Original Article

Comparison of Physical Activity Level and Functional Capacity in Patients with Type 2 Diabetes Mellitus and Healthy Controls.

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Abstract

Background: Improved physical activity can enhance glycemic control, functional capacity, and overall quality of life for individuals with Type 2 Diabetes Mellitus (T2DM)**.** Despite the known benefits of exercise for type 2 diabetes, many individuals with this condition remain inactive and fail to meet recommended activity levels. There's a lack of specific data on the functional capacity of Indian individuals with type 2 diabetes.

Purpose: The aim of this study was to compare physical activity level and functional capacity in patients with T2DM and healthy controls.

Materials and Methods: In this study, thirty patients with T2DM and 30 age, gender, and BMI-matched healthy controls were enrolled in the study. All participants met the inclusion criteria and provided written informed consent. The physical activity level was assessed using International Physical Activity Questionnaire (IPAQ) and functional capacity was assessed with 6 Minute Walk Distance (6MWD). The IPAQ score, IPAQ sitting hours and 6MWD were compared between the 2 groups. Data was tested for normality. Unpaired t-tests were used to compare Age, BMI, and 6MWD between groups. Mann-Whitney U tests were used to compare IPAQ scores and sitting hours.

Results: The study demonstrates T2DM patients have reduced functional capacity as compared to control group. A difference of 68.4 meters in 6MWD [p=0.000] was observed with no difference in physical activity levels between the two groups.

Conclusion: T2DM patients have reduced functional capacity as compared to control group. The mechanism of impaired functional capacity appears to be associated with the disease process. Therefore, early exercise prescription and physical fitness for improving glycemic control and functional capacity in T2DM patients is essential.

Key words: Type 2 Diabetes mellitus, functional capacity and physical activity level.

Introduction

Hallmark of Type Diabetes Mellitus is insulin resistance with relative insulin deficiency [1]. T2DM constitutes about 98% of the total Indian diabetic population [2]. According to the Diabetes Atlas 2006, India had 40.9 million people diagnosed with diabetes and this number is expected to rise

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to 69.9 million by 2025 [3]. T2DM is largely precipitated by insulin resistance due to weight gain because of diet and lack of physical activity [4].

Physical activity is defined as any bodily movement produced by skeletal muscles which require energy expenditure and includes exercise and incidental activity [1]. Physical activity is crucial for managing diabetes. It enhances insulin sensitivity and glucose tolerance, leading to improved glycemic control [5, 6]. Additionally, it lowers the risk of diabetes-related complications like nephropathy, retinopathy, neuropathy, and cardiovascular disease [7]. According to the American College of Sports Medicine (ACSM) guidelines, individuals with T2DM require at least 150 min/week of moderate to vigorous aerobic exercise for achieving optimal cardiovascular disease risk reduction [8]. Despite the known advantages of exercise, most people with type 2 diabetes are inactive compared to those without diabetes [5, 6].

Functional capacity is referred as the capability of performing tasks and activities that people find necessary or desirable in their lives [1]. Presence of diabetes may independently contribute to reduced exercise capacity [9, 10]. However, most of the activities of daily living are carried out at sub-maximal levels of exertion. 6-Minute Walk Test (6MWT) is a valid measure of predicted exercise capacity and correlates with the capacity to carry out Activities of Daily living (ADL) [4, 13] Thus, 6MWT which is a sub-maximal test will better reflect the functional capacity [12, 13].

Majority of the diabetes patients are sedentary. Difficulty taking part in exercise, tiredness, being distracted by television programs, lack of time and lack of local facilities are main reasons for inactivity [7]. Functional capacity among T2DM patients is reduced due to poor glucose metabolism, poor blood perfusion of muscles at cellular levels and impaired aortic compliance and myocardial work capacity.

Measuring functional capacity allows us to examine the effects of a disease on the performance of an individual. Increase in physical activity will improve glycemic control in T2DM, leading to increase functional capacity and improved quality of life.

AIM

The primary objective of this study was to compare the physical activity level and functional capacity in patients with type2 diabetes mellitus and age, gender, and BMI-matched healthy controls.

Material And Methodology

It is a Cross sectional study conducted at Physiotherapy and Endocrinology Outpatient Department (OPD) of Tertiary Health Care General Hospital from January 2021 to June 2021 (Post-Ethical Approval). A total of 60 participants (30 T2DM patients and 30 age, gender and BMI matched healthy controls) who met the inclusion criteria were enrolled in the study after taking a written consent.

Inclusion Criteria For Patients With T2DM

- T2DM patients with disease duration ≤5 years.
- HbA1c level- All inclusive.

Exclusion Criteria For Patients With T2DM

- Patients with more than 60 years of age.
- One or more positive mark on the Physical Activity Readiness Questionnaire (PAR-Q) [17, 18].
- Presence of complications such as diabetic neuropathy, peripheral vascular disease, foot ulcer.
- Any musculoskeletal pain NRS>2
- Pregnant and lactating women.
- Unwilling to participate.

Inclusion Criteria For Healthy Individuals

- Healthy individuals with age, gender and BMI match

Exclusion Criteria For Healthy Individuals

- One or more positive mark on the PAR-Q.
- Any musculoskeletal pain NRS>2
- Pregnant and lactating women.
- Unwilling to participate.

Outcome Measures:

1. International Physical Activity Questionnaire [14].

   The IPAQ asks about three specific types of activity which are: walking, moderate-intensity activities and vigorous intensity activities. Score will be presented with Metabolic equivalent (MET)-minutes/week which is a continuous variable.

a. Walking MET-minutes/week =3.3×walking minutes× days
b. Moderate MET-minutes/week= 4×activity minutes× days
c. Vigorous MET-minutes/week=8×activity minutes× days

   Total physical activity= a +b +c MET-minutes/week

   The IPAQ instruments have acceptable measurement properties, at least as good as other established self-reports. The reliability of IPAQ short form is 0.76 and acceptable validity [15].

2. 6-Minute Walk Test [16].

   The 6MWT is a safe, easy to administer test which better reflects activities of daily living. It was performed using the American Thoracic Society (ATS) Guidelines. The 6MWD, which is the primary measurement, was used to measure the functional capacity.

Procedure

Approval from Institutional Ethics Committee (Protocol no.-ECARP/2020/32, Date-13.02.2020) and MUHS was sought prior to commencement of the study. The study was conducted in collaboration with Endocrinology Department of Tertiary Health Care General Hospital. Patients diagnosed with type 2 diabetes mellitus by the endocrinologists were screened for the study.

Out of 120 patients screened, 30 patients met the inclusion criteria and were enrolled in the diabetic group after taking their informed consent. Similarly, 80 healthy individuals (relatives of patients) who accompanied the patients to the physiotherapy OPD and office going staff working within the institute were screened and enrolled after getting their consent. Their random blood sugar was tested to rule out diabetes. Out of 80 individuals screened, 30 met the inclusion criteria and were included in the control group. Demographic and Anthropometric data of all the participants was noted. In the study group, sensory and motor examination of all diabetic participants was done. Sensory examination included touch awareness, pain perception, pressure perception, temperature awareness. Motor examination was done using manual muscle testing. The HbA1c value (from last 3 months report) was noted. If reports were not available, the HbA1c test was done in the Endocrinology laboratory.

Participants were asked to fill the IPAQ to assess the physical activity level and a 6MWT was performed to assess the functional capacity as per the ATS guidelines. The data was collected and results were analyzed.

Figure no 1: Subject performing 6 Minute Walk test.

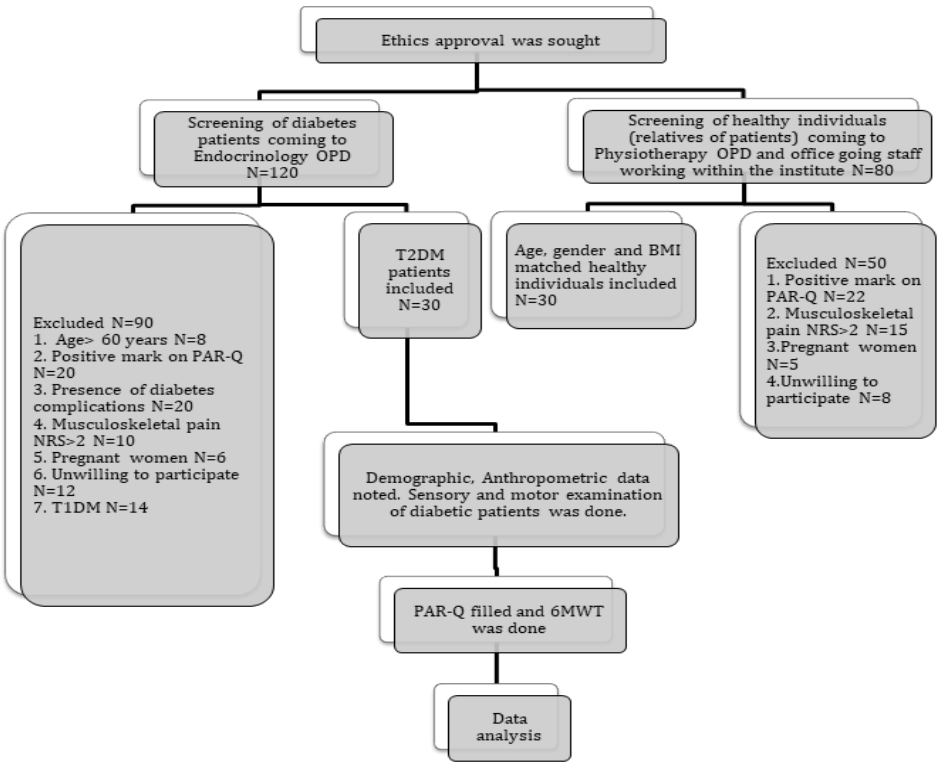

Figure no. 2 Consort flow diagram

Data Analysis

SPSS 16 software was used for data analysis. Data was tested for normality. Unpaired t test was used to compare Age and BMI between groups for matching. Unpaired t test was used to compare 6MWD between both groups.

Descriptive analysis of Age and BMI

	Group	N	Mean	Std. Deviation	Std. Error Mean
Age	Diabetic Group	30	44.7667	6.47373	1.18194
	Control Group	30	44.6333	6.18944	1.13003
BMI	Diabetic Group	30	26.9000	4.26550	.77877
	Control Group	30	26.9933	4.19087	.76514

Table No. 1: Descriptive analysis of Age and BMI. INTERPRETATION: Mean age of subjects with diabetes was 44.76 years ± 6.47 years and mean age of healthy adults was 44.63 years ±6.18 years. The mean BMI of subjects with diabetes was 26.9 kg/m²±4.26kg/m² and mean BMI of healthy adults was 26.99 kg/m²± 4.19 kg/m².

Gender Distribution

			Group		Total
			Diabetic Group	Control Group	
Gender	Female	Count	14	14	28
		% within Gender	50.0%	50.0%	100.0%
	Male	Count	16	16	32
		% within Gender	50.0%	50.0%	100.0%
Total		Count	30	30	60
		% within Gender	50.0%	50.0%	100.0%

Table No 2: Gender Distribution between Groups. INTERPRETATION: There were 16 males and 14 females in both groups. Both groups were matched with Gender.

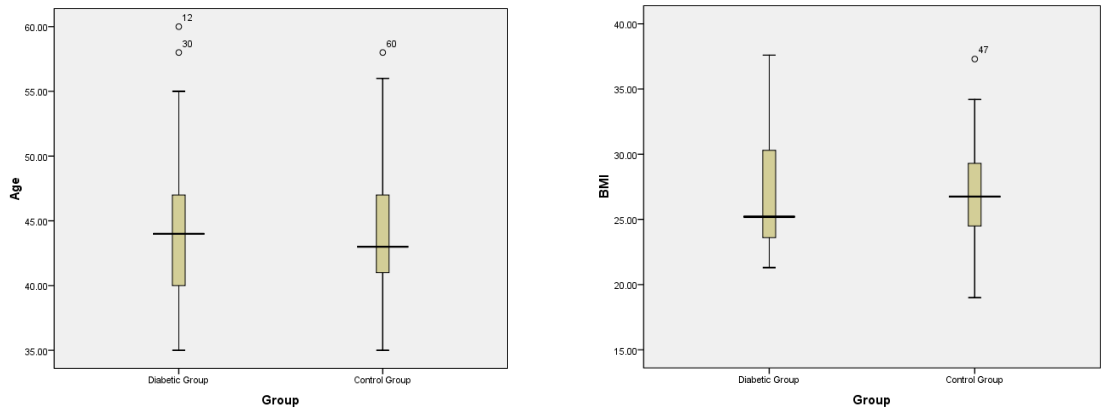

Figure No. 3: Boxplot of Age and BMI. INTERPRETATION: There is no significant difference between the groups with respect to age and BMI suggesting that both groups are matched.

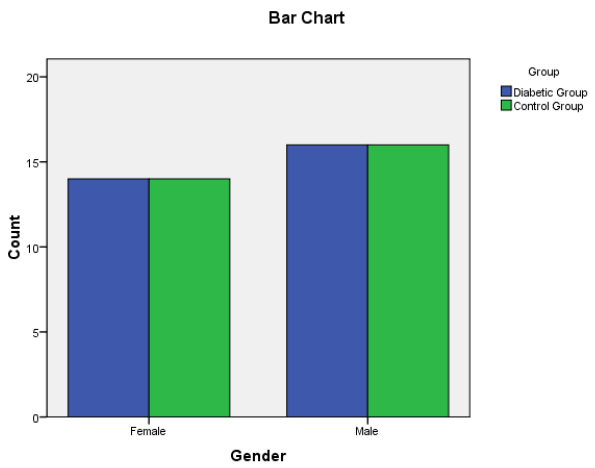

Figure No. 4: Bar Graph of Gender Distribution. INTERPRETATION: Both groups are matched with equal number of males and females. There were 16 males and 14 females in both groups.

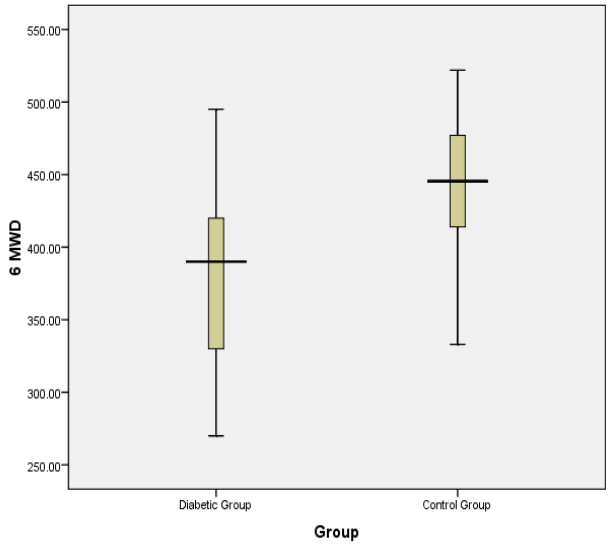

Figure No. 5: Boxplot of 6MWD: INTERPRETATION. The 6MWD in diabetic group is lesser than that of the control group. There is a significant difference of 68.4 meters between both groups (p=0.000).

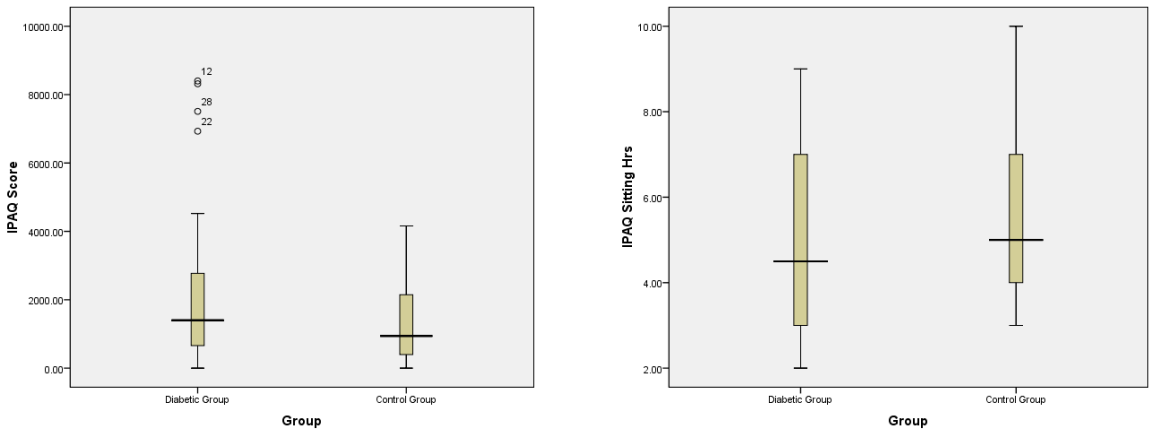

Figure No. 6: Boxplots of IPAQ Score and IPAQ sitting hours. INTERPRETATION: The Median IPAQ score is 1399.5 and 940.5 in diabetic and control groups respectively. There is no significant difference in IPAQ score (p=0.120) and IPAQ sitting hours (p=0.099) between diabetic and control groups

Results

Both groups are matched with respect to Age, BMI and Gender. The diabetic group walked 68.4 meters less during the 6MWT as compared to healthy Controls which was statistically significant (p=0.000). There was no difference in Physical activity levels (median IPAQ score, p=0.12) and sitting hours (IPAQ sitting hours, p=0.099) in both groups.

Discussion

The Aim of this study was to compare physical activity level and functional capacity in patients with type 2 DM and healthy controls. The study shows that patients with T2DM demonstrated significantly lower functional capacity than healthy controls (p=0.000). However, there is no significant difference in physical activity levels in both the groups (IPAQ score, p=0.12).

In this study, the diabetic group walked 68.4 meters less during the 6MWT as compared to healthy controls. A difference of 30 meters or more is considered clinically significant [19]. This suggests patients with T2DM have lower functional capacity than their age, gender and BMI matched healthy controls.

Some studies demonstrated an inverse relation between 6MWD and BMI in T2DM patients and also suggest that

Female diabetic patients had lower functional capacity as compared to male patients [11, 12]. In this study, despite of matching the BMI, diabetic subjects had a lower functional capacity as compared to healthy controls. Factors probably contributing to reduced exercise capacity in diabetics could be impaired glucose metabolism, reduced cardiac function and effect on respiratory systems.

Hyperglycemia affects cardiac function. It contributes to increased left ventricular mass [20]. This is due to factors like cardiomyocyte hypertrophy, collagen buildup, and protein glycation [20]. Glycation forms advanced glycation end products (AGEs) which can accumulate in tissues and cause left ventricle mass increment [20, 21]. This enhances myocardial oxidative stress. Additionally, hyperglycemia stiffens arteries, further straining the heart [20]. The compliance of the aorta plays an important role in modulating coronary blood flow. The vascular load and wall stress stimulates Left ventricular hypertrophy and remodeling that further affects myocardial work capacity and therefore, may result in reduced functional capacity [11]. In a study, A. Barmeyer et al (2009) stated that diastolic dysfunction is associated with a reduced exercise capacity. In diastolic dysfunction, the mechanical properties of the left ventricle are altered causing slowed diastolic filling which result in poor increase of cardiac output at exercise and can limit exercise capacity [22].

Poor glycemic control causes increased stiffness of pulmonary vessels, thickening of alveoli walls and basal membrane of capillaries and endothelium. This impairs diffusion of gases and decreases parenchymal elasticity [23]. These factors may influence the functional capacity. The huge vascular and capacitive reserve may compensate for partial loss of pulmonary parenchyma and make the complication clinically silent [23]. However, stress on the respiratory system such as during exercise, this effect may be elicited.

This study showed a reduced exercise capacity in diabetic group than the control group which could be attributed to the above-mentioned determinants of the disease process. There was no significant difference in median IPAQ scores i.e. Physical activity levels (p=0.12). The counseling provided by the endocrinologist for having a more active lifestyle as well as the diabetics being more conscious regarding their health may be the possible causes for diabetic group to be relatively more active than the control group. The control group was majorly from the office going staff of a tertiary hospital that have a sitting desk job and thus are relatively less active than the diabetic group. Therefore, no significant difference in physical activity level was observed between the diabetic group and the control group.

Decreased level of physical activity is inversely associated with increased sitting time [24]. This study shows that the mean sitting time in diabetic group was 4.8 hours per day and in control group was 5.7 hours per day. The American Diabetes Association has recommended that diabetes patients should be encouraged to decrease their sedentary time and to not sit for more than 90 minutes [25]. The study demonstrates that there was no significant difference in physical activity levels in T2DM patients as compared to their matched healthy controls. It also shows that T2DM patients are equally active yet their functional capacity is reduced due to the disease process suggesting that the disease process is having a negative impact on the functional capacity of individuals.

Conclusion

The study demonstrates T2DM patients have reduced functional capacity as compared to control group. A difference of 68.4 meters in 6MWD was observed with no difference in physical activity levels between patients with T2DM and Age, Gender and BMI matched healthy individuals in the control group.

Limitations

- Small sample size
- Participants had different job profiles which may cause variations in physical activity levels.

Clinical Implications

This study creates awareness about the importance of early exercise prescription and physical fitness for improving glycemic control and functional capacity in patients with type 2 diabetes.

Funding Sources: The study does not have financial support from any sources.

Ethical Clearance/Statement of Ethics The study has been approved by the Ethics Committee for Academic Research Projects (ECARP) PG Academic Committee, T.N.M.C, Mumbai, Maharashtra, India. (Date-13.02.2020, Protocol no.- ECARP/2020/32)

Conflicts of interest statement : There are no conflicts of interest

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