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# Reliability and minimal detectable change of the Step Test in patients with knee osteoarthritis

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**Abstract**

**Introduction.** The study aim was to evaluate the test-retest reliability and minimal detectable change of the Step Test in patients with knee osteoarthritis.

**Methods.** The intraclass correlation coefficient was used to assess the test-retest reliability of the Step Test. The minimal detectable change with 95% confidence interval (MDC95) was calculated to determine the true change. The inclusion criteria involved a diagnosis of knee osteoarthritis and age of ≥ 40 years.

**Results.** Thirty-eight participants who met the inclusion criteria were investigated. Seven were male and the mean age equalled 61.23 ± 9.31 years. Three patients had radiographic findings indicative of Kellgren-Lawrence grade II, 10 of grade III, and 25 of grade IV. The Step Test presented excellent test-retest reliability. The intraclass correlation coefficient was 0.97, standard error of the mean was 0.46, and the MDC95 was 1.27.

**Conclusions.** The Step Test is a reliable outcome measurement for the assessment of balance in patients with knee osteoarthritis, and it showed excellent test-retest reliability in these patients. The test may assist clinicians and researchers in evaluating balance and planning rehabilitation in patients with knee osteoarthritis.

**Key words:** balance, reliability, knee osteoarthritis, minimal detectable change

## Introduction

Osteoarthritis (OA) is one of the leading causes of disability worldwide [1]. Most of the individuals diagnosed with OA experience pain, and their performance in daily living activities is adversely affected by the disease [2].

Knee OA is a progressive joint disease that results in gradual degeneration of the articular cartilage and changes in the subchondral bone [3, 4]. Pain and joint stiffness in the affected joint cause a decrease in muscle strength, which leads to difficulties in activities performed by the individual in daily life, such as walking, squatting, and climbing up and down stairs [5–7]. Postural stability is affected owing to loss of proprioception in people with knee OA, and the risk of falling increases. Postural stability can be defined as maintaining the position of the person's body in space. It is quite necessary to maintain this during daily life activities and ambulation. Decreased postural stability is among the most important causes of falling. Falling constitutes a significant public health problem, and it is considered as one of the leading reasons for fatalities and hospital admissions [8, 9].

Knee OA generally causes disabilities that may limit the functional activity in daily life. Determining the potential impact of knee OA on disability is clinically important [10].

For clinicians and researchers, the objective assessment of physical function provides baseline values to estimate treatment effects and helps to make clinical decisions and monitor OA outcomes [11, 12].

Problems encountered in patient-reported outcome measurements include low sensitivity to change and ceiling effects in evaluating different interventions. Patient-reported outcome measurements show that they strongly correlate with pain and are not associated with the ability to perform functions but reflect the patient's perceptions of function. This indicates that they tend to overestimate long-term functional gains and have limited ability to detect dysfunction when pain and incompatible changes occur in function. Whereas patient-reported outcome measurements are related to the patient's belief and experience in their functional abilities, performance-based tests are a measure of the patient's true ability to function. This has made performance-based tests more objectively appealing to clinicians [13–15]. Increased evidence recommends that performance-based measures include several constructs of function, allowing them to better reflect changes in physical performance than self-reported measures alone [16].

As a performance-based measure, the Step Test has been used to evaluate dynamic balance. It is important to have a lateral weight shift during the test, as it is similar to the side-to-side weight shift during walking. The test is easy and safe to apply in the clinic. It is advantageous in that it requires minimum equipment: a 15 cm block is used for the test. The participant is expected to shift weight into single leg stance for 15 seconds as fast as possible [17].

The reliable and valid determination of outcome measures is crucial in both research and clinical practice [18]. Reliability allows the accurate evaluation of treatment effects or the amount of changes [19].

The Step Test has been evaluated for validity and reliability in patients with stroke and with hip OA, as well as in older people after hip fracture [17, 20, 21]. Although reliability estimates for different populations are available for the Step Test, reliability must be precise for each population.

The aims of the present study, therefore, were to deter-

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mine the test-retest reliability (TRR) and to calculate the minimal detectable change (MDC) for the Step Test in patients with knee OA.

## Subjects and methods

### Sample size

The G*Power software (version 3.1) was used for power analysis. The power analysis conducted a priori determined that a minimum of 38 subjects were required to establish a very good acceptable reliability coefficient of 0.85 with $\alpha = 0.05$.

### Participants

The inclusion criteria involved a diagnosis of knee OA in accordance with the American College of Rheumatology clinical classification criteria for knee OA and age of ≥ 40 years. The exclusion criteria were pre-existing neurological or orthopaedic diseases causing gait disturbance, myocardial infarction, and any operation within the previous 6 months. Thirty-eight participants who met these criteria were included.

### Procedure

Our study was a test-retest study. Demographic data, Hospital for Special Surgery (HSS) knee scores, and clinical data of the participants were recorded. The Step Test was performed by the patients twice a day. Between the measurements, the individuals were asked to sit for 1 hour to avoid fatigue.

The test was performed under the supervision of a physiotherapist who had more than 2 years of experience with this test. Each participant was evaluated by the same person.

The Step Test has been used to measure dynamic balance. It is important to have a lateral weight shift during the test, as it is similar to the side-to-side weight shift during walking. The participants were instructed to stand 5 cm in front of a block. They were expected to place the entire foot on the step and then back on the floor for 15 seconds as fast as possible. They were instructed not to move the supporting foot during the test period. The Step Test was demonstrated by the rater. The test period was started by saying 'go' and was finished by saying 'stop'. Time was measured with a stopwatch. The total number of times the foot was placed on the step was recorded [17, 20, 22]. The HSS score is established up to 100 points. Scores of ≤ 59 are considered poor, fair scores are 60–69 points, good scores are those of 70–84 points, and excellent scores are ≥ 85 points [23].

### Statistical analysis

The SPSS 22 software was used for statistical analyses. To calculate TRR, the intraclass correlation coefficient (ICC (2,1)) was used. To ensure the accuracy of the measurement method, the standard error of the mean (SEM) was calculated. The following formula was applied to calculate MDC with 95% confidence interval:

$$MDC95 = SEM \times 1.96 \times \sqrt{2}$$

## Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Dokuz Eylul University Ethics Committee (approval No.: 2018/28-10).

## Informed consent

Informed consent has been obtained from all individuals included in this study.

## Results

Thirty-eight participants with a diagnosis of knee OA were recruited. The descriptive statistics of the participants are displayed in Table 1. Thirty-one of the patients were women and seven were men. Three had radiographic findings indicative of Kellgren-Lawrence grade II, 10 of grade III, and 25 of grade IV. The HSS score equalled 69.31 ± 12.69 for the right knee and 67.52 ± 15.25 for the left knee. This implies that the participants had fair scores. All individuals completed the first and the second trials. No significant difference was found between the first and second trials of the Step Test ($p < 0.05$, $p = 0.68$). The Step Test presented excellent TRR in our study. Its ICC (2,1) was 0.97, while SEM and MDC95 equalled 0.46 and 1.27, respectively. The reliability results are shown in Table 2.

Table 1. Characteristics of the participants

| Characteristics ($n$ = 38) | Value (mean ± *SD*) |
|---|---|
| Age (years) | 61.23 ± 9.31 |
| Height (cm) | 162 ± 9.62 |
| Weight (kg) | 82.34 ± 15.03 |
| BMI (kg/m$^2$) | 31.34 ± 4.84 |
| HSS knee score right | 69.31 ± 12.69 |
| HSS knee score left | 67.52 ± 15.25 |

BMI – body mass index, HSS – Hospital for Special Surgery

Table 2. Minimal detectable changes and reliability of Step Test in patients with knee osteoarthritis

| First trial (mean ± *SD*) | Second trial (mean ± *SD*) | ICC (2,1) (95% CI) | SEM | MDC95 |
|---|---|---|---|---|
| 7.07 ± 2.88 | 7.13 ± 2.74 | 0.97 (0.92–0.97) | 0.46 | 1.27 |

ICC – intraclass correlation coefficient, SEM – standard error of the mean measurement with a 95% CI, MDC95 – minimal detectable change at the 95% confidence level

## Discussion

In this study, the Step Test presented excellent TRR in patients with knee OA. The ICC value was found to be 0.97. Clinically, assessing and monitoring the progression of the physical capacity of patients is important. Outcome measurements have to be reliable, specific for each population, and sensitive to changes in the patient's condition. Our study is the first one in the literature to investigate the MDC95, SEM, and TRR of the Step Test in patients with knee OA.

The Step Test evaluates dynamic balance. One of its most important features is weight shifting like in walking. Therefore, it seems to be an important parameter related to the daily life of the individuals. It has some advantages: minimal equipment requirements and an easy application in clinical practice. Depending on the cartilage tissue degeneration in the joint affected by knee OA, intra-articular receptors that provide proprioceptive sensation may be affected. The Step Test is very important in the evaluation of knee OA patients.

In the literature, ICCs for the Step Test were determined for different populations. Hill et al. [17] reported an ICC of 0.93 in patients with stroke, Choi et al. [20] established an ICC of

0.91 in patients with hip OA, Hong et al. [24] demonstrated an ICC ranging from 0.981 to 0.995 in patients with chronic stroke, and Sherrington and Lord [21] revealed an ICC of 0.75 in older people after hip fracture. ICC values between 0.75 and 0.90 have been suggested to be clinically acceptable [25], and so these results showed excellent reliability. Our findings are close to these results, with ICCs above 0.90. In our study, the ICC value was 0.97, denoting excellent reliability of the Step Test in patients with knee OA. The retest reliability of the Step Test was evaluated 1 hour after the first trial to avoid changes in the participants' physical condition, which might explain the higher TRR in our study. Overall, our findings are similar to those for patients with chronic stroke.

MDC was defined as the smallest amount of difference in individual scores that represented true change, and known values of TRR and MDC will assist clinicians in determining whether a change in a patient's condition is a true change [26]. Real clinical change can be recognized when the changed value exceeds MDC. SEM and MDC90 values were presented in the literature for hip OA. For patients with hip OA, SEM and MDC90 values equalled 1.54 and 4, respectively [4]. There are no other articles in the literature to discuss SEM and MDC95 values. Only one study showed that the Step Test could be performed with a small measurement error in the clinical routine. Our study found SEM and MDC95 of the Step Test in patients with knee OA to be 0.46 and 1.27, respectively; these values are smaller than those in the literature. This implies that the Step Test is consistent in patients with knee OA. Changes greater than the MDC95 value indicate a significant change for clinicians and researchers. These results give information about treatment effectiveness. In clinical practice, any changes in strolling speed measured by the Step Test following an intervention programme need to be above 1.27 repetitions to be considered clinically significant. Changes below the MDC95 value may provide information about whether the treatment was underutilized or not. Clinicians can change their treatment strategy if scores are lower than MDC95.

## Limitations

There were some limitations to our study. First, the fact that the majority of cases were grade 4 according to the Kellgren-Lawrence classification was a limitation in terms of the homogeneity of patients. Kellgren-Lawrence grade 4 corresponds to severe knee OA. These patients may have presented lower functional levels than other participants. Thus, the Step Test score may vary accordingly. Second, this being a single-centre study was a limitation. Third, we examined the selected measurements of TRR, MDC95, and SEM, but we did not provide an assessment of other properties, such as validity and responsiveness. Future research is needed to evaluate other measurements for this test for its integration in clinical practice.

## Conclusions

Our study has shown that the Step Test can be performed safely in research and clinical practice. The Step Test can also be tolerated by patients with knee OA. Changes in balance can be observed with this test in individuals with knee OA.

## Disclosure statement

No author has any financial interest or received any financial benefit from this research.

## Conflict of interest

The authors state no conflict of interest.

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