	*Mean*	*SR NO.*
0.37	2.9	PRETRAINING
0.29	4.1	POST TRAINING

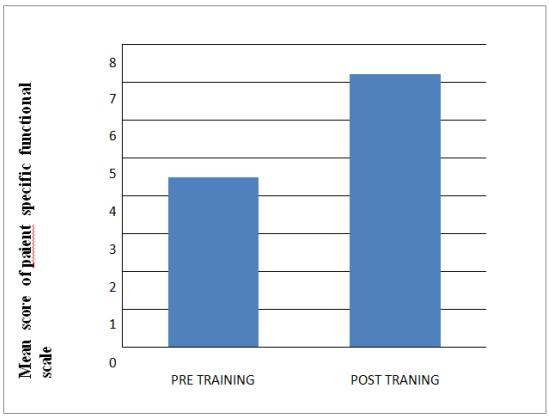
Inference-There is increase in muscle strength at moderate intensity exercise training with P value of <0.0001 considered extremely significant.

6.6 Comparison of physical function at high intensity using patient specific functional scale.



Standard Deviation	*Mean*	*SR NO.*
0.55	4.38	PRE TRAINING
0.46	7.09	POST TRAINING

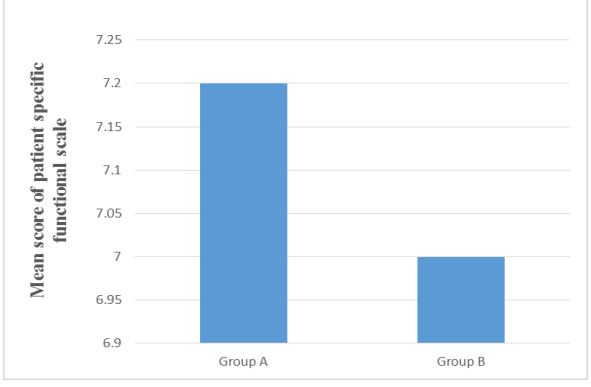
6.7 Comparison of physical function at moderate intensity using patient specific functional scale.



Standard Deviation	*Mean*	*SR NO.*
0.39	4.49	PRETRAINNG
0.34	7.20	POST TRAI NING

Inference-There is increase in patient specific functional scale score at moderate intensity exercise training with P value of <0.0001, considered extremely significant.

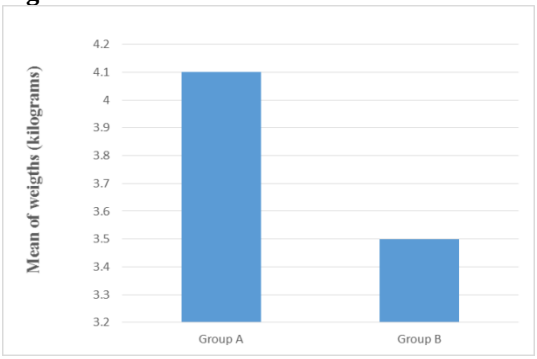
6.8 Comparison of physical function between Group A (Moderate intensity) and group B(High intensity) post training.



Standard Deviation	*Mean*	*SR NO.*
0.34	7.2	GROUP A
0.46	7.0	GROUPB

Inference-There is reduction in patient specific functional scale score at high intensity exercise training with P value of > 0.4829, considered not significant.

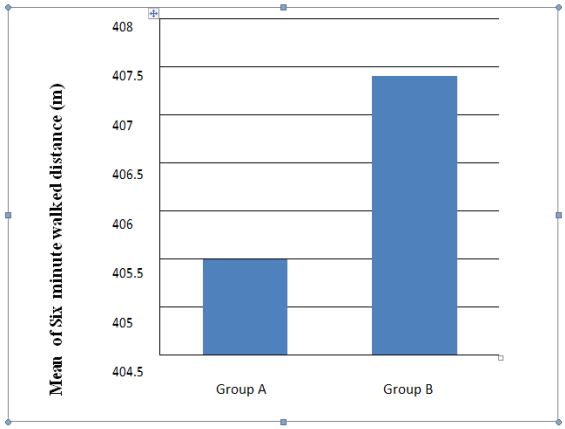
5.9Comparison of muscle strength between group A (moderate intensity) and Group B (High Intensity) post training



Standard Deviation	*Mean*	*SRNO.*
0.29	4.1	GROUP A
0.76	3.5	GROUPB

Inference-There is increase in muscle strength at moderate intensity exercise training with P value of < 0.0112, considered extremely significant.

5.10 Comparison Of Exercise Capacity Between Groupa (Moderate Intensity) And Group B (High Intesity) Post Training.



Standard Deviation	*Mean*	*SR NO.*
24.0	405.5	GROUP A
16.3	407.4	GROUPB

Inference-There is increase in exercise capacity at high intensity exercise training with P value of >0.8057, considered not significant.

7. Discussion

This investigation is a randomized clinical trial of the effects of exercise training intensity on physical fitness and physical function in people with type II diabetes. The results of this investigation indicated statistically significant improvement in all outcomes in both groups. However, gains in exercise capacity, and physical function were not statistically significantly different between the groups. Whereas gain in muscle strength was significantly different between Group A and Group B. Participants in both the Group A (Moderate intensity) and the Group B (High intensity) demonstrated significant and similar gains in, exercise capacity and physical function. Whereas participants in Group A (Moderate intensity) showed improvement in muscle strength than participants in Group B (High intensity).

The result of improvement in muscle strength between the, Group A and Group B was significantly different with the P value of 0.0112 (considered significant).Muscle strength show improvement in participants in Group A (moderate intensity), because, reduced muscle strength in people with Type 2 diabetes is associated with reduced oxidative capacity of skeletal muscles, and moderate intensity resistance training improved the skeletal muscle oxidative enzyme activity which led to increase in muscle strength [(5)]. Or this may be due to underline contractile properties of muscle have changed, that made increase in strength of muscle.

Exercise capacity showed no significant difference for participants in both the Group A and the Group B with the P value of 0.8057 (considered not significant).Which means Exercise capacity showed similar improvement in both the Group A and Group B. In individuals with type 2 diabetes performing aerobic exercise, Blood glucose utilization by muscles usually rises more than hepatic glucose production, and Blood glucose levels tend to decline and improves insulin action acutely. Plasma insulin levels normally fall, however, making the risk of exercise-induced hypoglycemia very minimal, even with prolonged Physical activity. Therefore, there was similar improvement in exercise capacity in both the Group A and Group B. There was no significant difference in improvements in physical function between the Group A and the Group B with the P value of 0.4829(considered not significant). People with type 2 diabetes are more likely to experience a greater loss of muscle strength, and decreased muscle strength is associated with a decreased level of physical function [(4,7)]. Also, people with type 2 diabetes typically have diminished exercise capacity, and decreased exercise capacity is related to physical disability [(5,4)]. The similar improvements in muscle strength and exercise capacity found between the groups in the present study could explain the similar gains in physical function.

8. Conclusion

By the above study we observed similar improvements in, exercise capacity, and physical function in people with type 2 diabetes when trained for short duration. This was irrespective of prescription of high or moderate intensity exercise training.

Also the above study showed improvement in muscle strength in people with Type 2 diabetes when treated with short term moderate intensity resistance exercise training. Physical therapists can make an evidence-based choice of

either moderate-intensity exercise training or high-intensity exercise training for people with type 2 diabetes.

9. Limitations

1) Small sample size
2) Long term exercise training effects on physical function was not considered.
3) Population more than age of 65 yrs was not included.
4) Immediate post exercise, blood glucose level was not checked to reduce the risk of exercise induced hypoglycemia.

10. Recommendations

1) Larger sample size can reduce error.
2) Long term exercise training effects on physical function of people with type 2 diabetes could be done for direct comparison.
3) Population age more than 65 can be included.
4) Immediate post exercise blood glucose level can be checked, to eliminate the risk of exercise induced hyperglycemia.

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