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Effect of nordic walking and treadmill walking on cardiorespiratory fitness in type 2 diabetes patients

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Abstract

Background & Purpose: Diabetes mellitus is a prominent cause of mortality and disability worldwide. Diabetes mellitus is a condition of abnormal protein, lipid, and carbohydrate metabolism caused by inadequate insulin production and diminished sensitivity of the tissues to the metabolic effects of insulin. Increasing cardiorespiratory fitness play an important protective role in T2DM. Aerobic exercises has been shown to improve cardiorespiratory fitness in T2DM patients. The study focuses on the effectiveness of Nordic walking versus treadmill walking to improve cardiorespiratory fitness in type 2 diabetes patients.

Methodology: 40 type 2 diabetes patients with age group between 45-65 years were included. They were randomly allocated in 2 groups. Group A received Nordic walking program and Group B received treadmill walking program. In this study blood sugar was measured by fasting blood sugar, cardiorespiratory fitness was measured by 6-minute walk test and rockpot fitness walking test, quality of life was measured by SF36 health questionnaire before and after 8 weeks of intervention.

Result: Result were stastically analyzed using t test using SPSS 26. There was a significant improvement at $p<0.05$ in group A and group B. In between Group analysis there was more significant improvement in FBS, 6MWT, ROCKPOT and SF36 at $p < 0.001$ in Group A than Group B.

Conclusion: This study showed that there is a positive effect of Nordic walking program and treadmill walking program to increase cardiorespiratory fitness in type 2 diabetes patients. But Group A showed greater significant difference as compared to Group B. Nordic walking program is more favorable when compared to treadmill walking program to improved cardiorespiratory fitness, blood sugar and health related quality of life.

Keywords: Type 2 diabetes, cardiorespiratory fitness, blood sugar, quality of life, Nordic walking, treadmill walking, FBS, 6MWT, ROCKPOT, SF36

Introduction

Diabetes is a group of metabolic diseases characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both. [1] Diabetes mellitus is a syndrome of impaired carbohydrate metabolism, lipids and proteins caused by tissues decreased sensitivity to insulin metabolic effects. [2] The two broad type of diabetes mellitus are type 1 DM and type 2 DM. Both types of diabetes are caused by abnormal glucose homeostasis as the pathogenic processes progress. Type 1 DM is the result of complete or near-total insulin deficiency. Type 2 DM is characterized by high blood glucose, insulin resistance and relative insulin deficiency.[3]

Diabetes affects both central and peripheral nervous systems. From every aspect of the nervous system and its supporting structures, from the cerebral cortex to the effector organs, may be involved with the complications of diabetes. These are caused by direct effect of hyperglycemia or hypoglycemia. Hyperglycemia induced metabolic derangements; neurochemical alterations; serum lipid changes; and vascular, coagulation, and thrombotic abnormalities. Diabetic peripheral neuropathies are one of the most common complications of diabetes. Whether selective and pure nerve fiber damage occur in this form of polyneuropathy is still unclear.[4,5]

The overexpression of these cytokines contributes to increased inflammation and lipid accumulation, which have a effect on blood vessels and can lead to the development of endothelial dysfunction, MI and cardiomyopathy. Patients with DM also have decreased adiponectin production which may lead to increase in atherosclerotic plaque.[6,7]

Type 2 diabetes have physiologic exercise limitations and decreased cardiorespiratory fitness (approximately 20% lower maximal oxygen uptake i.e VO2 max) when compared with those without diabetes that leads to decreased cardiorespiratory fitness and increased cardiovascular mortality. [8] Diabetes mellitus is a chronic disorder, represents a heterogeneous group of disorders that have hyperglycemia as a common feature, and if left uncontrolled or mismanaged, the physical burden, emotional consequences, and activities of daily living are affected leading to a poor quality of life (QoL) of the individual.[9]

Physical activity has been stated as one of the most important factors in the treatment of T2 DM and to improve and maintain the quality of life of the affected individual.[2,9] Exercise training is associated with lowering blood pressure, improving insulin sensitivity, and glucose control and improving lipoprotein profile.[8] Exercise moves sugar into the muscles for storage and promotes an immediate increase in insulin sensitivity which last for 2-48 hours, depending on exercise.[10] One study found that 60 minutes of cycling on a machine at a moderate pace increased insulin sensitivity for 48 hours.[11]

Cardiorespiratory fitness (CRF) also referred to as aerobic capacity is one of the most important components of physical fitness. Maximum oxygen consumption (VO2max) is considered to be the most widely accepted measure of CRF giving a baseline estimate of one's heart and lung capacity and can be used to follow the progress of daily physical exercise.[12] Higher levels of cardiorespiratory fitness (CRF) have been shown to be associated with higher levels of health related quality of life.[13]

Moderate to high levels of cardiorespiratory fitness also play a protective role in diabetes as individuals with low cardiorespiratory fitness are more likely to be insulin resistance.[14] CRF reflects one's capacity to achieve a certain exercise performance standard and increases

skeletal muscle mass, improves autonomic function, decreases secretions of pro-inflammatory cytokines, and modifies the metabolic risk factors for type 2 diabetes.[15]

Aerobic exercise training increases cardiorespiratory fitness in type2 diabetes patients.[16] Aerobic exercise is known to manage glycaemic control, cardiovascular risk factors and has also beneficial effects for metabolic profile in patients with T2DM. Aerobic exercise increases skeletal muscle capitalization and blood flow, muscular GLUT4 levels, hexokinase, and glycogen synthase activities.[17] In a meta-analysis study, aerobic exercise interventions of 8 weeks or more has been shown to be effective in improving cardiorespiratory fitness.[18,19]

Nordic walking is a form of physical activity requiring the use of specially designed poles, with which the force is pushed away from the ground, resembling the Nordic Skiing style. The main advantage of the NW technique is involvement of muscles not used during standard walking, which results in higher energy expenditure. It was found that during NW, oxygen consumption is about 18–25% higher compared to walking without poles at the same speed. The NW technique makes this possible and the importance of maintaining high-intensity exercise and a low rate of perceived exertion.[20]

In a recent studies shows that Nordic walking program is effective in improving BW control, body composition, muscular flexibility and VO2 max levels in T2DM patients.[19] In one another article confirms that Nordic walking activities for 4 months have improved sleep quality and the overall increase of physical activities, which represents a significant element of treatment and preventive measures for patients of Type II Diabetes Mellitus.[21]

Need of Study

Increasing cardiorespiratory fitness play an important protective role in T2DM. Aerobic exercises has been shown to improve cardiorespiratory fitness in T2DM patients according to different studies.

Among them, treadmill walking and Nordic walking both as individual have been proven for improving cardiorespiratory fitness. Both these walking involves large muscle group of lower limbs as well as muscular work of upper limbs and is able to increase insulin sensitivity and reduce many cardiovascular risk factors in T2DM.

But there is no studies comparing the effects of this both techniques in T2DM patients. Hence this study will be carried out to compare the effect of Nordic walking and treadmill walking to determine which of this intervention is better in order to improve cardiorespiratory fitness among T2DM patients.

Aim of The Study

Aim of the study is to compare the effects of Nordic walking and treadmill walking on cardiorespiratory fitness in type 2 diabetes patients.

Material And Methodology

Following ethical clearance number IECHR – SAINATH HOSPITAL/AHMC/50, an individual who met the inclusion criteria and fulfills initial evaluation were enrolled in this research. The consent form was filled once all of the participants had been informed about the study. They were distributed and assigned to either Group A or Group B, with 40 patients within each group.

Inclusion Criteria: Both male and female patients between age group of 45-65 years, FBS:126-250 mg / dl, PPBS: 11.1 – 13.9 mmol/L, Non-smokers and non-alcoholic subjects, Willingness to participate in the research.

Exclusion Criteria: Presence of any severe cardiovascular diseases, Presence of any musculoskeletal disorders, Any medication that restrict them to participate, Uncontrolled hypertension, Central and peripheral nervous system disorders, diabetic retinopathy, myopathy, Inability to concentrate, follow direction, Rheumatological disease, Impaired knee flexion of <90 degree

Outcome Measure: Fasting blood sugar, 6 minutes' walk test, Rock pot fitness walking test, SF 36 questionnaire

There are 2 groups, Group A = Nordic walking program

Group B = Treadmill walking program

Pre-assessment: Subject in both Groups were assessed by using fasting blood sugar test, 6-minute walk test, rockpot fitness walking test and SF36 questionnaire before starting the treatment.

Procedure of intervention:

All subjects were instructed to report immediately if they feel breathlessness, headache, dizziness or any other symptoms which are indicative for stopping exercise. Blood pressure, heart rate and respiratory rate were taken in supine at the beginning of exercise.

Throughout the duration of the exercises, blood pressure and respiratory, heart, and oxygen saturation rates were monitored with heart rate reserve maintained at moderate intensity of 40–65 % calculated by 220−patient's age.

Group A (Nordic walking):

Frequency – 3 times a week for 8 weeks Duration- 60 min

Warm up- (10-15) min, gentle mobility exercise. Low intensity aerobic walking, breathing exercise

Exercise- 30 min in 1st 3 weeks with low intensity

40 min in last 5 weeks with moderate intensity

Cool down- (10-15) min, self-stretching of major muscle groups

Group B (Treadmill walking)

Frequency- 3 times a week for 8 weeks Duration- 60 min

Warm up- (10-15) min, gentle mobility exercise. Low intensity aerobic walking, breathing exercise

Exercise- speed 3.4mph with fixed inclination of 4.2 angle and Borg's score of 13 -14 for rate of perceived exertion.

Statistical Analysis

The collected data were analysed using SPSS version 26.0. Paired and unpaired t-test are taken as the data followed normal distribution. According values they are allocated within and between group comparison with p value <0.001.

Result

In this study 40 patients were included. In group A there were 10 male and 10 female. In group B there were 11 male and 9 female.

The Mean score of Group A pre-FBS= 184.15, post-FBS= 145.70, Mean score of pre-6MWT= 408.20, post-6MWT= 627.25, Mean score of pre-Rockpot= 22.79, post-Rockpot= 40.55, Mean score of SF36: pre-physical functioning= 59.95, post physical functioning= 79.80, pre-physical health= 54.25, post-physical health= 75.30, pre-emotional problems= 0.00, post-emotional problems= 0.00, pre-energy/fatigue= 49.55, post-energy/fatigue= 79.95, pre-emotional well being= 50.10, post-emotional well being= 75.00, pre-social functioning= 46.90, post-social functioning=84.70, pre-pain= 51.20, post-pain= 75.50, pre general health= 46.75, post-general health=88.50.

pre and post mean data of FBS, 6MWT, ROCKPOT and SF36 of Group A. It suggest that there is significant difference in Group A (p<0.001)

The Mean score of Group B pre-FBS= 191.40, post-FBS= 164.05, Mean score of pre-6MWT= 413.60, post-6MWT= 578.10, Mean score of pre-Rockpot= 24.52,

post-Rockpot= 40.98, Mean score of SF36: pre-physical functioning= 60.50, post physical functioning= 75.50, pre-physical health= 53.80, post-physical health= 72.65, Pre-emotional problems= 0.00, post-emotional problems= 0.00, pre-energy/fatigue= 50.05, post-energy/fatigue= 75.50, pre-emotional well being= 49.90, post-emotional well being= 70.85, pre-social functioning= 50.60, post-social functioning=79,90, pre-pain= 47.30, post-pain= 105.70, pre general health= 44.20, post-general health=76.95.

Pre-post data of FBS, 6MWT, ROCKPOT and SF36 in Group A and Group B were assessed. Paired t-test was used and p value is <0.001. As a result, there was a considerable difference between the two groups. But Group A showed more significance improvement than Group B.

For group A mean score of FBS = 145.70 and group B mean score of FBS = 164.05, for group A mean score of 6 MWT = 627.25 and group B mean score of 6 MWT = 578.10, for group A mean score of ROCKPOT = 40.55 and group B mean score of ROCKPOT = 40.98, for group A mean score of SF36,post physical functioning = 79.80, post-physical health = 75.30, post-emotional problems = 0.00, post-energy/fatigue = 79.95, post-emotional wellbeing = 75.00, post-social functioning = 84.70, post-pain = 75.50, post- general health=88.50 and for group B mean score of SF36, post physical functioning= 75.50, post-physical health= 72.65, post-emotional problems= 0.00, post- energy/fatigue = 75.50, post-emotional wellbeing = 70.85, post-social functioning=79,90, post-pain= 105.70, post-general health=76.95. So, this shows Group A more effective rather than Group B. Group A and Group B intergroup significance p = <0.01. So, these results reveal that there is a considerable difference between Group A and Group B. As a result, the null hypothesis is inapplicable to this study.

Sample t-test was used to analysis of inter-group data. After comparison between both the Groups, significantly greater improvement was observed in GROUP A. Statistically NORDIC WALKING PROGRAM is more effective to increase cardiorespiratory fitness in type2 diabetes patients.

Discussion

The impact of Nordic walking versus treadmill walking on cardiorespiratory fitness in type 2 diabetes patients is examined in this study.

In this study group A was given 60 minutes Nordic walking program. After intervention blood sugar, walking distance, Vo2 max and quality of life evaluated by FBS, 6MWT, ROCKPOT and SF36. The result of pre intervention mean score of FBS=184.15, 6MWT= 408.20, ROCKPOT = 22.79 and SF36= pre-physical functioning= 59.95, pre- physical health= 54.25, pre-emotional problems= 0.00, pre-energy/fatigue= 49.55, pre- emotional wellbeing= 50.10, pre-social functioning= 46.90, pre-pain= 51.20, pre general health= 46.75. Post intervention mean score of FBS=145.70, 6MWT= 627.25, ROCKPOT= 40.55 and SF36 = post physical functioning= 79.80, post-physical health = 75.30, post-emotional problems= 0.00, post-energy/fatigue= 79.95, post-emotional wellbeing = 75.00, post-social functioning=84.70, post-pain = 75.50, post-general health = 88.50.

According to result there is significant difference of FBS, 6MWT, ROCKPOT and SF36 within the group. So there is improvement in blood sugar, cardiorespiratory fitness and quality of life within the group.

Roberto pippi, et al. (2020) had done a study to assess the impact of Nordic walking program on obese adults with and without type 2 diabetes. 108 obese adults , 45-65

years aged female and male with or without diabetes mellitus were taken. Protocol was given for 3 months, with 90 min duration for 2 days per week. The intervention consists of 2 forms of supervised exercise programs (Nordic walking and gym based exercise program). They used BMI, blood pressure, FBS, Hba1c, blood chemistry, fitness variables, such as aerobic fitness (maximal oxygen uptake, VO2 max) and muscular flexibility were evaluated using the Rockport fitness walking test and the Bending test (executed from vertical and horizontal position), respectively as outcome measures. This study showed significant improvement in all the outcome measures and it provided evidence to support the Nordic walking program.

T. fritz, et al (2011) had done a study to assess the impact of Nordic walking program in overweight individuals with type 2 diabetes mellitus, impaired or normal glucose tolerance. 212 overweight individuals 57-64 years aged female and male with type 2 diabetes mellitus were taken. Protocol was given for 4 months with 5-hour duration per week. They used self-reported physical activity and health related quality of life as outcome measures. This study showed significant improvement in quality of sleep following 4 months of Nordic walking. Nordic walking can be introduced in a primary healthcare setting as a low-cost mode of exercise that promotes weight loss and improved health satisfaction.

In group B was given 60 minutes treadmill walking program. After intervention blood sugar, walking distance, Vo2 max and quality of life evaluated by FBS, 6MWT, ROCKPOT and SF36.

The result of pre intervention mean score of FBS=191.40, 6MWT= 413.60, Rockpot=24.52 and SF36: pre-physical functioning= 60.50, pre-physical health= 53.80, pre-emotional problems= 0.00, pre-energy/fatigue= 50.05, pre-emotional well being= 49.90, pre-social functioning= 50.60, pre-pain= 47.30, pre general health= 44.20. Post intervention mean score of FBS=164.05,6MWT= 578.10, Rockpot= 40.98 and SF36: post physical functioning= 75.50, post-physical health= 72.65, post-emotional problems= 0.00, post-energy/fatigue= 75.50, post-emotional well being= 70.85, post- social functioning=79,90, post-pain= 105.70, post-general health=76.95. According to result there is significant difference of FBS, 6MWT, ROCKPOT and SF36 within the group. So there is improvement in blood sugar, cardiorespiratory fitness and quality of life within the group.

Paras arvindbhai parekh (2019) had done a study to assess the impact of treadmill exercise on blood glucose control in type 2 diabetes mellitus patients. 40 type 2 diabetes mellitus male patients, 45-55 years aged were taken. Protocol was given for 8 weeks with 40 minute duration, which include 5 minute of warm up, 30 minute treadmill walking followed by 5 minute of rest. They used FBS and PPBG level as outcome measures. This study showed significant decrease in FBS and PPBG level. Treadmill exercise is very useful for blood glucose control in addition to diet control and medicines. This article provide evidence to support treadmill walking program.

Sonill S. Maharaj et all (2014) had done a study to assess the impact of treadmill walking and rebound exercises on quality of life for patients with non-insulin dependent type 2 diabetes. 150 type 2 diabetes mellitus patients were taken. Protocol was given for 12 weeks with 30 min duration 3 times per week. They used SF36 to measure quality of life as outcome measure. This study showed significant improvement in quality of life after treadmill walking. Treadmill walking can be used to improve QoL for T2D patients and possibly reduce the side effects and

co-morbidities associated with diabetic medication and diabetes.

Exercise is crucial for the treatment and prevention of type 2 diabetes since it aids in the management of the condition's associated lipid, glucose, and blood glucose control problems as well as the maintenance and reduction of weight. Aerobic exercise has been shown to lower the risk of glucose intolerance condition in people with non-insulin dependent diabetes. Walking is regarded as the finest workout since it works both the muscles in the upper and lower extremities.

Result of this study showed that Nordic walking program and treadmill walking program both the group individually statistically significant to improve blood sugar level, cardiorespiratory fitness and quality of life. But Nordic walking program showed more improved effect when compared to treadmill walking program. Nordic walking program showed more improvement because Nordic walking has a greater cardiometabolic efficacy likely due to the continuous active use of muscles of trunk, upper and lower limbs compared to treadmill walking.

This study proves that Nordic walking program and treadmill walking program improved cardiorespiratory fitness in type 2 diabetes patients. So from this result we confirmed that

8 weeks of Nordic walking program shows more improvement in cardiorespiratory fitness in type 2 diabetes population while comparing both groups, group A showed more improved scores than group B.

Conclusion

This study showed that there is a positive effect of Nordic walking program and treadmill walking program to increase cardiorespiratory fitness in type 2 diabetes patients. But Group A showed greater significant difference as compared to Group B. Nordic walking program is more favorable when compared to treadmill walking program to improved cardiorespiratory fitness, blood sugar and health related quality of life.

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Legend Tables and Figures

Table 1: Comparison of pre and post mean in treadmillwalking program (Group B)

Outcomes Measures	Treadmill Walking		
	Mean	SD	P-Value
PRE FBS (mg/dl)	191.40	13.76	P<0.001
POST FBS (mg/dl)	164.05	12.17	
PRE 6MWT (meter)	413.60	40.57	P<0.001
POST 6MWT (meter)	578.10	27.13	
PRE ROCKPOT (ml/kg/min)	24.52	8.80	P<0.001
POST ROCKPOT (ml/kg/min)	40.98	7.14	

Outcomes Measures	Treadmill Walking		
	Mean	SD	P-Value
Pre Physical Functioning	60.50	5.70	P<0.001
Post Physical Functioning %	75.50	3.78	
Pre Physical Health	53.80	6.22	P<0.001
Post Physical Health %	72.65	2.21	
Pre Emotional Problems	0.00	0.00	1.000
Post Emotional Problems %	0.00	0.00	
Pre Energy/Fatigue	50.05	3.63	P<0.001
Post Energy/Fatigue %	75.50	3.78	
Pre Emotional Well Being	49.90	3.55	P<0.001
Post Emotional Well Being %	70.85	2.94	
Pre Social Functioning	50.60	4.25	P<0.001
Post Social Functioning %	79.90	3.92	
Pre Pain	47.30	2.64	P<0.001
Post Pain%	105.70	153.09	
Pre General Health	44.20	3.81	P<0.001
Post General Health %	76.95	5.86	

Table 2: Between Group Comparison

Outcomes Measures	Treadmill Walking			Nordic Walking			P-Value
	Mean	SD	P-Value	Mean	SD	P-Value	(Between Group)
Pre Physical Functioning	60.50	5.70	P<0.001	59.95	6.18	P<0.001	0.870
Post Physical Functioning %	75.50	3.78		79.80	3.65		0.003
Pre Physical Health	53.80	6.22	P<0.001	54.25`	6.22	P<0.001	0.764
Post Physical Health %	72.65	2.21		75.30	3.57		0.018
Pre Emotional Problems	0.00	0.00		0.00	0.00		1.000
Post Emotional Problems %	0.00	0.00	1.000	0.00	0.00	1.000	1.000
Pre Energy/Fatigue	50.05	3.63	P<0.001	49.55	5.61	P<0.001	0.989
Post Energy/Fatigue %	75.50	3.78		79.95	3.50		0.002
Pre Emotional Well Being	49.90	3.55	P<0.001	50.10	5.51	P<0.001	0.763
Post Emotional Well Being %	70.85	2.94		75.00	3.46		0.001
Pre Social Functioning	50.60	4.25		46.90	4.13	P<0.001	0.022
Post Social Functioning %	79.90	3.92	P<0.001	84.70	3.74		P<0.001
Pre Pain	47.30	2.64		51.20	4.71	P<0.001	0.008
Post Pain%	105.70	153.09	P<0.001	75.50	3.36		0.004
Pre General Health	44.20	3.81		46.75	6.00	P<0.001	0.188
Post General Health %	76.95	5.86	P<0.001	88.50	2.48		P<0.001

Outcomes Measures	Treadmill Walking			Nordic Walking			P-Value
	Mean	SD	P-Value	Mean	SD	P-Value	(Between Group)
PRE FBS (mg/dl)	191.40	13.76		184.15	13.60		0.62
POST FBS (mg/dl)	164.05	12.17	P<0.001	145.70	10.44	P<0.001	0.27
PRE 6 MWT (meter)	413.60	40.57		408.20	32.44		0.05
POST 6 MWT (meter)	578.10	27.13	P<0.001	627.25	34.77	P<0.001	0.29
PRE ROCK-POT (ml/kg/min)	24.52	8.80		22.79	8.37		0.76
POST ROCK POT (ml/kg/min)	40.98	7.14	P<0.001	40.55	7.99	P<0.001	0.55

Figure 1

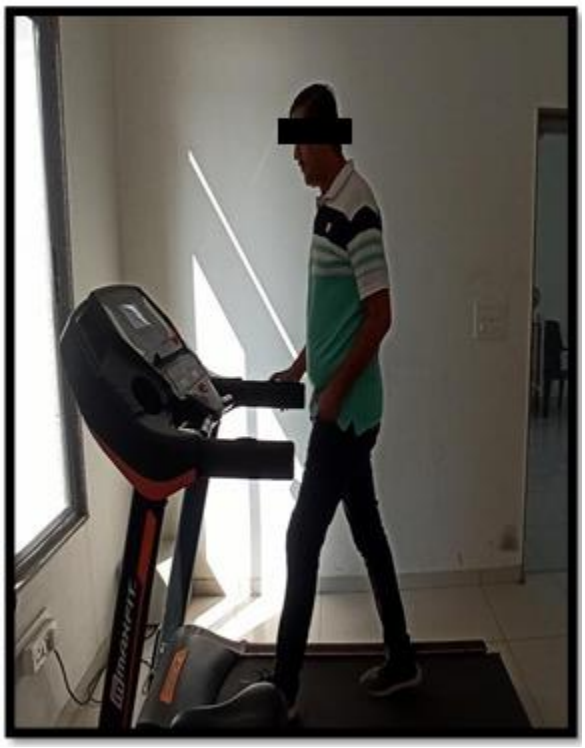

Figure 2