

Psychometric Validation of 6-Minute Walk Test in Patients with Knee Osteoarthritis: An Observational Cross-sectional Study

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Abstract

Introduction: The 6-Minute Walk Test (6-MWT) is a simple and commonly used functional performance test that assesses an individual's aerobic capacity and endurance of the lower limb. In knee osteoarthritis, the 6-MWT is often employed as a clinical assessment tool to evaluate functional capacity and monitor changes in physical performance over time. Individuals with knee osteoarthritis may experience pain, stiffness, and reduced mobility, significantly impacting their ability to walk and engage in daily activities.

Aim: This study determines the reliability, construct validity, and minimal detectable change of 6-MWT in patients with knee OA.

Materials and Method: This was an Observational Cross-sectional study. This study was conducted at The Sarvajani College of Physiotherapy, Surat for a period of one year *i.e.* from July 2022 to June 2023. A total of 90 patients with knee OA were selected as participants, and the study used outcome measures such as mWOMAC to assess the level of disability and 30s SST to examine the Functional capacity and Strength of the lower limbs. Only 44 of 90 participants performed 6-MWT again after 48 hours for reliability. Data obtained were analysed in SPSS version 20.0. Intra-class correlation coefficient (ICC) values were derived for test-retest reliability, Pearson's correlation was seen for validity assessment, and standard error of measurement (SEM) and minimum detectable change (MDC) were also calculated.

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Results: The mean age of the patient was 59.66±8.237, and the mean pain score was 6.04±1.805. The ICC values for test-retest reliability were 0.992, which showed excellent reliability. The SEM and MDC values were 9.018 meters and 24.92 meters, respectively. 6-MWT showed a high-level positive correlation with the 30sSST ($r = 0.821$) and a moderate negative correlation with the mWOMAC and NPRS ($r = -0.593$ & $r = -0.537$), respectively.

Conclusion: The 6-minute walk test is a reliable, valid test to assess the functional capacity in knee OA patients.

Keywords: 6-minute walk test; NPRS; WOMAC; 30-second sit-to-stand; Reliability; Validity.



INTRODUCTION

Osteoarthritis (OA) stands as a prevalent degenerative joint disorder affecting various structures such as cartilage, subarticular bone, ligaments, and muscles. Alongside articular cartilage degeneration, OA manifests through subarticular bone remodeling, osteophyte formation, ligament laxity, muscular weakening, and, in certain instances, synovial inflammation.¹ It represents a widespread musculoskeletal ailment across global demographics, with a reported prevalence of 29% among men and 47% among women worldwide.^{2,3}

The 6-minute walk test (6-MWT) serves as a crucial measure assessing an individual's walking distance over a span of 6 minutes, offering insights into exercise tolerance, cardiovascular fitness, and overall physical performance. Due to its simplicity, cost-effectiveness, and ease of administration, the 6-MWT emerges as a convenient tool for evaluating functional capacity in both clinical and research domains.⁴ Notably, Ateef *et al.*⁵ Scrutinized the 6-MWT within the context of primary knee osteoarthritis (OA), revealing commendable test-retest reliability alongside positive correlations with all subscales of the knee injury and osteoarthritis outcome score. This study addresses the need to understand the reliability, validity, responsiveness, and minimum detectable change of the 6-minute walk test (6-MWT) in knee osteoarthritis managed conservatively.

Despite the established validity and reliability of the 6-MWT in assessing functional abilities in cardiac rehabilitation patients and individuals with diminished exercise capacities^{6,7}, there exists a paucity of literature concerning its reliability, validity and minimum detectable change in knee osteoarthritis managed conservatively. Hence, the primary objective of this study is to ascertain the reliability, validity and minimum detectable change of the 6-MWT in knee osteoarthritis.

MATERIALS AND METHODS

Participants

This was an Observational Cross-sectional study to establish reliability and validity. This study was conducted at The Sarvajani College of Physiotherapy, Surat for a period of one year *i.e.* from July 2022 to June 2023. This study

used participants from various Physiotherapy departments and clinics with a clinical diagnosis of OA of Knee with purposive sampling. The sample size was calculated assuming test-retest reliability 'r' greater than or equal to 0.5, Type I (alpha) error 0.05, and power of the study (1-beta) 0.80 using G-power software. It was found to be 29 subjects, but we did this test-retest reliability on 44 subjects. Construct validity (Sample size 90) was analyzed using the Pearson correlation coefficient ('r') to determine the strength of the relationship between scores 6-MWT and the 30-Second Sit to Stand test, NPRS, and WOMAC.^{8,9}

Inclusion Criteria

- (a) Age 45-70 years
- (b) Average knee pain ≥ 3 on NPRS.
- (c) An orthopedic surgeon diagnosed the patient with OA knee based on radiographic tibiofemoral OA of KL Grade 1 to 3.¹⁰

Exclusion Criteria

- (a) Knee intraarticular injection or surgery in the past six months
- (b) Corticosteroid orally in the past month
- (c) Knee joint replacement or tibial-osteal surgeries
- (d) Systemic inflammatory arthritis
- (e) Unable to walk without a gait Aid
- (f) A patient with a severe cardiac condition

Outcome Measures

6-minute walk test (6-MWT): The 6-MWT is a simple, yet effective, test used to assess the functional capacity and endurance of patients. It involves measuring the distance an individual can walk on a flat, hard surface in six minutes.^{4,11}

30-second sit-to-stand test (30sSST): is a quick and practical test used to assess lower limb strength and functional mobility, balance, and risk of falls. It measures the number of times a person can stand up from a seated position in 30 seconds.¹²⁻¹⁴

Modified Western Ontario and McMaster Universities osteoarthritis index Gujarati version (mWOMAC): It is a questionnaire used for assessing pain, stiffness, and physical function in individuals with osteoarthritis.^{15,16}

Numeric pain rating scale (NPRS): This is a simple and reliable tool used to assess pain intensity. Patients are asked to rate their pain on a numerical scale, typically ranging from 0 to 10,

with 0 representing no pain and 10 representing the worst possible pain.^{17,18}

Procedure

All the 90 patients underwent all the outcome measures at the start of the study to evaluate their physical abilities and pain levels. A subset of participants (n=44) repeated the tests 48 hours later to determine test- retest reliability. Over the next 8 weeks, patients received physiotherapy designed to manage pain, improve mobility, and enhance functional abilities. (Fig. 1: Flow chart of the study). (The ICC values range from 0 to 1; 1 = perfect reliability, 0.90 to 0.99 = very high reliability; 0.70

to 0.89 = high reliability, 0.50 to 0.69 = moderate reliability, 0.26 to 0.49 = low reliability and 0.00 to 0.25 = little, if any, reliability).¹⁹

Statistical Analysis

Data obtained were analysed in SPSS version 20.0 Armonk, New York, USA. Intra-class correlation coefficient (ICC) values were derived for test-retest reliability. The Bland-Altman graph was used to analyze the limits of agreement between the first and second attempt measurements of 6-MWT. Pearson's correlation was done for validity assessment, and standard error of measurement (SEM) and minimum detectable change (MDC) were also calculated.

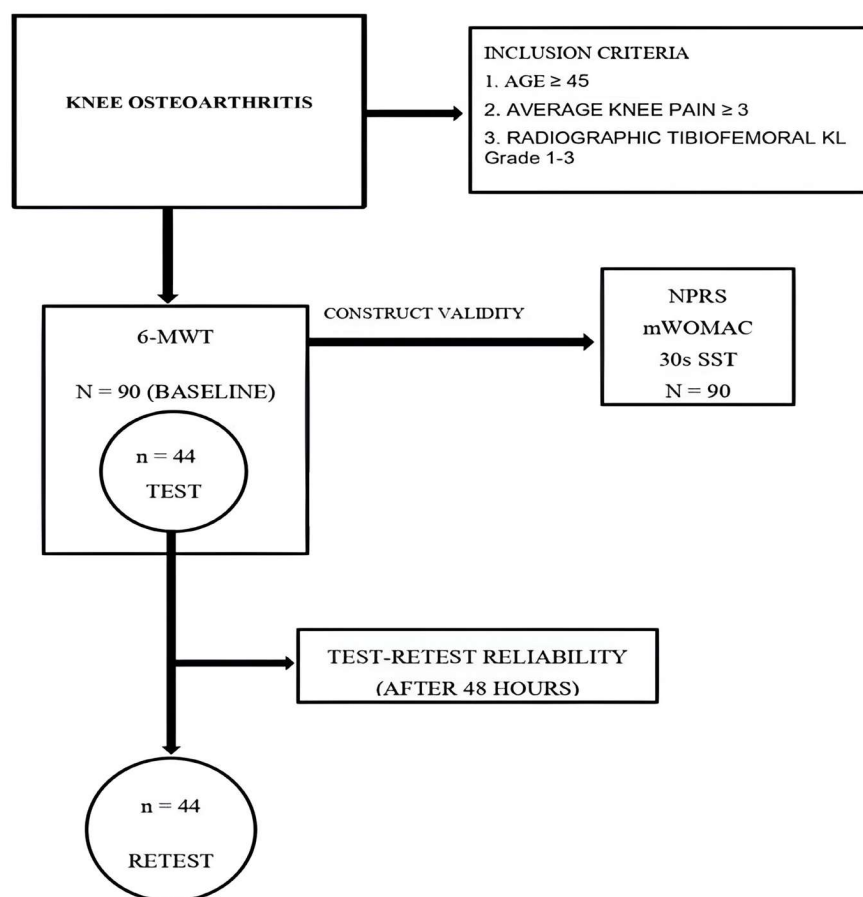


Fig. 1: Flow chart of the study

RESULTS

In this study, 90 subjects of knee OA were included. Of all the subjects included, 31 were males, and the rest 59 were female subjects. The patient's mean age was (in years) 59.66 ± 8.237 . The mean

pain duration of the participants was 34.82 ± 34.119 , and the average pain score of the participants was 6.04 ± 1.805 . Out of all the participants in the study, the majority 59 (65.6%) were females. There were only 31 (34.4%) males in the study. Out of these, 44 patients were used for the test-retest reliability; validity was seen for all 90 subjects and MDC was

seen for 27 subjects. The test-retest reliability of the 6-MWT was 0.992 showed very high reliability.

Level of Agreement

The Bland-Altman graph was used to analyze the limits of agreement between the first and second attempt measurements of 6-MWT.

The Bland-Altman plot²⁰ measures within-subject variation and the limits of the agreement. The Bland-Altman scatter plot showed the mean difference between the two measurements of the 6-MWT on the Y-axis and the average of the two measurements on the X-axis. And only one outlier was seen outside the 95% CI band indicating good level of agreement. Since most values fall between $\text{Mean} \pm 1.96\text{SD}$ ($p = 0.05$), it indicated excellent reliability (Fig. 2).

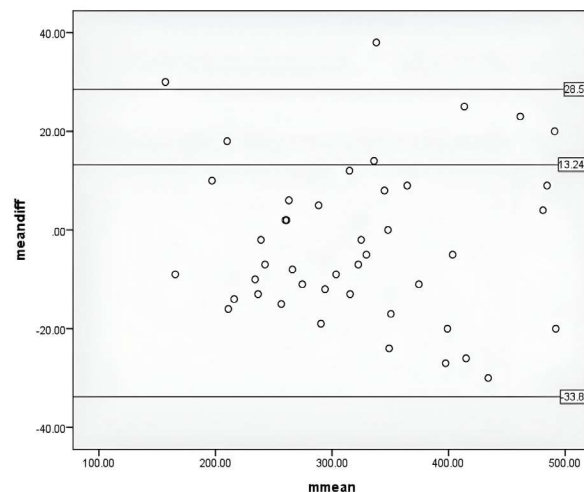


Fig. 2: Bland Altman Plot (n=44)

Standard Error of Measurement

The Standard Error of Measurement (SEM) measures absolute reliability. A smaller SEM value indicates more reliable measurements. ($\text{SEM} = \text{SD} \times \sqrt{1 - \text{ICC}}$) The calculated SEM for 6-MWT was 9.018.

Minimal Detectable Change

The minimal detectable change with a confidence level of 95% at the individual level (MDC 95%) was calculated ($\text{MDC} = 1.96 \sqrt{2} \times \text{SEM}$). According to this formula, the MDC for 6-MWT was 24.92 meters and is to be considered to make a real clinical change.

Construct Validity

The Construct validity was computed using the Person's correlation coefficient between the

6-MWT and the other variables, the mWOMAC, 30s SST, and the NPRS. 6-MWT showed a moderate negative correlation with the pain score (NPRS), a moderate negative correlation with the disability (mWOMAC), a high positive correlation with the physical performance (30s SST), and a highly significant p-value. (Table 1).

Table 1: Correlations between various variables

		NPRS	30s SST	mWOMAC
6-MWT	Pearson Correlation	-0.537	0.821	-0.593
	Sig. (2-tailed)	$P < 0.01$	$P < 0.01$	$P < 0.01$

DISCUSSION

This study assessed the reliability, validity and minimal detectable change of the 6-MWT in patients with knee OA. The 6-MWT has been extensively analyzed in numerous populations, including patients with knee OA. Ateef *et al.*⁵ Investigated the test-retest reliability of the 6-MWT with knee OA patients and demonstrated excellent reliability with an intraclass correlation coefficient (ICC) value of 0.991 (95% confidence interval: 0.986-0.994). The ICC value of 0.991 obtained by Ateef *et al.*⁵ provides convincing evidence for the high test-retest reliability of the 6-MWT in individuals with knee OA. Also, Meys R *et al.*²¹ reported that the 6-MWT showed excellent test-retest reliability (ICC: 0.91) in adult patients with asthma. Roberta Rikli and Jessie Jones²² reported that the 6-MWT had good test-retest reliability ($0.88 < R < 0.94$), particularly when a practice trial preceded the test trial. Deborah M Kennedy *et al.*²³ reported test-retest estimates of the 6-MWT is 0.94 (0.88,0.98) in a longitudinal study evaluating outcome following total hip and knee arthroplasty. The result of the present study is similar to these studies

The results obtained on analyzing the data showed a correlation of 6-MWT with various constructs that measured pain, disability, and physical performance. A Person's correlation was performed based on the study's sample size to find the validity. The 6-MWT showed a moderate negative correlation with the pain score (NPRS) and a highly significant p-value. The points on the graph were quite scattered. It showed a moderate negative correlation with the mWOMAC with a highly significant p-value; while a high positive correlation with the 30s SST and a highly significant p-value were seen.

Similarly, a study by McDonald CM *et al.*²⁴ evaluated the functional capacity of individuals

with Duchenne muscular dystrophy (DMD) in clinical trials and demonstrated excellent concurrent validity of the 6-MWT when compared to other endpoints. In a study by D M Hamilton and R G Haennel⁶ reported that the 6-minute walk was linearly related to maximum METs ($r = 0.687$, $P < 0.001$), supporting the validity of the test. Another study by Roberta Rikli and Jessie Jones²² stated that the Convergent validity of the 6-min walk test was demonstrated by its moderate correlation ($0.71 < r < 0.82$) with treadmill performance.

The SEM and MDC provide researchers and clinicians with some direction for true changes in the measurement, which are not due to random measurement errors. The SEM calculated for the variability in this study's first and second measurements of the 6-MWT is 9.018. The result showed that the minimal detectable change with a confidence level of 95% at the individual level (MDC95%) was 24.92 meters, which means that the smallest change of 24.92 meters can be considered to make a real clinical change. Scores at or above this MDC value are likely due to patient improvement instead of measurement error. Estimated minimal meaningful changes should be greater than the MDC value. The 6-MWT in intermittent claudication (IC)²⁵ the SEM for the 6-MWT was determined to be 16.6 meters, with a 95% confidence interval ranging from 14.6 to 19.3 meters, and the SEM percentage was calculated to be 4.2%.

Furthermore, The MDC for the 6-MWT in patients with IC was found to be 46 meters. There is scarce literature available on MDC of 6-MWT in knee OA managed conservatively. The preceding study²⁵ shows comparatively less SEM and MDC values than the present study. The sample size in this present study is similar to the given study²⁵; it is important to consider that variations across conditions may contribute to significant differences in the MDC and SEM.

Limitations

The findings of this study may be limited due to the following reasons: (a) As subjects were taken from Surat City, hence the generalizability of our findings may be limited to this specific population; and (b) we did not control the influence of pain interventions, such as medication, physiotherapy, or activity-related instructions, could introduce confounding variables that may impact the reliability, validity, and minimal detectable change of the 6-MWT.

CONCLUSION

The 6-MWT is a highly reliable and valid measure of functional capacity in patients with knee osteoarthritis. The minimal detectable change of 24.92 meters provides a reference for interpreting meaningful improvements or deteriorations in functional capacity. The 6-MWT measures functional capacity by determining the distance an individual can walk in six minutes, making it a simple, cost-effective, and widely utilized test.

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Conflicts of Interest

There are no conflicts of interest.

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