RESEARCH ARTICLE

EFFECTS OF MODERATE PHYSICAL ACTIVITY ON GLYCEMIC CONTROL IN TYPE-2 DIABETES MELLITUS: A RANDOMIZED CLINICAL TRIAL

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ABSTRACT

Background: Sedentary lifestyle cause obesity that can disturb body composition, metabolic profiles and insulin resistance which may then lead to ectopic fat in organs and thus leads to diabetes. Physical activity and life style modification was found to be very effective in reducing diabetes and its risk in adults**. Objective:** The objective of this study was to determine the effectiveness of moderate physical activity on glycemic control in Type-2 Diabetes Mellitus. **Methodology:** The participants with the age criteria of 35 years and above and non-insulin dependent type II diabetic mellitus were included in a study. A total of n=45 diabetic patient were assigned to three groups i.e. group A (brisk walk, n=16), Group B (aerobic training, n=16) and group C (resistance training, n=13). Each group performed these exercises for three months for five days a week, a total of 150 minutes per week. HbA1c test was used to determine the glucose level in blood. The data was presented in terms of frequency, percentage, mean, standard deviation, median, and mode. Depending on normality of the data, MANCOVA test was used for within group changes while paired sample T test was used for between group comparisons. Paired sample T test was used to determine correlation. **Results:** The mean age of n=45 study participants were 49.75 ±7.86 years. Between groups analysis showed that all groups significantly improved ($p<0.001$) regarding HBA1c level after 12 weeks intervention. However, no significant difference {$F(2,39)$, $p=0.117$} was observed among the groups regarding HBA1c level after 12 week intervention. **Conclusion:** Moderate physical activity showed significant improvement on HbA1c levels.

Keywords: Type 2 diabetes mellitus, moderate physical activity, HbA1c.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder and caused by insufficient secretion of insulin hormone due to malfunctioning of beta cells of pancreas. DM is mainly divided in two types; type-1 diabetes which occurs when pancreas fails to secrete insulin whereas in type-2 the pancreas retains some capacity to secrete insulin but insulin resistance is increased and leads to hyperglycemia. The prevalence of diabetes reported in Pakistan is 11.77% which comprised 14.81% in urban areas and 10.34% in rural areas of Pakistan[1]. However, the incidence of diabetes is increasing day by day due to obesity and ethnic changes in population. It is expected that the prevalence of diabetes would be double in upcoming decade[2].

The common signs and symptoms of hyperglycemic patient are polydipsia, polyuria, polyphagia, weight loss and visual impairments. Diabetic patients are exposed to lipid abnormalities, cardiovascular atherosclerosis, and peripheral arterial and cerebrovascular diseases along with micro vascular complications including nephropathy, retinopathy, and neuropathy. The other complications of chronic hyperglycemia included damage to kidneys, eyes, nerves, heart, and blood vessels. Therefore, glycemic control is the most basic way to manage this disease[3].

Sedentary lifestyle cause obesity that can disturb body composition, metabolic profiles and insulin resistance which may then lead to ectopic fat in organs and thus leads to diabetes[4]. Exercise has been considered one of the three cornerstones in the management of diabetes, the other two being dietary measures and drug therapies[5]. The moderate and vigorous intensity physical activity has great effects on improving health status of patients by preventing them from many diseases like cardiovascular, diabetes, stroke and cancers. World health organization reports one must need 150-300 minute moderate intensity of physical activity in a week to stay healthy [6].

Physical activity and life style modification was found to be very effective in reducing diabetes and its risk in adults[7]. Physical activity reduces the incidence of Type 2 Diabetes along with preventing from hyper insulinemia, fasting plasma/blood glucose, HbA1c, body fats, cholesterol, blood pressure, cardiovascular risk, and dosage of antidiabetic medications. Also, physical activity can

improve sensitivity to insulin, increases muscular strength, oxygen consumption, enhances aerobic capacity, and positively affects mental health of patients with diabetes[8]. A diabetic patient can do aerobic physical activity of 75-150 minutes using all major muscle groups for two or more days a week.

Many studies have been done on diabetic patients and their correlation with different exercise interventions to lower the glycemic levels such as strength training, aerobics training, brisk walk, combination of aerobics training and strength training. However, in this study brisk walk, aerobics and strength training was studied in a single study to determine which exercise intervention has more drastic effect in controlling the levels of HbA1c. It would contribute to the science literature and help professionals to choose the suitable exercise protocol for diabetic patients.

METHODOLOGY

A multi-arm, single cantered, randomized clinical trial was conducted at Fitness facility of Alpha gym, Islamabad for a time period of six months. The study was initiated after taking approval from Research Ethical Committee (REC) of Riphah International University, Islamabad. The written informed consent was taken from all participants and assuring them about confidentiality of the data according to the deceleration of Helsinki.

Patients were included with the age between 30-70 years, who had diagnosed Type-2 diabetes, were overweight with a BMI of 25 or greater, had HbA1c level more than 48mmol/mol or >6.5%, fasting Plasma Glucose level >126 mg/dl (7.0 mmol/l), random plasma glucose level >200 mg/dl (11.1 mmol /l), and were physically active without any mobility problems. While subjects who had Type-1 diabetes, insulin dependent type 2 diabetes, gestational diabetes, hypertension, smokers, cardiovascular disease, cerebrovascular disease, cardiopulmonary disorders, cognition problems, peripheral artery disease, dyslipidemia, proliferative or pre-proliferative retinopathy, nephropathy, neuropathy, radiculopathy and amputation during the time period of the study were excluded.

The total of n=45 participants were accessed for eligibility that fulfilled the inclusion criteria and were thus recruited through non-probability purposive sampling technique as shown in figure 1. The participants n=45 were randomly divided into three interventional groups i.e. group A (n=16), group B (n=16) and group C (n=13). It was a single blinded study and participants were kept blind to the allocated treatment.

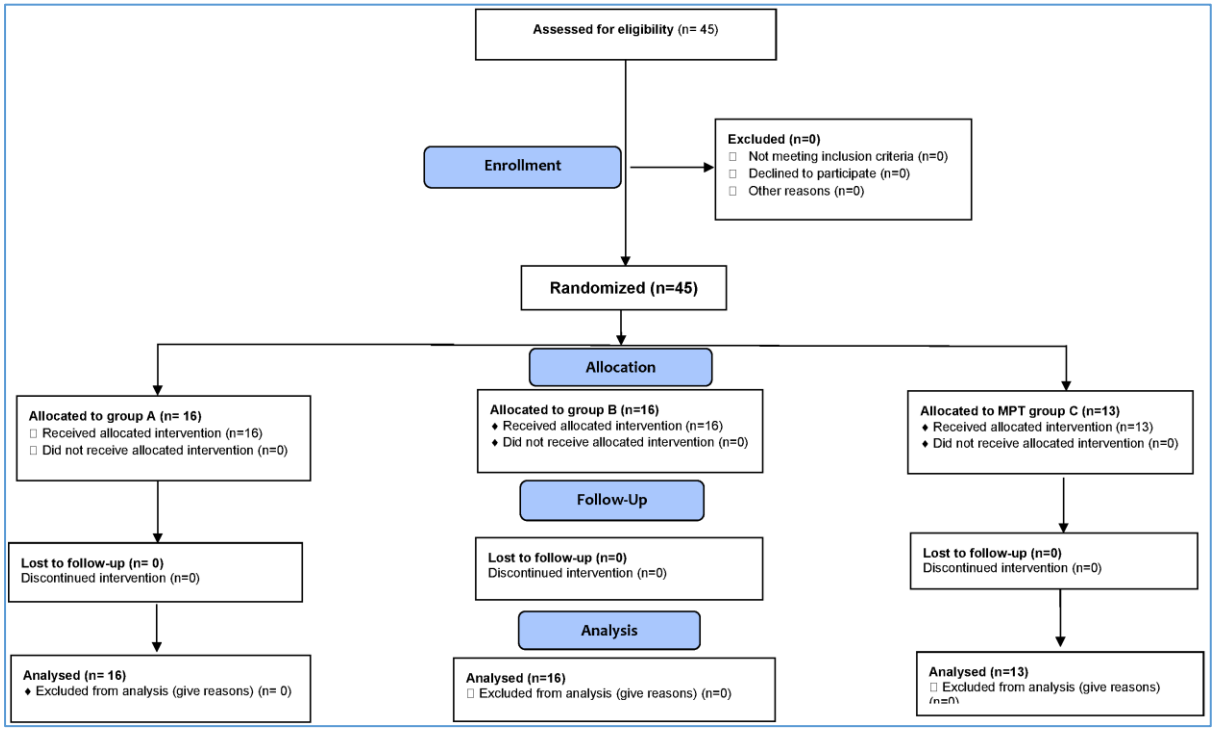

Figure 1: Consort diagram

The participants in group A were asked to do brisk walk of moderate intensity, while aerobics training was practiced in group B and strength training were performed by group C. The intervention was three months long and five-days a weeks. Each session lasted for 30 minutes as shown in table 1.

Table 1: Intervention given to the study participants

Group A	Group B	Group C
Intervention: Brisk Walk	Intervention: Aerobics: Body weight training (jumping jacks, high knees, wall push-ups)	Intervention: Strength Training: Weight training: bench press, shoulder press, squats, and leg press
Time: Approximately 30mins	Time: Approximately 30mins	Time: Approximately 30mins
Frequency: Once a day	Frequency: Once a day Repetitions: 3 sets and 20 reps each exercise	Frequency: Once a day Repetitions: 3 sets and 8-10 reps each exercise
Intensity: Moderate	Intensity: Moderate	Intensity: Moderate

The pre interventional data was collected before the start of intervention and post interventional data after 3 months. The demographics such as age, gender was obtained at baseline. HbA1c test was used to determine the glucose level in blood.

The data was presented in terms of frequency, percentage, mean, standard deviation, median, and mode. Depending on normality of the data, ANCOVA test was used for within group changes while paired sample t-test was used for between group comparisons. Paired sample t-test was used to determine correlation. Data was analyzed using SPSS version 26. The level of significance was set at 95% CI ($p<0.05$).

RESULTS

The mean age of n=45 study participants was 49.75 ±7.86. Of all the participants, n=35 were overweight n=35 and n=10 were obese with mean BMI of 29.47±2.16. The total number of male and female participants were n=33 and n=12 respectively.

Before the intervention all participants (n=45) were diabetic (7.50±0.803). In brisk walk group, after 12 weeks of intervention n=4 participant improved to pre-diabetic level and remaining n=12 have no change in the diabetic category. While in aerobic exercises group n=8 improved to pre-diabetic level and n=2 improved to normal range, and remaining n=6 showed no improvement. Furthermore the group who were receiving resistance training, only n=3 improved to pre dietetic level, and remaining n=10 showed no change in the dietetic category. The paired t-test showed that all groups significantly improved ($p<0.001$) regarding HBA1c level after 12 weeks intervention. (Table 2)

Table 2: Comparison Group A and Group B. (UESFI, FM, WM-G, WM-F & BRC.)

Variables	Assessment	Group A Median (IQR)	Group B Median (IQR)	p-value
Upper extremity Functional Index	Baseline	12(6)	10(2)	0.07
	3rd week	26(6)	21(5)	0.006
	6th week	35(6)	28(6)	0.005
Fugl meyer total	Baseline	14(6)	12(3.5)	0.5
	3rd week	24(3)	24(8)	0.5
	6th week	35(7)	34(5)	0.6
Wolf Motor(gross)	Baseline	14(2)	14(6)	0.2
	3rd week	21(3)	21(6)	0.07
	6th week	28(4)	24(5.5)	0.08
Wolf Motor(fine)	Baseline	10(2.5)	11(4)	0.2
	3rd week	15(7)	16(4)	0.1
	6th week	19(5.5)	19(3)	0.3
Burnnstrom Recovery scale	Baseline	5(1)	4(1)	0.3
	3rd week	6(1)	6(1)	0.4
	6th week	6(0)	6(0)	0.4

Significance level: p<0.05, p<0.01**, p<0.001****

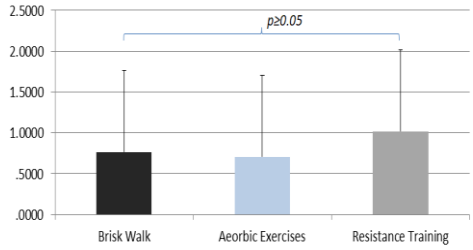

Figure 2: Comparison of HBA1c level (MD) among groups

One way ANCOVA was applied on mean differences of HBA1c while controlling the age, fat and BMI, which showed no significant difference {F(2,39), p=0.117} among the groups regarding HBA1c level after 12 week intervention. (Figure 2) The adjusted means for mean differences of HBA1c level were as follows; brisk walk group 0.794, aerobic exercises group 0.670 and resistance training group 1.028.

RESULTS

The aim of the study was to determine the effects of moderate physical activity on HbA1c level in type-2 diabetic patients. The post interventional analysis showed significant improvement in HbA1c values.

According to the results, brisk walk significantly improved the glucose level in blood which is concurrent with the previous study[9]. A previous study reported that brisk walk for 45-minutes showed significant improvement in hyperglycemia[10]. However, in a recent study 30-minutes brisk walk significantly improved the hyperglycemia, which may clinically beneficial. The possible reasons of significant improvement is the moderate intensity of brisk walk increases the requirement of glucose for muscles to work which lowers the blood glucose levels. Also, greater uptake of glucose by working muscles and less hepatic output of glucose leads to controlled HbA1c levels[11]. Hence, moderate intensity of brisk walk is important to control hyperglycemia.

Moreover, the findings of the current study showed that aerobic training significantly reduced the hyperglycemic level after the 12-weeks of intervention, which correlates with previous study that showed significant improvement in hyperglycemic levels in type 2 diabetic patients[12]. It has been observed that aerobic exercise significantly reduces the blood pressure, triglycerides, insulin resistance and A1C and also improves the oxidative capacity of skeletal muscle, insulin sensitivity and thus glycemic level[13].

Also, recent study reported significant improvement in hyperglycemia after 12-week of moderate intensity strength-training which corresponds with the previous study[13]. Since, diabetes is a major risk factor for low muscle strength[14] and ultimately functional status[15]. The resistance training exercise in adults improves body composition, strength, physical function, muscle strength and mass[16]. Therefore, resistance training not only improves muscle strength, lean muscle mass, bone mineral density but also enhancing glycemic control and prevent sarcopenia and osteoporosis thus improve functional status[17].

However, in context to the previous literature, combination of aerobics and strength training reported more significant results rather the aerobics and strength training alone. Sigal et al., conducted a 4-week follow-up study which correlates the effects of aerobic training and resistance training on patients with diabetes and determined combination of both has greater impact on controlling hyperglycemia[18].

The limitation of the study included daily BSR pre and post values were not monitored because of prick hesitation every day and it could be a factor to changed results with time. Moreover the study was conducted in Ramadan which may modify the results because of altered routine and changed dietary timings of fasting. The sample size was also small due to pandemic and single setting was available due to short time duration and thus results cannot be generalized.

CONCLUSION

It was concluded that all groups such as moderate intensity brisk walk, aerobics and resistance training showed significant improvement in hyperglycemic level after 12 weeks of intervention. While comparing the groups all modes of physical activity are equally effective in improving HBA1c level.

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