EFFECT OF AEROBICS AND RESISTANCE EXERCISE TRAINING INTERVENTION ON BLOOD GLUCOSE CONTROL IN TYPE2 DIABETIC PATIENTS REGARDING AMBO UNIVERSITY REFERRAL HOSPITAL

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Abstract

Type2 diabetes mellitus results from a combination of the inability of muscle cells to respond to insulin (insulin resistance) and inadequate compensatory insulin secretion. The addition of exercise to regular diabetic medication provided significantly favourable effects on glycemic control through managing blood glucose level. The purpose of this study was to examine the effect of aerobic and resistance exercise training intervention on blood glucose level in type2 DM outpatient. Twelve physically active adult that pass the set criteria with mean age of 50.43±12.50 with type 2DM were the subject of this study. The subjects were purposively selected by using convenient sampling technique. SPSS (23 version) were used for statistical data analysis. The paired sample T-test was used to test if there was a significant change in parameters. (P= 0.05). From our finding, we observed that, Fasting blood glucose, body weight, body mass index, volume of oxygen consumption (Vo_{2max}) and resting heart rate with in type2 diabetes were significantly decreased following the eight weeks intervention of combined aerobic and resistance exercise. Although, each type of exercise has its own benefit in glycemic control, this value was not achieved through a single exercise. Type2 diabetes mellitus results from a combination of the inability of muscle cells to respond to insulin (insulin resistance) and inadequate compensatory insulin secretion. The addition of exercise to regular diabetic medication provided significantly favourable effects on glycemic control through managing blood glucose level. The purpose of this study was to examine the effect of aerobic and resistance exercise training intervention on blood glucose level in type2 DM outpatient. Twelve physically active adult that pass the set criteria with mean age of 50.43±12.50 with type 2DM were the subject of this study. The subjects were purposively selected by using convenient sampling technique. SPSS (23 version) were used for statistical data analysis. The paired sample T-test was used to test if there was a significant change in parameters. (P= 0.05). From our finding, we observed that, Fasting blood glucose, body weight, body mass index, volume of oxygen consumption (Vo_{2max}) and resting heart rate with in type2 diabetes were significantly decreased following the eight weeks intervention of combined aerobic and resistance exercise. Although, each type of exercise has its own benefit in glycaemic control, this value was not achieved through a single exercise.
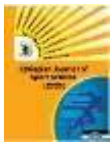
1. INTRODUCTION

Chronic diseases are the main killers in the present-day era. Physical inactivity is a number one reason for maximum persistent diseases (Booth, Roberts et al. 2012) Being physically inactive is associated with increased chronic disease risk. However, elevated physical activity (PA) and exercise are related to decrease continual disease risk (Anderson and Durstine 2019). Exercise is an effective device in combat to prevent and deal with numerous chronic diseases. What is beginning to be learned is the mechanisms through which exercising sustains and improves the quality of life (Drydon 2018). Type 2 diabetes is a metabolic disorder which is characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency. In 2010, it was estimated that there were 285 million diabetics worldwide and 80% live in less developed areas. In Ethiopia, according to WHO estimation, the number of diabetics' cases in the year 2000 was 800,000 and this number is expected to increase to 1.8 million by the year 2030 (Barceló, Aedo et al. 2003). According to World Health Organization–Diabetes country profiles, 2016 reported; in Ethiopia, the prevalence of diabetes was reached 3.8% in total population and 8850 people (1%) out of 3.8% have died in case of diabetes (Organization 2016). Physical activity, combined with diet and medication, are recommended treatments for type 2 diabetes by the World Health Organization. Blood glucose control is important in preventing and slowing the progression of complications There is evidence for effective interventions to improve the management of diabetes and to reduce its modifiable risk factors, but there are significant gaps in the knowledge base (TIME 2016). Recommended research to advance diabetes prevention and control includes; ongoing research into risk factors and prevention of all types of diabetes, Innovative intervention research to expand the evidence base for the promotion of physical activity, and Options to improve access to insulin (TIME 2016). A combination of aerobic and resistance exercise training can be extra effective in enhancing blood glucose (BG) management than both by itself; but, more studies are needed to decide if general caloric expenditure, workout duration, or exercise mode is responsible (Colberg, Sigal et al. 2010). Aerobic and resistance exercises have been confirmed to be effective physical activities on improving glycemic control for type2 diabetes patients. Aerobic exercise is physical exercise that involves large muscle groups to improve cardiovascular endurance. Resistance exercise is physical exercise that causes the muscles to contract against an external resistance, the purpose of which is to increase muscle strength and muscle mass. All forms of exercise training produce small benefits in the main measure of glucose control. The effects are similar to those of dietary, drug, and insulin treatments. The clinical importance of combining these treatments needs further research (Snowling and
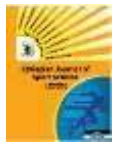
Hopkins 2006) Exercise remains hugely under-utilized in the management of Type 2 DM (Van Rooijen 2006)Higher prevalence of diabetes mellitus was observed than the international diabetic federation (IDF) projected estimate of DM for Ethiopia(Aynalem and Zeleke 2018). Further research is needed to assess the combined effects of aerobic exercise and resistance on blood glucose, HbA1c and the quality of life of T2DM (Fajriyah, Sudiana et al. 2020). Therefore, this study aims to evaluate the effectiveness of combined aerobic and resistance exercise intervention on blood glucose control with type2 DM Outpatient.

2. Material and Method
2.1 Study Design

One group pre-test-post-test prospective follow-up interventional study was used to examine the effect of aerobic and resistance exercise intervention on blood glucose level, blood pressure; resting heart rate and Vo_{2max} were measured. This study was experimental research

and the quantitative measurements were performed to examine the results of exercise intervention on the indicted variables control with in Type2 diabetics attending outpatient care at Ambo University Referral Hospital. The study was carried out from February 12/2022 to May 12/ 2022

2.2 The Subject

The participants in this study had a mean age of 50.25±14.43 and mean diabetes duration of 4.50±2.45.Each subject's blood glucose level, blood pressure; resting heart rate and Vo2 max were measured. Additionally, anthropometric parameters such as body weight and body mass index (BMI) were checked before doing any aerobics and resistance exercise and these values were tabulated. After 40-60 minutes of exercise intervention was executed frequently for 3 days per weeks and eight weeks, all dependent variable were checked (measured again). All measurements were accomplished with the help of the health profession

2.3 Inclusion and Exclusion criteria

Table 1: Show Inclusion and exclusion criteria of the participants

Inclusion criteria	Exclusion criteria
· Patients who are in follow up care in AURH	· Patients who were not interested to take part in the examination and unable to signed informed consent.
· Both Intercourse	
· Having with Type2 Diabetes	
· Signed consent form	· Patients with metabolic syndrome disease
· Outpatient follow-up care	

• Patients with disability which cause unable to perform exercise

3. Tools and Instrument of Data Collection

3.1 Tools

- Structured Questionnaire that contains information on the sociodemographic factors, behavioural measurements (WHO STEPS instrument), and Global Physical Activity Questionnaire (GPAQ).
- Physical Measurements
- Biochemical Measurement

3.2 Instruments

- Glucometer Blood glucose display (DIAVUE prudential), Test strips, Gloves, Cotton
- Portable weighing and height scale
- Sphygmomanometer (RI ester) and stethoscope

Training protocol

Table 3 The total three months of the schedule design

Modality	Layer
Frequency Total	3day/week
duration	12 week
Duration/session	40-60 minute
Intensity	50-70% MHR
Exercise day	Monday, Wednesday, and Friday
Intervention	Combined aerobic and resistance training

The training undergoes three training sessions per/week on the sports grounds and in a gymnasium for eight weeks. The training session consisted of aerobic exercise 10-minute warm-up period, which included walking and jogging, as well as muscle stretches. This was followed by 30 minutes of interchanged walking/running, such as trade meal running with the intensity controlled within the individualized 50-70% predicted heart rate maximum (HR max) and Each exercise of the resistance workout could be executed as one set of eight-10 repetitions, progressively based totally on the individual capacity. The base of each aerobic and resistance training into prescribed according to the American diabetic Association (Colberg, Sigal et al. 2016) At the end of every training session, there have been 10-minute of cool-down periods that contain slow
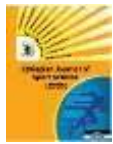
walking and gentle muscle stretches. Each training session lasts for forty-60 minutes and it was supervised by the researcher, assistance fitness profession and health care provider. Forty percentage (forty %) glucose or sugar will hold around the exercise floor for use in case of hypoglycaemia/shocking.

4. Method of Data analysis

All data collected on dependent variables through instrument were analysed using SPSS (version 23) for undertaking statistical data analyses. The dependent paired T-test was used to analysis the result of the pretest and posttest blood glucose degree, blood pressure, body mass index, resting heart rate and vo2 max values. First, descriptive analysis was performed to describe the sociodemographic, anthropometric and glycemic control parameters of the participants A p- value of <0.05 at 95% confidence level was used as a difference of statistical significance
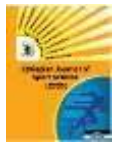
5. Result and Findings

The exercise regimen was well tolerated; no hypoglycaemia or injury was occurred during the exercise sessions. Due to time constraints out of 15 people, 3 patients discontinued the study. Twelve people were absolutely completed the testing and training requirements of the study.

5.1 Socio-Demographic Characteristics of the study subjects

Participant's socio demographic characteristics were reported in below table.

Table 7: Socio-demographic Characteristics of Study Subjects (n=12).

Variable	Status	Frequency	Percentage
Gender (Male/Female)		10/2	83.3/16.7%
Education status	No formal education	-	-
	Primary	3	25%
	Secondary and Diplom	6	50%
	First degree and above	3	25%
Residence	Rural	-	-
	Urban	12	100%
Marital status	Single	1	8.3%
	Married	11	91.7%
	Divorced	-	-
Occupation	Government employe	5	41.7%
	Self-employe	6	50%
	Pensioner	1	8.3

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Among study subjects completed the exercise protocol, half of the study subjects (50%) were attended secondary and diploma formal education, whereas 3% were have primary and 3% have first degree and above respectively. The

entire subjects (100%) were urban dwellers. Regarding occupational status, half of the subjects (50%) were self-employed, 41.7% were governmental employed, and one person (8.35%) of the subjects was pensioner respectively.

5.2 Behavioural and physical measurements of the study subjects

Table 3: Behavioural Characteristics of Study Subjects (n=12).

Variable	Response	Frequency	Percentage
Have smoke cigarettes	yes	4	33.3%
	No	8	66.7%
Have Drinking Alcohol	yes	9	75%
	No	3	25%

Among study participants, 33.3% of the subjects were smoke cigarettes and above half of the subjects (66.7%) were not smoked it. However, majority of the participants (75%) have drink alcohol which may one cause of the type2 diabetes and other chronic disease by means of disturbing the metabolic function of the body. Chronic alcohol consumption is considered to be a risk factor for type 2 diabetes mellitus, which

causes insulin resistance and pancreatic-cell dysfunction, both of which are necessary for the development of diabetes (Kim and Kim 2012) Additionally, Cigarette smoking increases the risk for type 2 diabetes incidence. Nicotine, acknowledged as the major pharmacologically active chemical in tobacco, is responsible for the association between cigarette smoking and development of diabetes (Xie, Liu et al. 2009).

Table 4 Global Physical Activity Questionnaire (GPAQ) of the study subject (12)

|	Physical activity question	Status	Frequency	Percentage
1	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?	yes	2	16.75
		No	10	83.3
2	Do you walk for at least 10 minutes continuously to get to and from places?	yes	9	75%
		No	4	
3		yes	2	16.75

| Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, [cycling, swimming, and volleyball] for at least 10 minutes continuously? | No | 10 | 83.3% |

Majority of the subjects' (83.3%) work does not involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking and only 16.7% of them have involved physical activity that includes moderate intensity activity. This table indicate that majority of the subjects were living sedentary life which stimulate type2 diabetes. Also, 83.3% of the subjects have no fitness or recreational activity such as brisk cycling; swimming and other ball games and only 16.7% of the participants have it. Physical inactivity and obesity are two major risk factors for the development of T2DM (Venables and Jeukendrup 2009)

5.3 Body mass index of the study subjects

According to described in table below, half of the study subjects in the pre-test (50%) and post-test (41.6%) were assigned to an overweight body mass index. The number of subjects in the obesity range was decreased from pretest value of 2 (16.7%) to posttest value of 1 (8.3%). The mean and standard deviation BMI of the subjects was reduced from pretest value of (25.27 ± 3.11) to posttest value of (24.58 ± 3.18). The result suggested that, the body mass index was decreased significantly by2.73% (P=0.001*) The result showed, the combined aerobic and resistance exercise can importantly reduce body mass index and promoting the management of the type2 diabetes through minimize excessive fatness.

Figure 5: Percent Distribution of Pre-test and Post-test BMI of the Study Subjects
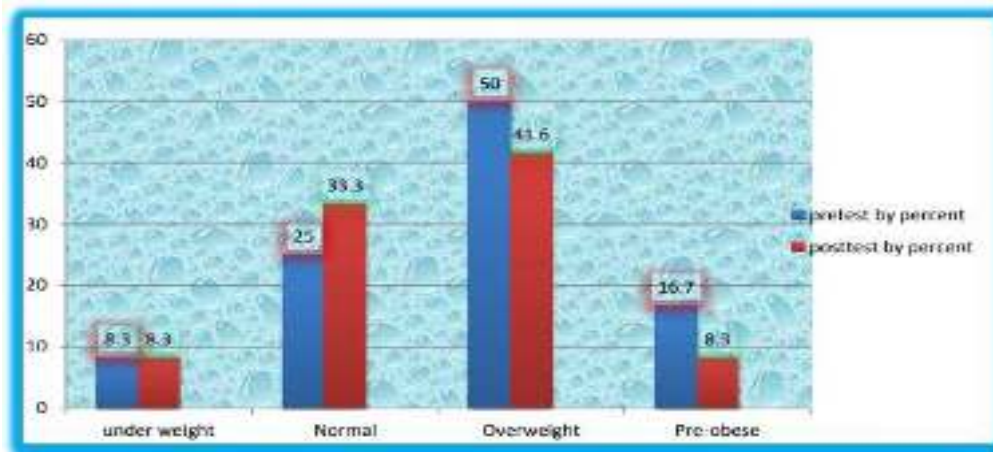
5.4 Fasting Blood glucose

From the figure below, the mean fasting blood glucose was decreased from 163.33 to 156.92 with mean reduction of 6.41. It was reduced by 3.92%. The result suggested that, FBG was significantly decreased following intervention of combined aerobic and resistance exercise after 8 weeks (P=0.003*)
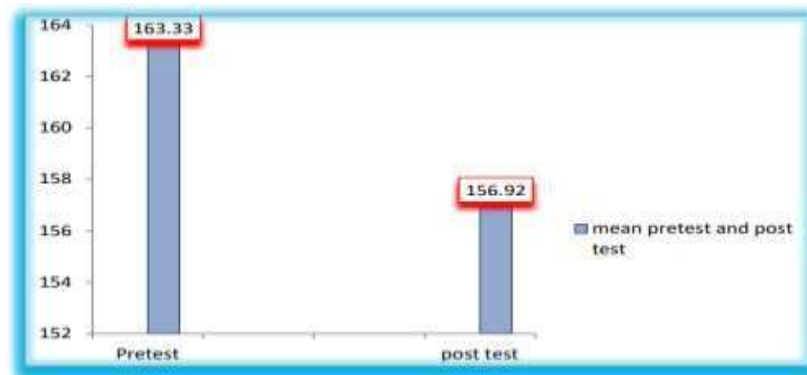

Figure 9 Mean pre-test and post test result

These results showed that, the combination of aerobic and resistance exercise really does have an effect on fasting blood glucose (plasma glucose) of type2 diabetic patients. This result displayed, type2 diabetic patients who have participated in the combination of exercise could have more managed their glycemic control after posttest than pretest (after 8 week intervention).it indicates, the combination of both exercise have positive effects on managing blood glucose of the type2 diabetes through decreasing blood glucose.

5.5 Blood Pressure

As showed below table, the mean systolic blood pressure was decreased from 138.67±15.67mmHg to 133.08± 13.42mmHg while diastolic blood pressure was dropped off from 81.25±7.93mmHg to 76.50±9.41mmHg. The below figure indicated that, Systolic and diastolic blood pressure was decreased by mean difference of 5.59 and 4.75 respectively. Although, it was decreased, the value was not statistically significant (p=0.056 for systolic and P=0.062 for diastolic blood pressure respectively).
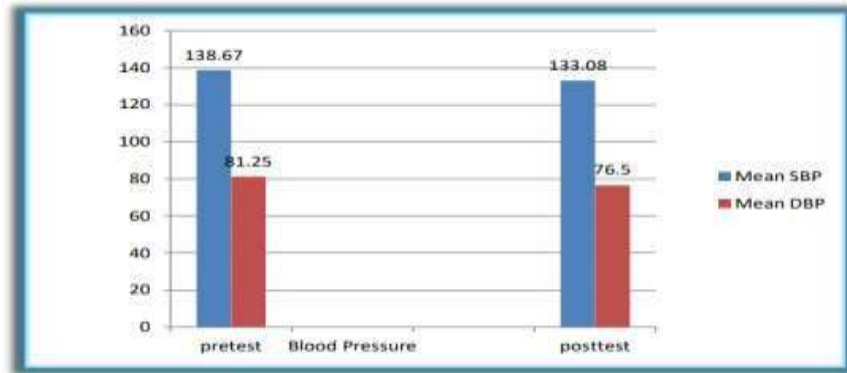
Figure3 Mean pre-test and post-test systolic and diastolic blood pressure

5.6 Resting heart rate

The below table displayed that, the resting heart rate was decreased from 84.14bp to 80.5bp. It was reduced by 4.33% . The result indicated that, the intervention of Combined aerobic and resistance exercise significantly decrease resting heart rate of type2 diabetic patients (P<0.05).
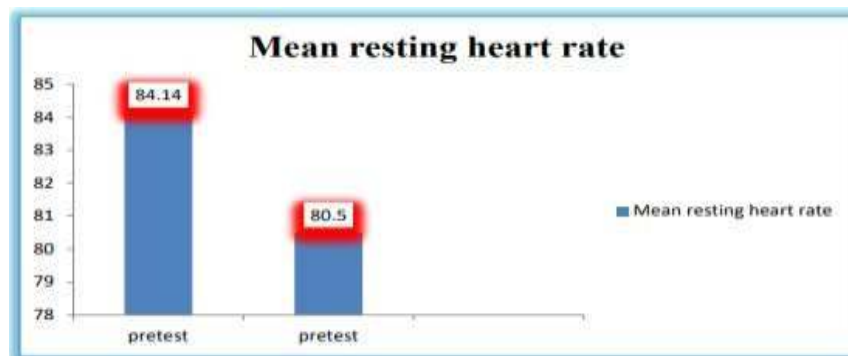

Figure7. Prepost test of resting heart rate

5.7 Volume of oxygen consumption (Vo2 max)

The following table showed that, the mean value of vo2 max was increased from pre-test (30.44±3.91 ml/kg/min) to post-test (31.66±4.01 ml/kg/min). It was increased by 4.01% and the result was statistically significant (P=0.029*). From this value, it showed that, the combination of aerobic and resistance exercises have a positive effect on fasting blood glucose (plasma glucose) of type2 diabetic patients through increasing the amount of vo2max after eight weeks. The mean value pre-test and post test result of oxygen consumption (Vo2max) was displayed as the following figure.
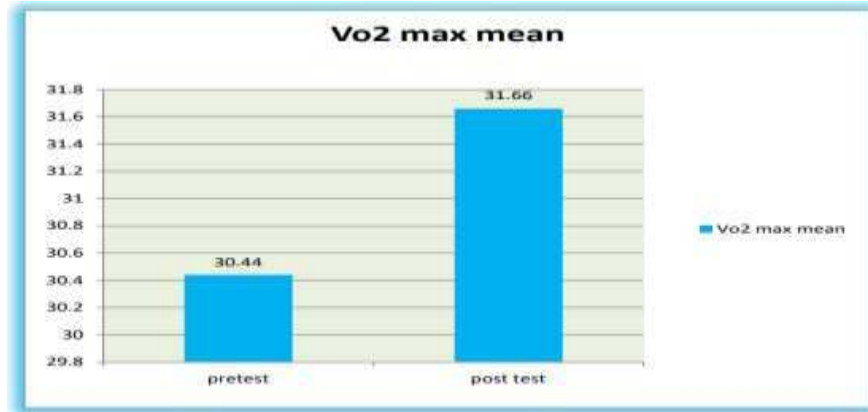
Figure7 Pre-test and post-test Vo2 max mean

The paired sample T-test showed the presence of statistically significant (p<0.05) decrement in fasting blood glucose, body weight, body mass index and volume of oxygen consumption (Vo2) max (Table 6). Although, there was decrement in mean, systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the study subjects, the change was not statistically significant(p>0.05).

Table 6: Statistical Correlation of Paired Sample Test between Pre and Post-test Measurements

Paired variables (Pre-test-post-test)	Differences					T	df	P-value
	Mean difference	Std. Error		95% CI of the Difference				
		Mean		Lower	upper			
Fasting blood glucose	6.42	5.96	1.72	2.63	10.20	3.73	11	0.003*
Body weight	1.42	1.39	0.40	2.30	3.52	3.52	11	0.005*
BMI	0.69	0.55	0.15	0.35	1.04	4.39	11	0.001*
SBP	5.58	9.19	2.66	-0.26	11.43	2.20	11	0.059*
DBP	4.75	7.92	2.28	-2.28	9.78	2.07	11	0.062
RHR	-	-	-	-	-	-	-	0.005*
Vo_{2max}	-1.22	1.66	0.48	-2.28	-0.13	-2.52	11	0.029*

*P<0.05 is statistically Significant

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Table 7: Comparison of Percentage Mean Change between Pre and Post-test Measurements

SN	Variable	Pretest mean	After treatment mean	Change mean in Percentage
1	FBG	163.33	156.92	3.92%
2	BMI	25.27	24.58	2.73%
3	SBP	138.67	133.08	4.03%
4	DBP	81.25	76.50	5.85%
5	Body weight	74.95	73.54	1.88%

From above table, the intervention of combined aerobic and resistance exercise resulted significantly decreased fasting blood glucose by 3.92%, body mass index 2.37%, body weight 1.88%,resting heart rate 4.33%, and Vo2 max 4.01% respectively following eight weeks of exercise intervention. Although the combination of exercise reduce the blood pressure of the type2 diabetes (SBP decreased from baseline by 4.03% and DBP reduced by 5.85%), the reduction was not statistically significant for both systolic and diastolic blood pressure (P=0.059* and P=0.069*) respectively.

6. Discussion

From the baseline pre-test data, we found that the current management of glycemic control in the study area was insufficient. Though the study subjects were on anti-diabetic medication, only 16.7% of them practiced physical exercise as part of the diabetes management. The baseline glycemic assessment of fasting blood glucose results indicated higher glycemic level with mean fasting blood glucose of (M=163.33±34.98) and the absolute majority (83.3%) of them were living sedentary life (not practiced physical activity) and half of the subject (50%) were overweight which cause type2 diabetes and increased its consistency. Risk factors for diabetes include overweight or obesity, an unhealthy diet and physical inactivity, which account for about 80% of the increase in prevalence of diabetes. These risk factors can be modified (Europe 2012).

From our finding, the eight weeks intervention of combined aerobic and resistance exercise decreased fasting blood glucose significantly. Moderate intensity combined aerobic and resistance exercise resulted in a significant improvement in patients' with type2 diabetes through controlling the blood glucose level. This study indicated that, the addition of these combined exercise to regular diabetic medication provided significantly favorable effects on glycemic control with significant reduction in fasting blood glucose (4.02%). Although, each type of exercise has its own advantage in glycemic control, this value was not achieved by a single exercise. It also demonstrated that, after

eight weeks of combined aerobic and resistance exercise, body weight, body mass index and resting heart rate were significantly decreased by 1.88%, 2.73% and 4.33% respectively. Also vo2 max was indicated significant improvement (4.01%). In these studies, the reduction value of BW, BMI and RHR were statistically significant. Therefore, from these study we displayed that combined aerobic and resistance exercise have positive impact on the management of type2DM through reducing body weight, decreasing resting heart rate and enhanced vo2 max.

7. Conclusion

From our finding we observed that, Fasting blood glucose, body weight, body mass index, volume of oxygen consumption (Vo2max) and resting heart rate of type2DM patients were significantly decreased following the eight weeks intervention of combined aerobic and resistance exercise($P<0.05$). Although systolic and diastolic blood pressure were decreased after intervened, the reduction value was statistically not significant. Moderate intensity combined aerobic and resistance exercise resulted in a significant improvement in patients' with type2 diabetes through controlling the blood glucose level. This study indicated that, the addition of these combined exercise to regular diabetic medication provided significantly favorable effects on glycemic control with significant reduction in fasting blood glucose (4.02%). Although, each type of exercise has its own advantage in

glycemic control, this value was not achieved by a single exercise.

8. Recommendation

Since pharmacological treatment alone is insufficient to maintain effective glycemic control in type 2 diabetes patients, exercise should be included as part of type2DM management. As a result, health care providers should recognize and prescribe individualized exercise depending on each patient's particular circumstances. Additionally, health care provider should be deliver awareness for the patients about the benefit of exercise in management of type2DM and glycemic control as well as patients should have to positive attitude on the merit of exercise and apply the given awareness and guideline. Based on our result, we also, recommending the incorporation of both combined aerobic and resistance exercise for type2DM patients because, each exercise has its own benefit and when it comes to combined, it yielding more advantages for body function and improve the effectiveness of organ systems. Further research with a large sample size, longer duration and control group are strongly recommended. Also it's important to incorporate with variables like glycosylated hemoglobin, lipid profiles and cardiovascular alterations.

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