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Comparison Between 6 Min Walk Test and Incremental Shuttle Walk Test in Middle Age People with Type 2 Diabetes: A Pilot Study

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ABSTRACT

Background: Type 2 diabetes is recognized as a serious public health concern with a considerable impact on human life and health expenditures. The arsenal of equipment used and the need for a team that involves trained professionals led scientists to develop options that could reflect the CPET. 6MWT is a practical and simple test that requires a patient to walk at the highest speed tolerated for 6 min. By contrast, ISWT offers a different protocol from the 6MWT, which is incremental and externally paced. ISWT is also simple, has good reproducibility.
Objective: To compare between Incremental shuttle walk test (ISWT) and 6-minute walk test (6MWT) in middle aged type 2 diabetes patient.
Method: A pilot study was conducted with research design Cross-sectional study, to assess Cardio Respiratory Fitness using incremental shuttle walk test (ISWT) in middle aged type 2 diabetes patient, to assess Cardio Respiratory Fitness using 6-minute walk test (6MWT) in middle aged type 2 diabetes patient and to compare between ISWT and 6MWT in middle aged type 2 diabetes patient. A total 15 study participants, each patient has to undergo both test with 30 min rest in between the test. Based on inclusion and exclusion criteria. Patient is admitted to the test.
Result: Out of 15 participants, 60% were under 50 years of age. The 6MWT showed higher VO_2 max but no significant difference compared to the ISWT. Participants walked significantly farther in the 6MWT (338.33 m) than in the ISWT (123.13 m). Fatigue scores significantly increased post-test for both the 6MWT and ISWT, with a greater improvement in the ISWT (2.93) compared to the 6MWT (1.87).
Conclusion: This study demonstrated that while the 6MWT and ISWT differ significantly in the distance covered. However, ISWT is better test to evaluate the vo2 max in compression with 6 MWT.
Key Message: This study compares the 6-Minute Walk Test (6MWT) and Incremental Shuttle Walk Test (ISWT) in individuals with Type 2 diabetes. While both tests assess cardiorespiratory fitness, the ISWT better reflects VO_2 max and induces greater fatigue, suggesting its potential for more accurate evaluation of exercise capacity in this population.

Keywords: Type 2 Diabetes, Incremental shuttle walk test, 6-minute walk test

BACKGROUND

Type 2 diabetes is a significant public health issue that affects both individual well-being and healthcare costs. The ongoing economic growth and urbanization in various regions have contributed to an increasing prevalence of diabetes globally.[1] Abnormal blood glucose levels are commonly accompanied by dyslipidaemia or hypertension, resulting in both incapacitation and reduced life expectancy for affected individuals, as well as an elevated susceptibility to sudden cardiac death.[2,3] Research indicates that diabetes is responsible for approximately 3 million deaths worldwide each year, and the global prevalence of the condition continues to rise annually.[4] In brief, Long-term type 2 diabetes (more than five years) is linked to diminished cardiorespiratory fitness, evident through lower exercise tolerance and a 20-30% decrease in VO2peak compared to age- and gender-matched, sedentary, obese individuals without diabetes.[5,6]

Cardiopulmonary exercise testing (CPET) is widely recognized as the most effective method for evaluating exercise capacity. However, due to the high cost of equipment and the need for trained professionals, researchers have worked to develop more affordable and simpler alternatives that can reflect the effectiveness of CPET, though they do not replace its comprehensive capabilities.[7] The 6-Minute Walk Test (6MWT) is a simple and effective evaluation where patients walk as fast as they can comfortably sustain for a duration of six minutes. It is personalized to the individual's capacity, allowing them to stop walking if needed. In contrast, the Incremental Shuttle Walk Test (ISWT) follows a different protocol, being an incremental and externally controlled test. This 12-level test (with 1-minute intervals per level) gradually increases speed through an auditory signal that helps regulate the pace, using a 10-meter shuttle circuit marked by two cones. The ISWT is also simple to administer, reliable, and does not require specialized equipment.[8]

MATERIAL AND METHOD

A pilot study was conducted in A tertiary hospital, Mangalore, Karnataka with research design Cross-sectional study, to assess Cardio Respiratory Fitness using incremental shuttle walk test (ISWT) in middle aged type 2 diabetes patient, to assess Cardio Respiratory Fitness using 6-minute walk test (6MWT) in middle aged type 2 diabetes patient and to compare between ISWT and 6MWT in middle aged type 2 diabetes patient. A total 15 study participants, each patient has to undergo both test with 30 min rest in between the test. Based on inclusion Gender: both male and female, Age group: As per WHO middle age people 45 to 60 years, clinically diagnosed with Type 2 Diabetes mellitus within 5 years and under control, Patient who is willing to participate with consent form signed and exclusion criteria: Any lower limb fracture or other comorbidity which restrict the walking, Patient with Above 24.9 BMI, Patient with chronic history of smoking, Patient with major cardiovascular diseases, Individual with having cognitive decline. Sampling procedure was Convenient sampling technique will be adopted to select the individuals for the study. Sample size was estimated using Standard deviation of 6 min walk test from the study conducted by Lim HJ et al. Sample size for this Pilot study was 15 participant was taken. Duration of the study Approximately 7 months (July 2024 to Jan 2025).

PROCEDURE

Ethical clearance was obtained by an Institutional Ethical Committee. Subjects fulfilling the inclusion and exclusion criteria was enrolled for the study. A brief introduction about the procedure was explained to the subjects. An initial examination including demographic data was carried out prior to the study. Demographic data in the form of age, gender, BMI, occupation, previous history and vitals was collected. Age is middle aged 45-60 as per WHO, type 2 diabetic population. Both the test was done in the same population. 20

mins rest was given before the test begins. Comparison of the 6MWT and ISWT is done to elucidate the Cardiorespiratory fitness. The rest period of 30 mins was given between 6min walk test and incremental shuttle walk test to minimize participant fatigue and to recover resting heart rate.

6 MWT: Two cones were placed at two ends of the hallway. Vitals was measured before the test. Individuals was instructed to walk at self-paced between the two points for 6 minutes and the distance is recorded than again vitals was measured at the end of the test.

Incremental shuttle walk test: Two cones placed both the ends of 10m. Vitals was measured before the test. Individuals was instructed to walk externally paced maximal exercise test where the speed of walking increases with each level, controlled by a series of pre-recorded signals. The test continues until the participant can no longer continue or cannot keep up with the required pace. The maximum duration of the test is 20 min and at end of test vitals was measured.

ETHICAL CONSIDERATION:

Study was conducted after administrative approval from the university research committee. All the participants were explained about the study and a written consent was obtained.

OUTCOME MEASURES:

CARDIO RESPIRATORY FITNESS

Cardiorespiratory fitness refers to the capacity of the circulatory and respiratory systems to supply oxygen to skeletal muscle mitochondria for energy production needed during physical activity. Cardiorespiratory fitness can be directly measured as peak oxygen uptake (VO2peak). Estimated as the exercise or functional capacity (peak work rate) assessed through an exercise test. investigating CRF as a key outcome measure have used estimates of CRF, with a range of different methods for deriving the estimate.[9]

6 MINUTE WALK TEST

The 6MWT was performed according to standardised criteria. Participants were instructed to walk as far as possible along a 30-meter corridor for six minutes, with the aim of achieving their maximum possible walking distance in six minutes. Standardised instructions were provided and standardised encouragement was given each minute. Participants were permitted to stop and rest if required but were encouraged to continue walking as soon as they were able.[10] Strong internal reliability for both the CB (intraclass correlation coefficient (ICC) = 0.93) and the TL 6MWT (ICC = 0.98) was found. The results indicate that a TL 6MWT performed outdoors can be a highly valid and reliable tool to assess functional capacity in patients with DM2.[11]

INCREMENTAL SHUTTLE WALK TEST

Patients were required to walk along a level 10 m course at a previously determined speed dictated by signals from an audio tape recorder. The walking speed was progressively increased at 1 min intervals, for a total of 12 stages. The test was terminated if the patient was unable to continue at the desired speed or if the patient failed to complete the shuttle course in the allowed time. As with the six-minute walk test, systolic and diastolic blood pressures, heart rate, perceived exertion (Borg's 6 to 20 category ratio scale) and distance walked were determined on exercise cessation.[12] The exercise tests exhibited strong to outstanding test-retest reliability, with the Incremental Shuttle Walk Test (ISWT) distance and Cardiopulmonary Exercise Test (CPX) peak VO2 both showing an Intraclass Correlation Coefficient (ICC) of 0.90. Additionally, the ISWT demonstrated excellent reliability along with commendable concurrent validity.[13]

STATISTICAL ANALYSIS

The statistical analysis was done using SPPS 23.0. The categorical variables were

represented in frequency and percentage. The numerical variables were presented using mean and standard deviation. Comparison was done using Paired t test. A p-value less than 0.05 was considered statistically significant.

RESULTS

The mean VO_2 max was higher for the 6MWT (19.269 ± 2.774) compared to the ISWT (18.373 ± 2.683), but the difference was not statistically significant (t = 1.288, p = 0.219). In terms of distance covered, participants walked significantly farther in the 6MWT (338.333 ± 64.086 m) than in the ISWT (123.133 ± 91.592 m), with a highly significant difference (t = 8.578, p < 0.001). The mean HR MAX was slightly higher for the 6MWT (102.267 ± 13.745) than for the ISWT (98.533 ± 15.547), though this difference was also not statistically significant (t = 1.362, p = 0.195).

In the 6MWT, the mean pre-test fatigue score was 6.067 ± 0.258, which significantly increased to 7.933 ± 1.387 post-test, with a t-value of 6.089 and a statistically significant p-value of <0.001. Similarly, in the ISWT, the mean pre-test fatigue score was 6.133 ± 0.352, rising significantly to 9.067 ± 2.344 post-test, with a t-value of 5.196 and a p-value of <0.001.

The 6MWT showed increase the mean fatigue score by 1.867 ± 1.187, The ISWT demonstrated a higher mean fatigue score by 2.933 ± 2.187. The result is statistically significant with p<0.05.

Table 1: Age distribution

Age	Frequency	Percent
<50 years	9	60.0
>=50 years	6	40.0
Total	15	100.0

Out of the 15 participants, 60% were aged below 50 years, while the remaining 40% were aged 50 years or above with minimum of 45 years and maximum of 62 years.

Table 2: Comparison in VO2 max, distance and HR MAX

		Mean	Std. Deviation	t value	p value
VO2max	6 MWT	19.269	2.774	1.288	0.219
	ISWT	18.373	2.683		
distance in m	6 MWT	338.333	64.086	8.578	p<0.001
	ISWT	123.133	91.592		
HR MAX	6 MWT	102.267	13.745	1.362	0.195
	ISWT	98.533	15.547		

(6MWT: 6-minute walk test, ISWT: Incremental shuttle walk test)

Table 3: Pre post Comparison of fatigue score

		Mean	Std. Deviation	t value	p value
6min walk test	Pre	6.067	0.258	6.089	p<0.001
	Post	7.933	1.387		
Incremental shuttle walk test	Pre	6.133	0.352	5.196	p<0.001
	Post	9.067	2.344		

The study assessed fatigue levels using RPE and to assess the cardio respiratory fitness the 6-Minute Walk Test (6MWT) and the Incremental Shuttle Walk Test (ISWT) by comparing pre-test and post-test scores.

Table 4: Improvement in fatigue score

	Mean	Std. Deviation	t value	p value
Increase in fatigue score by 6 MWT	1.867	1.187		
Increase in fatigue score by ISWT	2.933	2.187	2.874	0.012

The fatigue scores were compared between two methods: the 6-minute walk test (6MWT) and the incremental shuttle walk test (ISWT).

DISCUSSION

This study aimed to compare two commonly used exercise tests, the 6-Minute Walk Test (6MWT) and the Incremental Shuttle Walk Test (ISWT), with respect to several physiological measures (VO_2 max, distance covered, HR max) and fatigue levels in a sample of 15 participants. The statistical analysis revealed both similarities and differences in the performance of these tests, providing valuable insights into their application and potential Clinical relevance.

The mean VO_2 max was similar in both 6 MWT and ISWT with P value, $p = 0.219$. In terms of distance covered, participants walked significantly farther in the 6MWT than in the ISWT $p < 0.001$ The mean HR MAX was slightly higher for the 6MWT than for the ISWT difference was also not statistically significant $p = 0.195$. The study assessed the cardio respiratory fitness through 6-Minute Walk Test (6MWT) and the Incremental Shuttle Walk Test. The mean fatigue score was higher in ISWT as compare to 6MWT $p < 0.05$.

To date, many studies have confirmed that 6MWT and ISWT are valid, reliable, and responsive to therapeutic interventions.[14] The 6MWT is a self-paced submaximal test and can be performed continuously or intermittently. This test is sensitive to methodological variations, such as encouragement, oxygen supplement, and circumstances like wheeled walking aid, circular/straight track, indoors/outdoors.[10]

By contrast, ISWT is an externally paced maximal exercise test. This feature may be an advantage in circumstances where methodological variation is a concern if the test is performed by various sites or operators. In addition, where the larger space requirements of 6MWT preclude its use, ISWT can be a useful alternative. The protocol of ISWT is more standardized than that of 6MWT, and the proposal of incremental values is also clear in the shuttle walk test. In addition, ISWT shows a linear change of lung gas exchange including peak VO_2, but 6MWT shows an exponential change.[15]

Our study confirmed that the ISWT requires more effort by the participants due to external factors had a relatively higher intensity of exercise, unlike the 6MWT, which is affected by participants' internal factors. This is similar to results reported by previous studies that the ISWT had a stronger correlation of exercise response with CPX than the 6MWT. With regard to the difference in RPE that the patients self-evaluated the load and difficulty of exercise intensity between the groups, the intensity in the 6MWT was significantly different from the ISWT.[16]

Thus, adoption of various complementary tests and evaluation of exercise capacity with an appropriate test will enable comprehensive assessment and provision of an individualized exercise program.

CONCLUSIONS

This study demonstrated that while the 6MWT and ISWT differ significantly in the distance covered. However, ISWT is better test to evaluate the vo2 max in compression with 6 MWT.

Limitation

Further studies with larger and more diverse samples, as well as longer follow-up periods, would be beneficial to better understand the long-term implications of these tests and their ability to predict clinical outcomes in T2DM patients.

Declaration by Authors
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