

Comparison between 6 Min Walk Test and Incremental Shuttle Walk Test in Middle Aged Women with Type 2 Diabetes: A Pilot Study

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ABSTRACT

Background: It is estimated that ~415 million individuals around the globe are living with diabetes, with 91% of them having type 2 diabetes mellitus (T2DM). Cardiovascular disease (CVD) poses a significant clinical and economic burden for individuals with type 2 diabetes mellitus (T2DM). Women with type 2 diabetes have a 25–50% higher relative risk of experiencing a cardiovascular event compared to men with the same condition.

Objective: To compare the incremental shuttle, walk test (ISWT) and the 6-minute walk test (6MWT) in middle-aged women with type 2 diabetes.

Method: A pilot cross-sectional study was conducted to assess cardio-respiratory fitness using the incremental shuttle walk test (ISWT) and the 6-minute walk test (6MWT) in middle-aged women with type 2 diabetes, and to compare ISWT and 6MWT in middle-aged women with type 2 diabetes. A total of 15 participants were recruited according to the inclusion and exclusion criteria. Both tests, with a 30-minute rest in between, were conducted.

Result: Comparison between two cardio-respiratory fitness tests was done using a paired t-test. The mean VO₂ max for the 6-minute walk test was 17.616±2.775, while for the incremental shuttle walk test, it was slightly lower at 16.851±1.084. The t-value of 1.347 and p-value of 0.199 indicate that the difference is not statistically significant ($p > 0.05$). The t-value of 10.748 and p-value of $p < 0.001$ suggest a highly significant difference ($p < 0.05$), indicating that the 6-minute walk test allows for significantly greater distance coverage compared to the incremental shuttle walk test.

Conclusion: The significant difference in distance suggests the 6-minute walk test is better for assessing endurance, while the incremental shuttle walk test induces higher perceived exertion and cardiovascular stress.

KEYWORDS: Type 2 diabetes, Women, Incremental shuttle walk test, 6-minute walk test.

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BACKGROUND

It is estimated that ~415 million individuals around the globe are living with diabetes, with 91% of them having type 2 diabetes mellitus

(T2DM) [1]. In India, there are currently >77 million adults diagnosed with diabetes, and this figure is projected to nearly double, reaching 134 million by 2042 [1,2]. Across the cohort,

individuals with Type 2 diabetes mellitus face shortened life expectancy by nearly 10 years, with cardiovascular disease (CVD) being the leading cause of death among individuals with T2DM [3]. In fact, approximately 70% of individuals aged 65 and older with type 2 diabetes mellitus die from cardiovascular disease [4]. Cardiovascular disease poses a significant clinical and economic burden for individuals with type 2 diabetes mellitus [5]. Peters SA et al conducted a systematic review and meta-analysis in 2014, showing an elevated relative risk of type 2 diabetes and cardiovascular events in women, nearly 25–50% compared to men with the same condition [6]. Cardiorespiratory fitness is a strong predictor of lifespan and overall mortality, and it tends to be lower in individuals with diabetes, especially in women [7-9].

Cardiorespiratory fitness (CRF) is often measured by assessing peak oxygen uptake ($\text{VO}_{2\text{peak}}$) [10]. There are both direct and indirect methods for measuring maximum oxygen uptake. The direct method, considered the most reliable, involves analysing exhaled gases just before the end of an incremental exercise test, typically using a treadmill or cycle ergometer, until the subject reaches an all-out effort and can no longer continue. However, this approach requires expensive equipment, advanced measurement technology, and a significant amount of time. In contrast, the indirect method estimates oxygen uptake based on data like heart rate collected during submaximal exercise [11].

The 6-minute walk test (6-MWT) is a simple, safe, and reliable method for assessing cardiovascular endurance. It can be performed in small indoor spaces and low-resource clinics.¹² The incremental shuttle walk test (ISWT) directs an individual to walk at an increasingly graded pace every minute, guided by prerecorded signals. It shows a stronger correlation with maximal oxygen uptake compared to the six-minute walk test. The ISWT has proven to be simple, valid, reliable, reproducible, and safe when performed correctly, and has been effectively used in patients [13].

MATERIALS AND METHODS

A pilot study was conducted in a tertiary hospital, Mangalore, Karnataka with research design

Pilot Cross-sectional study, to assess cardio respiratory fitness using incremental shuttle walk test (ISWT) in middle aged women with type 2 diabetes, 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 women with type 2 diabetes patient. A total of 15 participants, each patient underwent both tests with a 30-minute rest period in between. Based on the inclusion criteria, 15 female participants were recruited, aged between 45 and 60 years, and clinically diagnosed with type 2 diabetes mellitus within the past 5 years, with the condition under control. Participants were required to be willing to participate and sign a consent form. The exclusion criteria included individuals with lower limb fractures or other comorbidities that restrict walking, those with a BMI above 24.9, individuals with a chronic history of smoking, patients with major cardiovascular diseases, and those with cognitive decline. A convenience sampling technique was used to select participants for the study. The sample size was estimated based on the standard deviation of the 6-minute walk test from a study conducted by Lim HJ et al. The study was completed over approximately 7 months, from July 2024 to January 2025.

Procedure: Ethical clearance was obtained by an Institutional Ethical Committee. Subjects fulfilling the inclusion and exclusion criteria were enrolled in the study. A brief introduction to 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 were collected. The age range is middle-aged, 45-60, as per the WHO classification for type 2 diabetic women. Both test was done in the same population. 20 minutes of rest were given before the test began. Comparison of the 6MWT and ISWT is done to elucidate the Cardiorespiratory fitness. A rest period of 30 minutes was given between the 6-minute walk test and the 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 were measured before the test. Individuals were instructed to walk at a self-paced rate between

the two points for 6 minutes, and the distance was recorded. Then, their vitals were measured at the end of the test. Incremental shuttle walk test: Two cones were placed at both ends of 10m. Vitals were measured before the test. Individuals were 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 minutes, and at the end of the test, vitals were measured.

OUTCOME MEASURES

Cardiorespiratory Fitness: Cardiorespiratory fitness (CRF) is a vital component of overall physical health, associated with numerous positive health outcomes. It refers to the ability of the heart, lungs, and muscles to transfer oxygen efficiently during sustained moderate-to-vigorous physical activity. CRF is commonly measured by maximal oxygen consumption (VO₂max) [15].

6-minute walk test: We have conducted the 6-minute walk test (6MWT) following the guidelines provided by the American Thoracic Society and the European Respiratory Society. Participants were asked to walk as far as possible within six minutes along a flat, 30-meter-long indoor corridor. Two traffic cones indicated the walking path, and the corridor was marked every 3 meters. Standardized instructions were given to participants, along with verbal encouragement at one-minute intervals throughout the test. The total distance covered during the test was recorded in meters [15]. The internal reliability was ICC = 0.98. These findings suggest that this is a highly reliable and valid method for evaluating functional capacity in patients with type 2 diabetes (T2DM).

Incremental Shuttle Walk Test: The incremental shuttle walking test (ISWT) was conducted with a minimum rest period of 30 minutes between tests. The test was carried out on a 10-meter course, marked by two cones placed 0.5 meters from each end. The longest distance covered in any test was used for analysis. Participants were instructed to walk or run around the course at speeds dictated by an audio signal, with speed increments indicated by a

series of three bleeps. An adapted version of the modified protocol was used, allowing the audio signals to continue until participants reached maximal effort, surpassing the 12 speed levels outlined in the original protocol, and even running if needed [16]. The exercise tests demonstrated strong to exceptional test-retest reliability, with both the incremental shuttle walk test (ISWT) distance and the cardiopulmonary exercise test (CPX) peak VO₂ showing an intraclass correlation coefficient (ICC) of 0.90. Furthermore, the ISWT exhibited excellent reliability and notable concurrent validity [17].

RESULT

The statistical analysis was done using SPSS 23.0. The categorical variables were represented in frequency and percentage. Numerical variables were presented using mean and standard deviation. Pre-post comparison was done using a paired sample t-test. Comparison between two submaximal tests was done using a paired t-test. A p-value <0.05 was considered statistically significant.

The data represents the age distribution of a group of 15 women. The majority (40%) fell within the 45-49 age range, followed by 33.3% who were 55 years or older. The smallest group, making up 26.7%, consisted of individuals aged 50-54 years.

When the VO₂ max, distance walked, maximum heart rate (HR max), rate of perceived exertion, systolic (SBP), and diastolic blood pressure (DBP) were compared using a paired t-test, there was a significant difference in distance walked, HR max, RPE, SBP, and DBP (p<0.05) between the 6MWT and ISWT.

Table 1: Comparison of variables measured using the 6-minute walk test and the incremental shuttle walk test.

Parameter	6MWT	ISWT	Mean ± SD	t value	p value
VO ₂ max	17.616	16.851	17.616±2.775 16.851±1.084	1.347	0.199
Distance	293.333	103.2	293.333±54.340 103.200±73.427	10.748	0.001
Hr max	87.733	83.4	87.733±11.386 83.400±8.113	7.877	0.05
RPE	2.867	4.667	2.867±1.187 4.667±1.633	3.453	0.05
SBP	6	11.067	6.000±3.381 11.067±6.431	2.701	0.05
DBP	3.667	5.667	3.667±4.419 5.667±4.169	1.275	0.213

Significant difference seen in distance walked HR max, RPE, SBP and DBP (p<0.05) between the 6MWT and ISWT.

DISCUSSION

This study aimed to compare two submaximal exercise tests in women with type 2 diabetes, the 6-minute walk test (6MWT) and the incremental shuttle walk test (ISWT), in terms of various physiological measures (VO₂ max, distance covered, HR max) and fatigue levels in a group of 15 participants. The statistical analysis highlighted both similarities and differences in test performance, offering valuable insights into their application and clinical relevance.

The 6-minute walk test (6MWT) is often applied to assess functional status and predict outcomes in individuals with a variety of conditions, such as COPD. It is often used to monitor the effects of interventions, including rehabilitation programs, treatment changes, and oxygen therapy, on walking ability. However, there is a dearth in literature on the use of the 6MWT in people with type 2 diabetes. Diabetes is a condition that can impair physical capacity, potentially affecting walking performance and overall mobility [18]. For example, Janevic et al [19]. A notable decrease in the distance walked during the 6-minute walk test has been observed in elderly women with diabetes (aged over 60). Other studies have reported similar findings, highlighting the impact of both conditions on physical capacity.

The ISWT is an externally paced walking test, and running is not allowed. This restriction can lead to a “ceiling effect,” where lactate production is reduced. We believe that this difference between tests may explain the observed discrepancies in ventilatory efficiency results in women [20]. In the ISWT, the intensity gradually increases as the walking speed is elevated every minute. After approximately three minutes, the walking speed in the ISWT matches that of the treadmill [21].

Our study found that the ISWT requires greater effort from participants, primarily due to external factors that contribute to a higher intensity of exercise. In contrast, the 6MWT is influenced more by internal factors of the participants. These findings align with previous research, which showed that the ISWT has a stronger correlation with exercise response in CPX compared to the 6MWT. Additionally, when

patients self-assessed the perceived exertion (RPE), there was a significant difference in the intensity of exercise between the 6MWT and ISWT groups [22,23].

Limitation: Further studies with larger and more diverse samples would be beneficial to understand better the long-term implications of these tests and their ability to predict clinical outcomes in patients with Type 2 Diabetes mellitus.

CONCLUSION

The 6-minute walk test tends to result in greater distance covered, slightly higher HR max, and a more moderate increase in SBP and RPE compared to the incremental shuttle walk test, which leads to higher RPE, SBP, and DBP values. The significant difference in distance covered suggests that the 6-minute walk test might be a better test for assessing endurance. In contrast, the incremental shuttle walk test might push participants to higher levels of perceived exertion and cardiovascular stress, as indicated by higher SBP and DBP post-test.

ABBREVIATIONS

T2DM - Type 2 diabetes mellitus
CVD - Cardio vascular disease
6mwt - Six-minute Walk test
ISWT - Incremental Shuttle Walk test
CRF - Cardio respiratory fitness
VO₂max - Maximum oxygen consumption

Declaration of Authors:

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REFERENCES

- [1]. Einarson TR, Acs A, Ludwig C, Panton UH. Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007-2017. *Cardiovascular diabetology*. 2018 Dec;17:1-9. <https://doi.org/10.1186/s12933-018-0728-6> PMID:29884191 PMCID:PMC5994068
- [2]. Luhar S, Kondal D, Jones R, Anjana RM, Patel SA, Kinra S, Clarke L, Ali MK, Prabhakaran D, Kadir MM, Tandon N. Lifetime risk of diabetes in metropolitan cities in India. *Diabetologia*. 2021 Mar;64:521-9. <https://doi.org/10.1007/s00125-020-05330-1> PMID:33225415 PMCID:PMC7864818

- [3]. International Diabetes Federation. Diabetes and cardiovascular disease. Brussels: International Diabetes Federation; 2016. p. 1-144. Available from CVD_in_diabetes_report_compressed.pdf
- [4]. De Rosa S, Arcidiacono B, Chiefari E, Brunetti A, Indolfi C, Foti DP. Type 2 diabetes mellitus and cardiovascular disease: genetic and epigenetic links. *Frontiers in endocrinology*. 2018 Jan 17;9:2. <https://doi.org/10.3389/fendo.2018.00002> PMID:29387042 PMCID:PMC5776102
- [5]. Einarson TR, Acs A, Ludwig C, Panton UH. Economic burden of cardiovascular disease in type 2 diabetes: a systematic review. *Value in Health*. 2018 Jul 1;21(7):881-90. <https://doi.org/10.1016/j.jval.2017.12.019> PMID:30005761
- [6]. Peters SA, Huxley RR, Woodward M. Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. *Diabetologia* 2014;57(8):1542-1551. <https://doi.org/10.1007/s00125-014-3260-6> PMID:24859435
- [7]. Huebschmann AG, Huxley RR, Kohrt WM, Zeitler P, Regensteiner JG, Reusch JE. Sex differences in the burden of type 2 diabetes and cardiovascular risk across the life course. *Diabetologia*. 2019 Oct;62:1761-72. <https://doi.org/10.1007/s00125-019-4939-5> PMID:31451872 PMCID:PMC7008947
- [8]. Regensteiner JG, Bauer TA, Huebschmann AG et al. Sex differences in the effects of type 2 diabetes on exercise performance. *Med Sci Sports Exerc*. 2015; 47(1):58-65. <https://doi.org/10.1249/MSS.0000000000000371> PMID:24811327 PMCID:PMC4296732
- [9]. Naci H, Ioannidis JP. (2013) Comparative effectiveness of exercise and drug interventions on mortality outcomes: metaepidemiological study. *BMJ* 2013;347:f5577. <https://doi.org/10.1136/bmj.f5577> PMID:24473061 PMCID:PMC3788175
- [10]. Liu Y, Li N, Zhang S, Feng Y, Zhang Y, Shao Y, Wu J. Independent influence of type 2 diabetes on reduced cardiopulmonary fitness in patients after percutaneous coronary intervention: a cross-sectional study. *Scientific Reports*. 2025 Feb 19;15(1):6071. <https://doi.org/10.1038/s41598-025-90281-z> PMID:39972067 PMCID:PMC11839949
- [11]. Lee MC. Validity of the 6-minute walk test and step test for evaluation of cardio respiratory fitness in patients with type 2 diabetes mellitus. *Journal of exercise nutrition & biochemistry*. 2018 Mar 31;22(1):49. <https://doi.org/10.20463/jenb.2018.0008> PMID:29673246 PMCID:PMC5909078
- [12]. Kammin EJ. The 6-minute walk test: indications and guidelines for use in outpatient practices. *The Journal for Nurse Practitioners*. 2022 Jun 1;18(6):608-10. <https://doi.org/10.1016/j.nurpra.2022.04.013> PMID:35578650 PMCID:PMC9095083
- [13]. Agarwal B, Shah M, Andhare N, Mullerpatan R. Incremental shuttle walk test: Reference values and predictive equation for healthy Indian adults. *Lung India*. 2016 Jan 1;33(1):36-41. <https://doi.org/10.4103/0970-2113.173056> PMID:26933305 PMCID:PMC4748663
- [14]. Zeiher J, Ombrellaro KJ, Perumal N, Keil T, Mensink GB, Finger JD. Correlates and determinants of cardiorespiratory fitness in adults: a systematic review. *Sports medicine-open*. 2019 Dec;5:1-24. <https://doi.org/10.1186/s40798-019-0211-2> PMID:31482208 PMCID:PMC6722171
- [15]. Dourado VZ, Nishiaka RK, Simões MS, Lauria VT, Tanni SE, Godoy I, Gagliardi AR, Romiti M, Arantes RL. Classification of cardiorespiratory fitness using the six-minute walk test in adults: Comparison with cardiopulmonary exercise testing. *Pulmonology*. 2021 Nov 1;27(6):500-8. <https://doi.org/10.1016/j.pulmoe.2021.03.006> PMID:33958319
- [16]. Pepera G, Karanasiou E, Blioumpa C, Antoniou V, Kalatzis K, Lanaras L, Batalik L. Tele-assessment of functional capacity through the six-minute walk test in patients with diabetes mellitus type 2: validity and reliability of repeated measurements. *Sensors*. 2023 Jan 25;23(3):1354. <https://doi.org/10.3390/s23031354> PMID:36772396 PMCID:PMC9920804
- [17]. Probst VS, Hernandez NA, Teixeira DC, Felcar JM, Mesquita RB, Gonçalves CG, Hayashi D, Singh S, Pitta F. Reference values for the incremental shuttle walking test. *Respiratory medicine*. 2012 Feb 1;106(2):243-8. <https://doi.org/10.1016/j.rmed.2011.07.023> PMID:21865021
- [18]. Jürgensen SP, Trimer R, Dourado VZ, Di Thommazo Luporini L, Bonjorno Junior JC, Oliveira CR, Arena R, Mendes RG, Borghi Silva A. Shuttle walking test in obese women: test retest reliability and concurrent validity with peak oxygen uptake. *Clinical physiology and functional imaging*. 2015 Mar;35(2):120-6. <https://doi.org/10.1111/cpf.12135> PMID:24589245
- [19]. Kuziemski K, S³omiński W, Jassem E. Impact of diabetes mellitus on functional exercise capacity and pulmonary functions in patients with diabetes and healthy persons. *BMC endocrine disorders*. 2019 Dec;19:1-8. <https://doi.org/10.1186/s12902-018-0328-1> PMID:30606177 PMCID:PMC6318966
- [20]. Janevic MR, Janz NK, Connell CM, et al. Progression of symptoms and functioning among female cardiac patients with and without diabetes. *J Women's Health (Larchmt)*. 2011;20:107-15. <https://doi.org/10.1089/jwh.2010.2123> PMID:21091196 PMCID:PMC3052276
- [21]. Sperandio EF, Guerra RL, Dourado VZ. Dynamic physiological responses to the incremental shuttle walk test in adults. *Fisioterapia em Movimento*. 2017;

30(4):821-30.

<https://doi.org/10.1590/1980-5918.030.004.ao18>

- [22]. Paulino GeiselP, de Oliveira Nascimento I, Mendonça Gonçalves Machado M, Lucas Gomes Mateus dos Santos R, Nézio Gomes BR, Pontes Przybysz GM, de Figueiredo Magalhães Pereira I, Gomes Pereira DA. Incremental shuttle walking test for calf muscle oxygenation assessment in peripheral arterial disease: a cross-sectional study. *Scientific Reports*. 2025 Jan 2;15(1):488. <https://doi.org/10.1038/s41598-024-84662-z> PMID:39747567 PMCID:PMC11696925

- [23]. Lim HJ, Jee SJ, Lee MM. Comparison of incremental shuttle walking test, 6-minute walking test, and cardiopulmonary exercise stress test in patients with myocardial infarction. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2022 Oct 17;28:e938140-1. <https://doi.org/10.12659/MSM.938140> PMID:36245105 PMCID:PMC9585920

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