

To See the Effects of Aerobic Exercise Alone, Resistance Exercise Alone and Its Combination on HR, RR, BP, SPO₂, BMI, LDL and HDL in Patients with Type 2 Diabetes

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ABSTRACT

Background: Physical activity plays an important role in the management of type 2 diabetes patients which has an impact on its metabolic responses and can favorably change abnormal blood glucose and insulin resistance. Goal of the study was to investigate the effects of three different modalities of exercise i.e. aerobic and resistance exercise and combination of both exercises on cardio respiratory fitness levels in type 2 diabetes patients.

Methods: A randomized control trial in which 40 Subjects with type 2 DM were selected for the study for 8 weeks of exercise training. Participants were randomly distributed into the four groups each having 10 subjects (Group A-AT, Aerobic training), (group B-RT, Resistance training), (Group C-ATRT, combined –Aerobic Training-Resistance training.) and (Group-D control Group). All subjects were evaluated for the outcomes measures for Cardio respiratory fitness level evaluation before the commencement of training (pre-training) and at the end of 8-week of training period (post-training).

Results: There were no statistically significant differences between the groups. Within group analysis showed that both the treatments were equally effective in improving the dependent variables for type 2 DM patients. The results showed significant effect in cardio respiratory fitness levels on AT alone and RT alone than ATRT combined.

Conclusion: The primary outcome of the current study demonstrates that AT alone or RT alone was particularly more effective than combined ATRT in improving CRF in type 2 DM individuals which is defined as having low CRF by established clinical cut points, with a significant number of participants with type 2 diabetes traversing out of low CRF categories.

KEY WORDS: DM- diabetes mellitus, AT-Aerobic training, RT-Resistance training, ATRT-Aerobic training Resistance training, CRF-Cardio respiratory fitness level

INTRODUCTION

According to the International Diabetes Federation, 61.3 million people in India had diabetes and 77.2 million were prediabetics in 2011. That figure is projected to rise to 101.2 million by 2030 (3). IDF data reveal that India has more diabetes than the United States. In fact, India is ranked second in the

world in diabetes prevalence, just behind China.¹

According to American Diabetes Association, Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is

associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels².

Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of the beta-cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action. The basis of the abnormalities in carbohydrate, fat, and protein metabolism in diabetes is deficient action of insulin on target tissues. Deficient insulin action results from inadequate insulin secretion and/or diminished tissue responses to insulin at one or more points in the complex pathways of hormone action. Impairment of insulin secretion and defects in insulin action frequently coexist in the same patient, and it is often unclear which abnormality, if either alone, is the primary cause of the hyperglycemia².

The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. The prevalence of diabetes is higher in men than women, but there are more women with diabetes than men. The urban population in developing countries is projected to double between 2000 and 2030. The most important demographic change to diabetes prevalence across the world appears to be the increase in the proportion of people greater than 65 years of age³.

The most recent reported prevalence of prediabetes: diabetes in regional countries were; Bangladesh–4.7%: 8.5% (2004–2005; Rural), Maldives–3.0%:3.7% (2004; National), Nepal 19.5%: 9.5% (2007; Urban), Pakistan–3.0%:7.2% (2002; Rural), Sri Lanka–11.5%:10.3% (2005–2006; National). A high epidemicity index was seen in Sri Lanka (2005/2006–52.8%), while for other countries, the epidemicity index was comparatively low (rural India 2007–26.9%; urban India 2002/2005–31.3%, and urban Bangladesh–33.1%)⁴. prevalence of T2DM in Syria is projected to

double in the period between 2003 and 2022 (from 10% to 21%). The projected increase in T2DM prevalence is higher in men (148%) than in women (93%). The increase in prevalence of T2DM is expected to be most marked in people younger than 55 years especially the 25–34 years age group⁵. Aerobic Exercise: Aerobic or “with oxygen” exercises provide cardiovascular conditioning. This is endurance-type exercises in which a person’s muscles move in a rhythmic and coordinated manner for a sustained period. People refer to these exercises as aerobic because they require oxygen to generate energy. Aerobic exercises increase a person’s heart rate and breathing rate to supply more oxygen to the body’s muscles. Examples of aerobic exercise include: brisk walking, running, cycling, swimming etc.^{6,7}

Resistance Exercise: is any form of active exercise in which dynamic or static muscle contraction is resisted by an outside force applied manually or mechanically^{6, 7}. Resistance exercise, also referred to as resistance training, ^{8,9,10,11} is an essential element of rehabilitation programs for persons with impaired function and an integral component of conditioning programs for those who wish to promote or maintain health and physical well-being, potentially enhance performance of motor skills, and prevent or reduce the risk of injury and disease.^{12,13,14}. combined aerobic and resistance training compared with either type of exercise alone. So in present study we aimed to see the effect of aerobic and resistance exercise training in combination or alone for eight weeks on variables like heart rate, respiratory rate, blood pressure, O₂ saturation, BMI, LDL-C, HDL-C in case of type 2 diabetes patient to improve Cardio respiratory fitness level.

METHODOLOGY

A randomized control study was conducted among type 2 diabetes patients from IIMS&R at Lucknow city, Uttar Pradesh. In our study 40 Subjects with type 2 DM were selected for the study for 8 weeks of

exercise training. All subjects were evaluated for the outcomes measures for Cardio respiratory fitness level evaluation before the commencement of training (pre-training) and at the end of 8-week of training period (post-training).

Inclusion criteria: Age: 30-75 years of age. Gender: Male and Female, Type 2 diabetic patient, Willingness of patient to participate in the study.

Exclusion Criteria: Presence of any medical history of stroke, Advanced neuropathy., Advanced retinopathy, Recent thoracic and abdominal surgery, any associative restrictive lung disease All the selected subjects were informed in detailed about the type and nature of the study. Patients were requested to sign the consent form. A complete cardiopulmonary physiotherapy assessment was done for each patient. Patient meeting inclusion and exclusion criteria was selected for the study and randomly assigned into experimental (Group A-AT, Aerobic training), (group B-RT, Resistance training), (Group C-ATRT, combined –Aerobic Training-Resistance training.) and control group (Group-D control Group). The treatment duration for both the groups was framed as:

1. Duration per session: 30 minutes per session
2. No. of sessions per day: Once a day
3. No. of days per week: 3 days per week
4. Duration of the study: 8 weeks
5. Conventional physical therapy interventions were given to both the groups including stretching and relaxation classes.

All the subjects were evaluated for the outcomes measures for measuring Cardio respiratory fitness levels parameters like Heart rate, Respiratory rate, Blood pressure, O₂ Saturation, BMI, LDL and HDL before the commencement of training (pre-training) and at the end of 8-week training period (post-training). Each subject was evaluated

individually and tested following standard protocol.

Group A

Patients received aerobic exercise training by using the ergometer and treadmill. This exercise training was performed for duration of 30 minutes, 3 times weekly for 8weeks

Group B

Patients received resistance training exercise which was performed by using dumbbell and sand bags. It was given for 8weeks, for 30 min, 3times weekly for 8 weeks. Strengthening exercises per week comprised of two sets of four upper body exercises (bench press, seated row, shoulder press and pull down), three sets of three lower-body exercises (leg press, extension and flexion), two sets of abdominal crunches and back extensions. Each sets consisted of 10-12 repetitions, and amount of weight lift was progressively increased.

Group C

Patients received aerobic exercise training and resistance training in combined form. This exercise training was performing by using the ergometer, treadmill and dumbbell. This exercise training was performing 30 minutes 3 times weekly for 8weeks.

Conventional physical therapy treatment given to both groups including: Relaxation and stretching classes.

Group D

Group D is a control group and no. of patient was also 10 in number. This group received relaxation and stretching program for 30 minutes 3 times weekly for 8 weeks.

DATA ANALYSIS

The descriptive statistics were used to determine the mean and standard deviation of variables. Repeated measure ANOVA was used to determine changes within group. P values for significant changes were equal or less than 0.05.

Table No. 1: Distribution of gender of the study subjects in different groups

Variable	Group A	Group B	Group C	Group D	p-value
Sex (Male/Female)	6/4	5/4	5/5	6/6	0.829

Table 1 showed the distribution of gender of the study subjects in different groups. Statistical analysis showed that the distribution of male and female is almost same in each group (p=0.829) i.e. Study is sex matched experiment.

Table 2: Mean age of study subjects in different groups

Variable	Group A(1)	Group B(2)	Group C(3)	Group D(4)	p-value
Age	50.40±5.91	39.11±6.23	47.30±10.73	58.90±4.38	0.000

Post hoc comparison: group 1 vs 2, 1 vs 4, 2 vs 3, 2 vs 4, 3 vs 4 are significant

Table 2 showed the mean age of study subjects with group A-50.40 years with SD 5.91, group B -39.11 years with SD 6.23, group C- 47.30 years with SD 10.73 and in group D is 58.90 years with SD 4.38.

Table No. 3: Mean height of study subjects in different groups

Variable	Group A	Group B	Group C	Group D	p-value
Height (In cm)	162.05±4.90	161.98±3.75	162.05±4.60	158.75±7.59	0.452

Post hoc test: No pair is significant

Table 3 reveals the mean Height of study subjects in different groups. It showed that the average height of study subjects is almost same in each group (p=0.452).

Table No. 4: Mean weight of study subjects in different groups

Variable	Group A	Group B	Group C	Group D	p-value
Weight (in kg)	85.50±5.04	79.96±15.05	84.58±12.64	81.19±11.57	0.681

Pot hoc test: no pair is significant

Table 4 reveals the mean weight of study subjects in different groups. It showed that the average weight of study subjects is almost same in each group (p=0.681).

DEMOGRAPHIC DATA

Demographic data shows the personal characteristics of the study subjects. In the present study we have 40 respondents in which 50 % are male and 50 % are female. The total number of study subjects were 40 which is equally distributed in four groups;

group A (10 subjects), group B (10 subjects), group C (10 subjects) and group D (10 subjects). The ratio of male to female subjects were 25% in group A, 25% group B, 25% in group C and 25% in group D respectively (total 100%).

Variable	Group A	Group B	Group C	Group D	p-value
HR 0	97.90±11.40	95.66±13.89	94.90±12.41	85.10±18.67	0.220
HR 8W	87.80±9.08	92.44±12.49	93.80±11.60	106.70±16.86	0.016
Within group significance	p=0.000	p=0.012	p=0.057	p=0.000	

Table 5: Mean Heart rate of study subjects at 0 day and after 8 Week in different group

Above table showed the mean heart rate of study subjects at 0 day and after 8 Week in different group. At 0 day the mean heart rate of study subjects in all four groups were almost same (p=0.220) while after 8 weeks there is a significant difference in mean

heart rate among groups (p=0.016). After 8 weeks minimum heart rate was found in group A, while maximum heart rate was found in group D. Within group variation showed highly significant change in heart rate within all groups except group C.

Variable	Group A	Group B	Group C	Group D	p-value
RR 0	13.80±1.31	17.77±3.56	18.10±3.47	17.00±3.94	0.021
RR 8W	10.10±1.28	16.77±2.94	17.50±3.02	19.80±3.76	0.041
Within group significance	p=0.000	p=0.017	p=0.25	p=0.000	

Table 6: showed the mean respiratory rate of study subjects at 0 day and after 8 Week in different group.

At 0 day the mean respiratory rate of study subjects in all four groups were found significantly different (p=0.021) and after 8 weeks there was significant difference in mean respiratory rate among groups (p=0.041). After 8 weeks minimum

respiratory rate was found in group A while maximum respiratory rate was found in group D. Within group variation showed a highly significant change in respiratory rate within all groups except group C.

Variable	Group A	Group B	Group C	Group D	p-value
SBP 0	132.70±4.96	131.44±8.45	129.30±7.39	131.60±7.83	0.765
SBP 8W	131.20±4.07	125.55±8.58	127.60±6.11	81.80±7.77	0.000
Within group significance	p=0.002	p=0.001	p=0.016	p=0.000	

Table 7: Mean Systolic Blood Pressure of study subjects at 0 day and at 8 Week in different group

It showed the effect of different interventions on Systolic Blood Pressure. At baseline period the Systolic blood pressure is not significantly different among groups (F=0.385, p=0.76) however this was

significant at 8 week (p=0.000). Within group variation showed significant changes in SBP between 0 day and 8th week within all groups (p<0.05).

Variable	Group A	Group B	Group C	Group D	p-value
DBP 0	79.80±3.76	84.66±6.61	80.30±8.54	134.10±8.10	0.000
DBP 8W	78.70±2.83	82.22±6.33	79.50±6.29	86.60±12.17	0.114
Within group significance	p=0.031	p=0.000	p=0.29	p=0.000	

Table 8: Mean Diastolic Blood Pressure of study subjects at 0 day and at 8 Week in different group.

It Showed the effect of different interventions on Diastolic Blood Pressure. At baseline period the diastolic blood pressure is significantly different among groups (p=0.000) however this is

insignificant at 8 week (p=0.114). Within group variation shows significant changes in DBP between 0 day and 8th week in group (p<0.05) in group A, B, D & group C.

Variable	Group A	Group B	Group C	Group D	p-value
SPO2 0	95.30±2.26	96.33±1.73	95.70±2.68	96.60±1.17	0.491
SPO2 8W	92.50±4.57	95.55±1.33	95.97±1.59	96.00±2.10	0.020
Within group significance	p=0.051	p=0.010	p=0.561	p=0.27	

Table 9: depicts the effect of different interventions on SPO2 in different time periods.

At baseline period there was no significant difference in SPO2 level (F=0.822, p=0.491) among four groups while after 8 weeks this difference was found to be significant (F=3.720, p=0.020). Within group analysis showed significant increment in SPO2 level in pre-post.

Variable	Group A	Group B	Group C	Group D	p-value
LDL 0	118.45±22.09	84.98±23.22	104.52±24.54	96.00±2.10	0.015
LDL 8W	118.45±22.09	79.98±23.18	103.12±24.40	87.67±27.30	0.007
Within group significance	p=1.00	p=0.0001	p=0.0013	p=0.001	

Table 10: Mean LDL of study subjects at 0 day and at 8 Week in different group

It reveals the effect of different intervention on LDL at 0 day and after 8 week. Statistical analysis showed that initially the

level of LDL was significantly different among groups (p=0.015) while this difference was also seen after 8 weeks

($p=0.007$). After pre –post-test experiment it was revealed that there’s no changes in LDL level between 0 day and 8 weeks in group

A, however this difference was highly significant in other groups.

Variable	Group A	Group B	Group C	Group D	p-value
HDL 0	43.50±8.31	42.22±6.05	44.79±9.22	45.51±6.29	0.794
HDL 8 Week	43.50±8.31	44.22±6.05	45.09±7.87	45.51±6.29	0.927
Within group significance	$p=1.0$	$p=1.0$	$p=0.541$	$p=1.0$	

Table 11: Mean HDL of study subjects at 0 day and at 8 Week in different group

It reveals the effect of different intervention on HDL at 0 day and after 8 week. Statistical analysis shows that initially and after 8 week there was no difference in mean HDL level among groups ($F=0.343$, $p=0.794$ & $f=0.153$, $p=0.927$). The within groups variation showed that there was no difference in pre & post HDL level in all four groups.

DISCUSSION

Heart Rate

At 0 day the mean heart rate of study subjects in all four groups were almost same ($p=0.220$) while after 8 weeks there is a significant difference in mean heart rate among groups (0.016). After 8 weeks minimum heart rate was found in group A while maximum heart rate was found in group D. Within group variation showed highly significant change in heart rate within all groups except group C.

Result of the present study is similar to the findings of Zuyao Yang et al (2013), they did study on Resistance Exercise versus Aerobic Exercise for Type 2 Diabetes for duration of at least 8 weeks and they have concluded that four trials with 231 participants provided data on maximum heart rate. Within-group pre-post changes in maximum heart rate in resistance and aerobic groups were -0.45 beats per minute (-2.23, 1.33) and -3.82 beats per minute (-4.51, -3.12), respectively. The difference in within-group change in maximum heart rate between resistance and aerobic groups was 3.44 beats per minute (2.49, 4.39) ($I2 = 0\%$, $p = 0.90$).¹⁵

Shweta Shenoy et al (2009), they did study on the effects of progressive resistance training and aerobic exercise on type 2 diabetic in Indian Population, There was

significant reduction in heart rate by 17.8% in PRT group as compared to 2.3% decrease and 1.2% increase in AE and control group, respectively. PRT group exhibited significant reductions in heart rate ($p=0.007$).¹⁶

Respiratory Rate

At 0 day the mean respiratory rate of study subjects in all four groups were found significantly different ($p=0.021$) and after 8 weeks there was a significant difference in mean respiratory rate among groups ($p=0.041$) i.e. minimum respiratory rate was found in group A while maximum respiratory rate was found in group D. Within group variation showed a highly significant change in respiratory rate within all groups except group C.

BP (SBP& DBP)

Present study showed the effect of different interventions on Systolic Blood Pressure. At baseline period the Systolic blood pressure is not significantly different among groups ($p=0.76$) however this is significant at 8 week ($p=0.000$). Within group variation showed significant changes in SBP between 0 day and 8th week within all groups ($p<0.05$). At baseline period the diastolic blood pressure is significantly different among groups ($p=0.000$) however this is insignificant at 8 week ($p=0.114$). Within group variation shows significant changes in DBP between 0 day and 8th week in group ($p<0.05$) in group A, B, D & group C.

Huimin Yan et al (2014), They did study on the effect of Aerobic Training on Glucose Control and Blood Pressure in T2DDM East African Males, 41 physically active males with type 2 diabetes mellitus were recruited and randomly assigned to 12 weeks and

they have concluded that SBP & DBP at the end of the intervention were significantly lower in the exercise group (EX) than control group (CON) after covering for the baseline values ($P < 0.05$). The change of HbA1c (-1.0 ± 0.03) over the 12 weeks was significantly correlated with the change of SBP (0.3 ± 2.7 mm Hg, $r = 0.4$, $P < 0.05$) and DBP (-1.4 ± 1.5 mm Hg, $r = 0.4$, $P < 0.05$).¹⁷ Zuyao Yang et al (2013), they did study on Resistance Exercise versus Aerobic Exercise for Type 2 Diabetes for duration of at least 8 weeks and they have concluded that Ten trials with a total of 422 participants provided data on blood pressure. The within group pre-post changes in systolic blood pressure in resistance and aerobic groups were -7.02 mmHg (-11.03 , -3.01) and -8.69 mmHg (-11.14 , -6.23), respectively. The corresponding values for diastolic blood pressure were -4.40 mmHg (-6.53 , -2.28) and -4.98 mmHg (-8.89 , -1.08). The difference in within-group change for systolic and diastolic blood pressure between resistance and aerobic groups were 2.25 mmHg (-2.06 , 6.56) and 0.28 mmHg (-2.92 , 3.49), respectively, with substantial statistical heterogeneity in both meta-analyses ($I^2 = 70\%$, $p = 0.001$ and $I^2 = 79\%$, $p = 0.001$, respectively).¹⁵ Sijie Tan et al (2012), they did study on the Effects of six months of combined aerobic and resistance training for elderly patients with type 2 diabetes and 30 elderly patients were (65.9 ± 4.2 yrs) included, they have concluded that the results were based on the observations of 15 subjects in the exercise group and 10 subjects in the control group who completed the study. Random grouping did not result in significant differences in the variables between the groups at the baseline. Exercise subjects decreased their SBP after training but the change was not different to that of the control group.¹⁸

SPO2

In the present study it was found that the baseline period there is no significant difference in SPO2 level ($P = 0.491$) among four groups. While after 8 weeks this

difference was found to be significant ($P = 0.020$). Within group analysis showed significant increase in SPO2 level in pre-post.

LDL&HDL

In the present study it was found that the statistical analysis shows that initially the level of LDL was significantly different among groups ($p = 0.015$) while this difference is also seen after 8 weeks ($p = 0.007$). After pre-posttest experiment it is revealed that there is no changes in LDL level between 0 day and 8 weeks in group A, however this difference is highly significant in other groups and for HDL it was found that the Statistical analysis shows that initially and after 8 week there was no difference in mean HDL level among groups ($p = 0.794$ & $p = 0.927$). The within groups variation shows that there is no difference in pre & post HDL level in all four groups.

Jyotsna Aggarwala et al (2016), they did study on the effects of aerobic exercise on blood glucose levels and lipid profile in Diabetes Mellitus type 2 Subjects for 4 weeks The 20 subjects included were sedentary men & women suffering from type 2 diabetes mellitus. They have concluded that after implementation of 4 weeks duration of aerobic exercise the percentage(%) of fall in LDL (mg/dl) was 1.82% ($p > 0.05$) and there was not any improvement in HDL (mg/dl) i.e. 0% ($p > 0.05$).¹⁹

Etemadi Amin et al (2014), they did study on The Comparison of the Effect of Eight weeks Aerobic and Resistance Training on Lipid profile patients with Diabetes type 2, for 8 weeks and 45 patients with diabetes type 2 were selected by targeted sampling method and divided into two aerobic training and resistance experimental groups and one control group and they have concluded that results of that study showed a significant improve in HDL after aerobic training course and meaningful improve in HDL after resistance training course. In aerobic training HDL pre-test 20.39 ± 10.9

and post-test is 27.46±9.32 and in resistance training HDL pre-test is 67.38±5.99 and post-test is 60.42±7.07. The amount of LDL was not changed significantly in these patients with aerobic and resistance exercises.²⁰

CONCLUSION

Although many treatment methods are currently in vogue in order to deal these kinds of patients, we are in emergent need of applying the correct technique which suits the patient's need for improving Cardio respiratory fitness level. The outcomes of the present study showed that trained subjects achieved significant changes in their HR, RR, BP, SPO₂, LDL following 8 weeks of aerobic, resistance and combined aerobic-resistance exercise but in group A (Aerobic Ex.) LDL was not significantly changed; as well as HDL & BMI are not changed after following 8 weeks of intervention in all groups. These results demonstrate that even elderly and middle aged patients with long-term type2 diabetes can obtain benefits from aerobic, resistance and combined exercise training.

Declaration by Authors

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