

A STUDY TO FIND THE CORRELATION BETWEEN SIX MINUTES WALK DISTANCE AND BLOOD GLUCOSE LEVEL IN DIABETIC PATIENTS

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ABSTRACT

Introduction: Physical activity has been recommended for patients with Type 2 Diabetes Mellitus (T2DM) as it provides enormous physiological benefits by reducing the risk factors for development of complications, improves blood glucose control, overall health and quality of life. Formulation of an individualized exercise prescription based on exercise capacity and baseline plasma glucose levels is mandatory, as an exercise intensity which is considered moderate for one might turn out to be extremely rigorous for another patient with T2DM.

Materials and Methods: The relationship between 6 minute walk test (6MWT) & some correlates of T2DM was investigated in order to formulate an exercise prescription. This observational study of 102 T2DM patients from whom an informed consent was obtained, was conducted at the diabetic clinic of Sri Ramachandra medical college and research institute. The patients were instructed and made to perform a 6MWT according to ATS guidelines. The measurements included the 6-Minute Walk Distance (6MWD) for exercise capacity and the T2DM correlates including age, gender, fasting blood glucose, post prandial blood glucose, HbA1C, duration of diabetes, BMI and waist hip ratio (WHR).

Results: The relationships between the parameters were determined using Pearson's correlation coefficient at a significance level of 0.05. The participants consisted of 55 males (53.1%) & 47 females (46.1%). The mean 6MWD for males was 353.73±53.750mts & females was 317.55±58.037mts. The 6MWD correlated significantly ($P < 0.05$) with fasting blood glucose [$r = -0.319$], post prandial blood glucose ($r = -0.320$), HbA1C ($r = -0.381$), BMI ($r = -0.378$), while the 6MWD didn't show a correlation ($P > 0.05$) with WHR ($r = 0.191$ (females), $r = -0.058$ (males)), duration of diabetes ($r = -0.020$) and age ($r = -0.112$).

Conclusion: Thus low exercise capacity in patients with T2DM was associated with higher adiposity & poor glycaemic control. Therefore these factors should be given consideration when prescribing exercises for patients with T2DM in order to ensure safety and efficiency of the exercise session.

KEY WORDS: Diabetes Mellitus, 6MWD, Fasting Blood Glucose, Waist Hip Ratio, HbA1C.

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INTRODUCTION

Type 2 Diabetes mellitus (T2DM), A combination of insulin resistance and inadequate compensatory insulin secretory response, is considered to be a "complex disease" as this disorder is polygenetic and strongly influenced

by environmental factor. It is a disease which is largely precipitated by insulin resistance due to two factors namely weight gain because of dietary modifications and lack of physical activity due to sedentary lifestyle.

Hypo and Hyper glycaemia being the two ends of a broad spectrum are considered to be the major complications resulting in severe micro and macro vascular complications. Some of the risks associated with these complications are correlated with age [1], gender, poorly controlled blood glucose levels [2], waist circumference, waist hip ratio [3] body mass index [4] & HbA1c levels [5]. These variables are easily measured in clinic.

According to Sigal et al. (2006), it is essential that before beginning a program of physical activity which is anything more strenuous than brisk walking, people with diabetes should be assessed & screened for vascular, neurological, cardiovascular complications & other coexisting morbidities as these are important considerations for physiotherapist designing the exercise program for the individual to avoid adverse reactions resulting in deleterious and life threatening effects on the individual's health status [6].

Formulation of an individualized exercise prescription is essential because variations exists depending on individual's age, previous levels of physical activity, exercise capacity, body mass index, body composition, lifestyle and base line plasma blood glucose levels [7,8]. Structured exercise plan is considered an important cornerstone to achieve good glycaemic control in T2DM. This can be achieved via a thorough pre-activity screening. The development of an effective, easily accessible and safe assessment pattern to determine the exercise capacity and then using those results to plan an exercise prescription is the need of the hour.

Therefore this study has been aimed to find the relationship between 6-minute walk test distance and the variables that correlate to T2DM (age, gender, BMI, WHR, FBG, PP, HbA1C, VO₂ max). This has been achieved using a 6 MWT in accordance to ATS (2002 guidelines) which is an effective method of determining the safety levels for a T2DM patient to engage in exercising and his functional exercise capacity. PAR-Q questionnaire has been used to ensure medical oversight in evaluating the patient's health profile [8].

MATERIALS AND METHODS

The observational study of patients with T2DM was conducted at Sri Ramachandra Medical Center and Hospital, Department of Endocrinology, where ethical approval was sought and obtained.

The study was introduced to all the patients with T2DM attending the clinic on their respective clinic day. The set eligibility criteria included: Patients in the outpatient department diagnosed with T2DM, aged between thirty to sixty nine years without any apparent cardiovascular disorders, Absence of positive response to any question on the Physical Activity Readiness Questionnaire (PAR-Q), willingness to give informed consent and participate in the Six minute walk test. Patients excluded from the study were those who had Absolute/Relative contra indications for the 6MWT.

Out of the 207 T2DM patients attending the Diabetic clinic only 102 agreed to participate in the study and met the inclusion criteria. These patients were screened. The tools used were PAR-Q which assessed the self reported fitness of the individuals for the exercise test and blood glucose reports having FBG, PP, HbA1c levels. The participants were requested to indicate their willingness to participate after detailed briefing on the requirements for the study. The interested and consented subjects were taken up for data collection. The nature and purpose of the study was explained to all the participants. The demographic details, Body Mass Index (BMI), Waist –Hip ratio, waist circumference and duration of diabetes, occupation, and fasting and post prandial blood glucose levels (FBG & PP) on the day of testing, HbA1C levels were assessed and values were noted.

Six Minute Walk Test: Performed as per guidelines of American Thoracic Society (ATS) [8]. The 6MWT was performed indoors, along a 30m long, flat, straight, well ventilated enclosed corridor with a hard surface free of obstacles. The length of the corridor was marked every three meters. The turnaround points were marked with a cone (yellow traffic cone). A starting line, which marks the beginning and end of each sixty meter lap, was marked on the floor

using brightly colored tape. A portable pulse oxymeter was connected to the patient and the resting heart rate and oxygen saturation (SPO₂) were monitored and documented before the start of the test. All vitals were monitored and documented. The patient was asked to start walking and stop watch was started, the therapist continuously monitored the patient during the test .the patient was instructed to inform if he feels any discomfort through action. When the test was performed the heart rate and SPO₂ was monitored and changes were noted. Patient was encouraged to walk as much as possible. Test was stopped exactly at the end of six minutes. The no. of laps and extra distance walked was noticed and documented. The post activity vitals were continuously monitored for two to three minutes, which is considered as time period for the vitals to come back to the resting level.

RESULTS AND TABLES

In this study data were collected from 102 subjects. The collected data were tabulated and analyzed with SPSS 17.0 version, the variables

such as age, gender, BMI, WHR, FBG, PP, HbA1C, VO₂ max were calculated and their mean and standard deviation were computed. The normality of the variables was identified by Shapiro-Wilk normality test. In bivariate analysis to find the significance difference between independent samples (Male & Female) non parametric test Mann-Whitney t-test was used. To assess the relationship between the variables non parametric Spearman's correlation was used. In all the above statistical tools the probability value P=.05 is considered as significant level. The 6MWD and the other variables namely age, gender, BMI, WHR, FBG, PP, and HbA1C were compared with ANOVA and unpaired t -Test.

The participants comprised of 55 males (53.9%) and 47 females (46.1%).The mean 6MWD for males was 353.73 meters and 317.55 meters in females. Comparison and correlation was made between 6MWD and the variables of T2DM.The results were as follows:

Comparison between 6MWD and varying ranges of FBG,PP, HbA1c, BMI, WHR in females showed

COMPARISON BETWEEN 6MWD AND	NUMBER	MEAN	STD.DEV	t/F	LEVEL OF SIGNIFICANCE
FBG (mg/dl)					
Upto 130 (normal)	41	354.51	58.17	t=2.5418	0.012
>130(uncontrolled)	61	325.33	55.96		
PP (mg/dl)					
Upto 180(controlled)	34	350.74	57.92	t=1.6885	0.054
>180(uncontrolled)	68	330.22	57.8		
HbA1c					
5 TO 6.5	19	362.37	49.057	F=5.724	0.004
6.6 TO 8	38	348.55	53.169		
8.1 TO 15	45	316.66	60.65		
BMI (Kg/m²)					
Under weight (<18.5)	0	0	0	F=4.0	0.01
Normal (18.6-24.9)	29	366.72	57.621		
Over weight (25-29.9)	64	326.48	55.917		
Obesity class 1 (30-34.9)	7	310.71	52.474		
Obesity class 2 (35-39.5)	0	0	0		
Obesity class 3 (>40)	2	305.6	50.607		
Age groups					
<52	50	335.1	55.02	t=0.33	0.7414
>=52	52	338.94	61.9		
Duration of DM					
Upto 9 yrs	80	337.69	59.52	t=0.2064	0.8369
>9 yrs	22	334.77	55.24		
WHR in females					
Upto 1.066	28	304.1379	53.62	t=2.3993	0.0204
>1.066	19	342.75	57.844		
WHR in males					
Upto 1.040	17	348.52	49.85	t=0.4762	0.6359
>1.040	38	356.05	57.693		

Table 1: Comparison between 6MWD and Variables of T2DM:

Table 2: Correlation between 6MWD and correlates of T2DM using spearman correlation coefficient.

	6MWD	AGE	F.B.G	P.P	HbA1C	WHR	DURATION OF DIABETES	BMI	VO ₂ MAX
	(M,F)	(M,F)	(M,F)	(M,F)	(M,F)	(M,F)	(M,F)	(M,F)	(M,F)
6MWD	(1,1)								
AGE	(-0.08,-0.13)	(1,1)							
F.B.G	(-0.20,0.37**)	(-0.22,-0.32*)	(1,1)						
P.P	(-0.22,-0.40**)	(-0.22,-0.26)	(0.74**,0.72**)	(1,1)					
HbA1C	(-0.18,-0.55**)	(-0.11,-0.07)	(0.72**,0.69**)	(0.64**,0.74**)	(1,1)				
WHR	(-0.06,0.19)	(-0.14,0.04)	(0.16,-0.29*)	(0.38**,0.37**)	(0.18,-0.33*)	(1,1)			
DURATION OF DIABETES	(-0.07,-0.01)	(0.51**,0.46)	(0.08,0.0)	(-0.01,-0.09)	(0.20,0.04)	(-0.04,-0.60)	(1,1)		
BMI	(-0.21,0.34*)	(-0.19,0.12)	(0.20,0.15)	(0.19,0.22)	(0.21,0.17)	(0.27*,0.09)	(-0.08,0.02)	(1,1)	
VO ₂ MAX	(1.0**,0.99**)	(-0.08,-0.14)	(-0.20,-0.36*)	(-0.22,-0.38**)	(-0.18,-0.54**)	(-0.06,0.18)	(-0.07,-0.01)	(-0.21,-0.33)	(1,1)

Notes: *Significant at $p < 0.05$; **Significant at $p < 0.01$

(M, F) = (Male, Female); 6MWD = 6 Minute Walk Distance; FBG = Fasting Blood Glucose; PP-Post prandial blood glucose, HbA1C-Glycated Haemoglobin, VO₂ Max-Maximum Oxygen Uptake, BMI = Body Mass Index; WHR = Waist Hip Ratio.

statistical significance at ($p=0.012$), ($p=0.054$), ($p=0.004$), ($p=0.010$), ($p=0.204$) respectively. Thus as the FBG, PP, HbA1c, BMI, WHR (females) levels increased, the walk distance covered reduced considerably.

Comparison between 6MWD in differing age groups, duration of DM, WHR in males showed no significance with ($p=0.7414$), ($p=.8369$), ($p=0.6359$) respectively. There existed a significant ($P<0.05$) inverse correlation between 6MWD and FBG ($r= -.319$), PP ($r= -.320$), HbA1c ($r= -.381$) and BMI ($r= -.378$) while 6MWD showed no correlation ($P>0.05$) with WHR in females($r=.191$), WHR in males ($r= -.058$), duration of D.M ($r= -.020$) and age ($r= -0.1125$).

DISCUSSION

Six- minute walk test correlates with the capacity to carry out ADL. It tests at the sub maximal exercise capacity of an individual which is safe & feasible. In the present study the mean 6MWD was found to be 337.1 ± 58.37 meters among the 102 T2DM subjects, which is far less than their apparently healthy counterparts who were found to have an average of 698 ± 96 meters [9].

Various variables have been attributed to contribute to the onset of the disease and its influence on Physical activity levels on subject's with T2DM. In this study the variables influencing the blood glucose levels were compared with their sub maximal exercise capacity levels using a 6 MWT, and the following inferences were made:

Body Mass Index (BMI): Overweight and obesity are conventional measurement of BMI. In this study the subjects were categorized based on their BMI values into normal, overweight, obese (class 1,2,3) categories to which the 6MWD was compared .It was found that the 6MWD & BMI showed significant ($p=0.010$)negative correlation ($r=-0.378$). This result is similar to the study by M. Hulens et al (2003) [4] who concluded that exercise capacity is decreased in both sub maximal and peak intensity in individuals with varying ranges of BMI .

Fasting Blood Glucose (FBG): The comparison made between the 6MWD & varying ranges of FBG levels which ranged between 60-460 mg/dl. These were then divided into two groups , as upto 130 mg/dl which is considered controlled & above 130 mg/dl which is considered uncontrolled in accordance to ADA guidelines 2007 [10]. It was found that the 6MWD & FBG showed significant ($p=0.012$) inverse correlation ($r=-0.319$).This was in accordance to the study by James. S. Reitman et al 1984 [11], who concluded that aerobic exercises has profound influence in regulating FBG levels.

Post prandial blood glucose (PP): Amongst the 102 subjects recruited for this study, their PP blood glucose level ranged between 100-600 mg/dl. These subjects were then divided into two groups, as up to 180 mg/dl which is considered controlled & above 180 mg/dl which is considered uncontrolled in accordance to ADA guidelines 2007 [10]. On comparison there existed less significant ($p=0.054$) negative corre-

-lation ($r=-0.320$). Moshe S. et al 1989 [12] concluded that low physical activity in T2DM increases FBG and PP levels due to decreased catabolism.

Glycated Haemoglobin (HbA1C): In this study the distance covered during a 6MWT for the subjects were compared amongst varying ranges of HbA1C levels. Classification into three categories (i.e. 5-6.5%-good control, 6.6-8% -fair control, >8%-poor control) were made based on their HbA1C levels. This study showed that the 6MWD & HbA1C were highly significant ($p=0.004$) with inverse correlation ($r=-0.381$). The low exercise capacity in T2DM could be related to high affinity of HbA1c to oxygen & energy metabolism of the cell leads to chronic fatigue and severe decrease in exercise capacity [13].

Waist Hip Ratio (WHR): The 6MWD amongst varying ranges of WHR in females & males were separately analyzed in this study after dividing them into two groups based on their respective mean values (i.e in males the mean W:H ratio was 1.04, thus they were divided into one group having upto 1.04 and other group having >1.04, similarly among the female population the mean was found to be 1.066, thus they were divided into one group consisting of W:H ratio upto 1.06 and other group, >1.06). It was found that there did not exist a significant correlation between WHR and 6MWD. This result was similar to the study performed by A.F.Adeniyi et al (2010) [17] who concluded that the waist hip ratio correlated with the 6MWD in the male participants and not in the female participants. In the present study, the population wasn't evenly distributed. This could be the reason for not having found a correlation.

AGE: Aging which is associated with increased oxidative stress and impaired anti-oxidant defense has been a contributory factor for initiation and progression of complications in Diabetes mellitus [15]. The 102 subjects taken for the study fell between the age of 30 yrs to 70 yrs, therefore their mean age was calculated which 52 yrs. They were then divided into two groups (i.e. Less than 52 yrs and more than or equal to 52 years). The mean 6MWD in these two groups were compared and it was concluded that that there does not exist a correlation

between the distance covered during a 6MWT in ranges of varied age groups ($p=0.7414$).

DURATION: The subjects were categorized into 2 broad categories of onset of D.M i.e. up to 9 years and more than 9 years, based on the mean duration of diabetes. When the 6MWD were compared there existed no correlation ($p=.8369$) between duration of the disease and distance covered in 6MWT. This result was similar to the conclusion drawn from the study performed by Adeniyi et al (2010) [17].

Thus In this study it was found that high fasting blood glucose, post prandial blood glucose, HbA1C levels, BMI, WHR in females, were related to lower exercise capacity in patients with T2DM. It was however noted that the duration of diabetes, WHR in males and age did not correlate significantly with the 6MWD. The limitation of this study was that The 6MWD was assessed only during the post prandial phase. The test could have been administered both during fasting and post prandial phase. Further scope for this study will be that Comparison of HbA1C prior to exercise training and 12 weeks post exercise training can be done & Regression equation can be formulated for six minute walk distance in patients with varying ranges of blood glucose levels

The clinical implication of the study finding is that regardless of the duration of diabetes and WHR, prescription of physical exercise to patients with T2DM who are older, with poor glycaemic control and with high values of body mass index, has to be done with caution as these factors limit the intensity at which these categories of patients should exercise. These factors should be given due consideration when prescribing exercises.

Conflicts of interest: None

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