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Review

A Narrative Review on Measurement Properties of Fixed-distance Walk Tests Up To 40 Meters for Adults With Knee Osteoarthritis

Hiral Master[1], Grace Coleman[2], Fiona Dobson[3], Kim Bennell[3], Rana S. Hinman[3], Jason T. Jakiela[4], and Daniel K. White[4]

ABSTRACT. Knee osteoarthritis (OA) is a serious disease and has no cure to date. Knee OA is a leading cause of functional limitation (e.g., difficulty walking). Walking speed is 1 method of quantifying difficulty with walking and should be assessed in clinical practice for adults with knee OA because it has prognostic value and is modifiable. Specifically, slow walking speed is associated with increased risk of adverse health outcomes, including all-cause mortality in adults with knee OA and can be modified by engaging in physical activity or exercise. However, at present, there is little consensus on the distance and instructions used to conduct the walk test. Distance is often selected based on space availability, and instruction varies, from asking the participants to walk at a comfortable pace versus as fast as possible. Therefore, the purpose of this narrative review is to summarize the measurement properties, strengths, and limitations of a fixed-distance walk test ≤ 40 meters in adults with knee OA. Good measurement properties in terms of reliability and validity were observed across the different testing protocols for fixed-distance walk test (i.e., any distance ≤ 40 m and fast- or self-paced). Therefore, clinicians and researchers can select a testing protocol that can safely and consistently be performed over time, as well as provide a practice trial to acclimatize the patients to the fixed-distance walk test.

Key Indexing Terms: knee osteoarthritis, outcomes, performance-based test, physical function, psychometrics, walking speed

Knee osteoarthritis (OA) is a leading cause of functional limitation, such as difficulty walking[1,2,3,4], and it affects over 250 million people worldwide[5]. Walking ability serves as an important indicator of overall health in adults with knee OA, given that adults who report difficulty walking have a 51% higher risk for all-cause mortality compared to those with no difficulty[6]. Walking speed is one method of quantifying difficulty with walking. Slow walking speed is associated with a variety of health outcomes, including disability, prolonged hospitalization, and all-cause mortality in well-functioning older adults[7,8,9,10,11] and other patient populations, such as those with stroke and spinal cord injury[12,13,14]. For this reason, walking speed is considered a "functional" vital sign of overall health[10,15]. Additionally, engaging in physical activity or exercise improves walking speed and minimizes the risk of developing walking difficulty[16,17,18]; these are important for the knee OA population given that no cure has been found to date. Therefore, walking speed should be assessed in clinical practice for adults with knee OA because it is modifiable and has prognostic value.

There are different protocols for walk tests, specifically a fixed-duration [6-min walk test (6MWT)], fixed-distance (8-foot, 10-meter, or 20-meter walk test), or walk tests with incremental speed (shuttle walk test). In this review, we will focus only on a fixed-distance walk test ≤ 40 meters because it measures the ability to walk over short distances, an activity commonly restricted in adults with knee OA. Fixed-distance walk tests measure the time needed to ambulate over a specific distance. Participants are instructed to walk either at a comfortable/usual pace [self-paced walk test (SPWT)] or as fast as possible [fast-paced walk test (FPWT)]. Walking speed can then be calculated by dividing the total distance by the total time taken to complete the test. Slower walking speed indicates worse

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[1]H. Master, PT, PhD, MPH, Department of Orthopaedic Surgery, Vanderbilt University Medical Center, Nashville, Tennessee, and Department of Physical Therapy, College of Health Sciences, University of Delaware, Newark, Delaware; [2]G. Coleman, BS, SPT, Department of Physical Therapy, College of Health Sciences, University of Delaware, Newark, Delaware; [3]F. Dobson, PT, PhD, K. Bennell, PT, PhD, R.S. Hinman, PT, PhD, Centre for Health, Exercise and Sports Medicine, Department of Physiotherapy, University of Melbourne, Melbourne, Australia; [4]J.T. Jakiela, MS, D.K. White, PT, ScD, MSc, Department of Physical Therapy, College of Health Sciences, University of Delaware, and Biomechanics and Movement Science Interdisciplinary Program, University of Delaware, Newark, Delaware, USA.

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Address correspondence to D.K. White, STAR Health Sciences Complex, 540 S. College Avenue Newark, DE 19713, USA. Email: dkw@udel.edu.

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physical function[11]. Both self-paced and fast-paced walk tests have been used in various patient populations, including those with and without musculoskeletal pain, and those with neurological diseases such as stroke[12,13,14].

To facilitate the use of walk tests, understanding its measurement properties is critical for both clinicians and researchers. From a clinical perspective, knowledge about psychometric properties will guide healthcare professionals to screen patients and assess their expected health, as well as describe whether patients have improved or worsened over time. For instance, it will help healthcare professionals to identify whether observed change is meaningful or considered as a measurement error. Comparing scores to normative values will help quantify walking impairments. From a research perspective, understanding the psychometric properties of walk tests will assist researchers in choosing the most reliable and responsive walk tests when selecting outcomes for clinical trials or observational studies.

The Osteoarthritis Research Society International (OARSI) recommends the 40-meter FPWT (40mFPWT) to assess physical function in adults with knee OA[19]. However, the distances and instructions utilized for conducting walk tests (i.e., participants are told to walk at comfortable pace vs as fast as possible) are variable. Distance is usually selected based on the space available within the clinical and research settings. To better facilitate the use of the walk test in research and clinical practice, there is a need to understand the psychometric properties and predictive elements of walking speed measured using fixed-distance walk tests. A systematic review on walk tests in knee OA was conducted in 2012[20]. Therefore, the purpose of this narrative review is to provide an up-to-date description of measurement properties of fixed-distance walk tests ≤ 40 meters in knee OA and discuss their strengths and limitations. A goal of this review is to encourage clinicians and researchers to make use of walk tests, given that they are quick and easy tests to utilize. Another goal is to provide insights on how to implement walk tests in the clinical and research settings based on the latest evidence. Additionally, an infographic has been created to provide a visual representation for the narrative review (Figure 1).

Methods

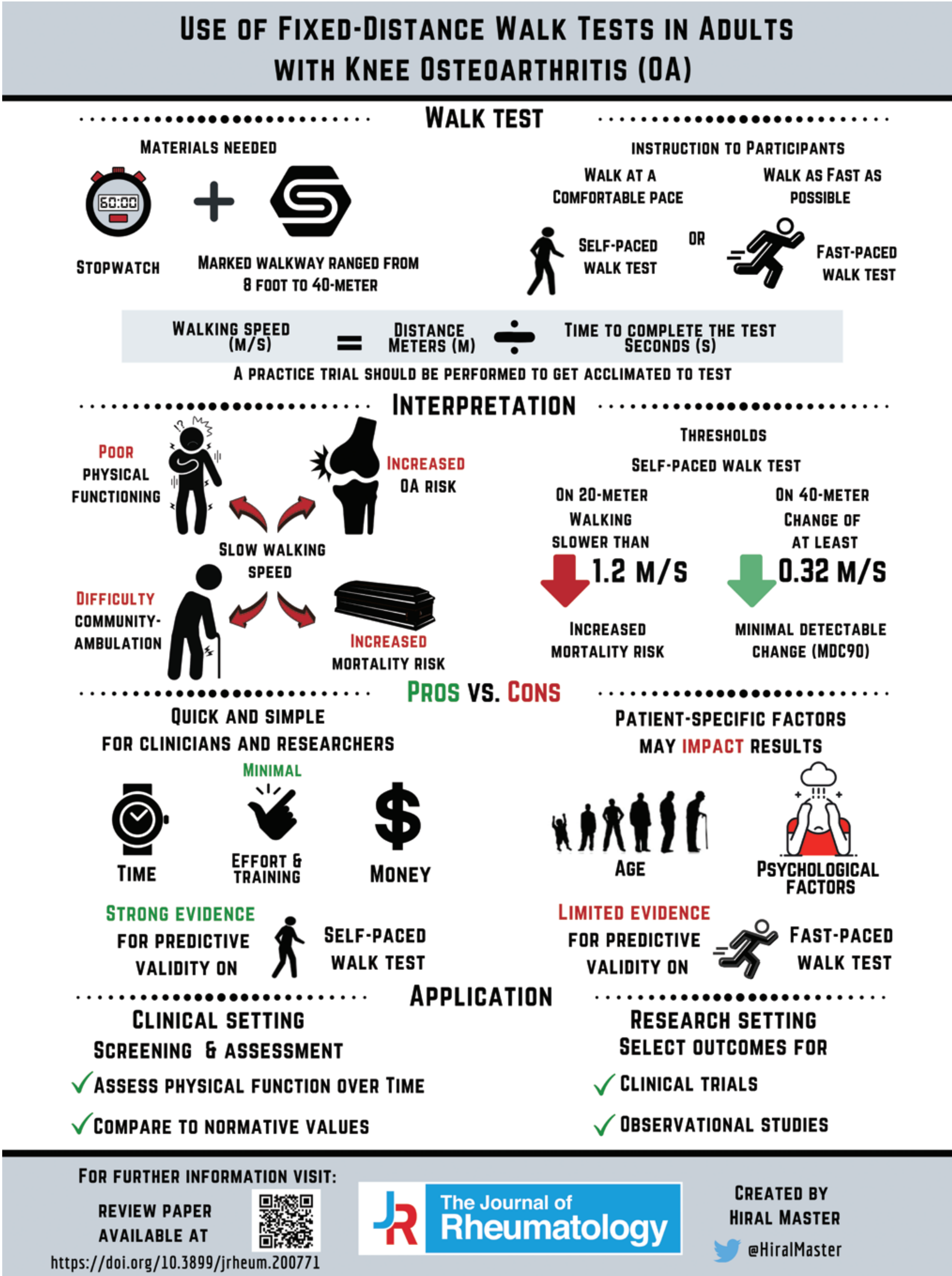
Relevant literature for articles investigating the measurement properties of walk tests in adults with knee OA were identified using targeted search in PubMed and Google Scholar. Broad searches were initially performed using "walk test" and "knee osteoarthritis" alone and in combination with several different terms, including "performance-based measures," "psychometric property," "reliability," "validity," "construct validity," "predictive validity," "health outcomes," and "measurement property." Only English-language articles indexed in PubMed or Google Scholar through August 2020 were included. Titles, abstracts, and full reports of the identified articles were screened for relevance. The articles were included in this review if they examined at least 1 measurement property of fixed-distance walk test ≤ 40 meters in adults with knee OA.

In this review, we examined the following measurement properties of walk tests of varying distances in adults with knee OA: reliability, validity, measurement error, and responsiveness.

- Reliability refers to the consistency of the walk test. Specifically, test-retest reliability examines the reproducibility of the test results across different (interrater) and/or same (intrarater) examiners over multiple sessions, which can be evaluated using intraclass correlation coefficients (ICC)[21].
- Construct validity examines the relationship of the walk test to another test of physical function or purported constructs, which can be evaluated using a correlation coefficient. Predictive validity provides information regarding the ability of the test to predict future health outcomes, including mortality[21].
- The standard error of measurement (SEM) is the amount of error that reflects the measurement error of the walk test. SEM is the dispersion around the true value for the walk test. Minimal detectable change (MDC) is the minimum amount of change, beyond measurement error, necessary to ensure that the change was not due to random variability[21].
- Responsiveness is the ability of the test to identify clinically relevant or meaningful change following an intervention, or over time. This can be determined using test scores anchored to patient-reported or provider-reported thresholds, and interpreted using the minimum clinically important difference (MCID)[22].

Quality review of the literature

The methodological quality of the studies included in the review was investigated using the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) checklist[23]. This appraisal was performed only for studies that investigated the following measurement properties: reliability, construct validity, measurement error, and responsiveness. We acknowledged that the COSMIN checklist was originally developed to investigate the methodological quality of each measurement property for patient-reported outcome measures. However, since its inception, the checklist has been used to evaluate methodological quality for performance-based measures including walk tests[20,24]. We used the checklist to evaluate reliability, construct validity, measurement error, and responsiveness when reported by the included studies. Each measurement property contains items related to study design and statistical methods that can be used to assess whether a study on a specific measurement property meets the standard for good methodological quality. Each item is rated as excellent, good, fair, or poor. We utilized a similar scoring approach that was taken by Dobson, *et al*[20]. Specifically, in agreement with the COSMIN developers, the authors chose to use the "second worst score counts" method, as several of the studies would be appraised as "poor" based on small sample size. We reported the scoring as "+" for positive, "?" for indeterminate, and "–" for poor ratings. The detailed methodology for determining positive, indeterminate, and poor rating for each psychometric properties of the walk tests has been published in a previous study by Dobson, *et al*[20]. "NR" (not reported) was used if the specific measurement property was not reported or investigated in the study.



USE OF FIXED-DISTANCE WALK TESTS IN ADULTS WITH KNEE OSTEOARTHRITIS (OA)
WALK TEST
MATERIALS NEEDED
60:00
STOPWATCH
MARKED WALKWAY RANGED FROM 8 FOOT TO 40-METER
INSTRUCTION TO PARTICIPANTS
WALK AT A COMFORTABLE PACE
WALK AS FAST AS POSSIBLE
SELF-PACED WALK TEST
OR
FAST-PACED WALK TEST
WALKING SPEED (M/S) = DISTANCE METERS (M) ÷ TIME TO COMPLETE THE TEST SECONDS (S)
A PRACTICE TRIAL SHOULD BE PERFORMED TO GET ACCLIMATED TO TEST
INTERPRETATION
POOR PHYSICAL FUNCTIONING
INCREASED OA RISK
SLOW WALKING SPEED
DIFFICULTY COMMUNITY-AMBULATION
INCREASED MORTALITY RISK
THRESHOLDS
SELF-PACED WALK TEST
ON 20-METER WALKING SLOWER THAN
1.2 M/S
INCREASED MORTALITY RISK
ON 40-METER CHANGE OF AT LEAST
0.32 M/S
MINIMAL DETECTABLE CHANGE (MDC90)
PROS VS. CONS
QUICK AND SIMPLE FOR CLINICIANS AND RESEARCHERS
TIME
MINIMAL EFFORT & TRAINING
MONEY
PATIENT-SPECIFIC FACTORS MAY IMPACT RESULTS
AGE
PSYCHOLOGICAL FACTORS
STRONG EVIDENCE FOR PREDICTIVE VALIDITY ON
SELF-PACED WALK TEST
LIMITED EVIDENCE FOR PREDICTIVE VALIDITY ON
FAST-PACED WALK TEST
APPLICATION
CLINICAL SETTING
SCREENING & ASSESSMENT
✓ASSESS PHYSICAL FUNCTION OVER TIME
✓COMPARE TO NORMATIVE VALUES
RESEARCH SETTING
SELECT OUTCOMES FOR
✓CLINICAL TRIALS
✓OBSERVATIONAL STUDIES
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Figure 1.

Results

An electronic broad search yielded 1012 abstracts, which were reviewed (by titles and abstracts) for relevance according to our inclusion criteria and 972 articles were subsequently excluded. This left a total of 40 articles for full review. After full review, including manual search of reference lists, 22 articles were subsequently excluded, given that they used fixed-time walk tests (e.g., 6MWT) or other performance-based measures (e.g., sit-to-stand test), or did not include the knee OA population). Thus, a total of 18 articles were included in this review, of which 12 articles described reliability, construct validity, and/or measurement error, and 6 articles described predictive validity of the fixed-distance walk test up to 40 meters in adults with, or at risk of, knee OA. The majority of the included studies only assessed 2 or fewer of the psychometric properties (17/18, 94.4%), while Tolk, *et al*[25] was the only study to assess 4 properties (reliability, construct validity, measurement error, and responsiveness). Gill, *et al* assessed 3 properties (reliability, construct validity, and measurement error) from the same sample (i.e., adults awaiting for hip/knee replacement as well), but these were reported in 2 separate articles[26,27].

Reliability. To determine the reliability of the walk test, 1 study used ICC1,1 (1-way random single measures)[26], 3 studies used ICC2,1 (2-way random single measures)[28,29,30], 1 study used ICC3,1 (2-way mixed single measures)[31], 3 studies used ICC (no information on type available)[25,32,33], and 1 study used Spearman correlation[34]. Good reliability has been seen in the 50-foot, 8-meter, 13-meter, 20-meter, and 40-meter walk tests. Specifically, the test-retest and/or intra-/interrater reliability for the 50-foot, 8-meter, and 40-meter FPWT were excellent, with ICC being > 0.9[25,26,29,30,31]. Two studies have shown good test-retest reliability for the 13-meter SPWT and 20-meter SPWT (20mSPWT), ICC > 0.9, or Spearman rho between the sessions being > 0.9[32,34]. A few studies reported improvement in test-retest reliability when the first trial was excluded from the analysis[26,29,34] (Table 1). Fransen, *et al*[29] investigated reliability for both SPWT and FPWT in the study. In this study, 1 test was conducted prior to each session where participants were instructed to walk at an unspecified pace. Regardless of whether it was fast-paced or self-paced, the reliability of a fixed-distance walk test ≤ 40 meters was excellent in adults with varying severity of knee OA (mild OA to those waiting for knee replacement surgery)[26,28,34]. Of the 9 studies that assessed reliability, 5 studies[25,26,28,31,35] had participants who used assistive devices/walking aids. However, the effects of the use of an assistive device on reliability were not fully explored.

Construct validity. Regardless of test distances, FPWT have shown good construct validity with other known measures of physical function [i.e., 30-second chair stand test, 36-item Short Form Health Survey (SF-36) physical function scale, quadriceps strength, SF-36 physical component summary scale, Western Ontario and McMaster Universities Arthritis Index (WOMAC) function, and Lower Extremity Functional Scale[27,32,35,36]; Table 1]. One study by Tolk, *et al*[25] found that the 40mFPWT had limited construct validity (Spearman rho of 40mFPWT with Knee injury and Osteoarthritis Outcome Score-Physical Function Short Form < 0.3). However, the same study found a moderate to strong correlation between the 40mFPWT and quadriceps strength (Spearman rho > 0.6)[25]. The evidence for SPWT was limited, although a study conducted by Bacon, *et al*[37] showed that quadriceps strength and 20mSPWT may have nonlinear relation in adults with symptomatic knee OA.

Predictive validity. Slow walking speed can predict incident symptomatic and radiographic knee OA in community-dwelling participants[38]. Further, slow walking speed was associated with increased mortality risk[39] irrespective of the history of decline over the past 1 year in adults with knee OA[40], and indicates physical inability to engage in physical activity (i.e., walking fewer steps per day[41]; Table 2). However, evidence on predictive validity for FPWT is limited.

Walking slower than 1.2 m/s on a 20mSPWT and walking slower than 0.5 m/s on an 8-foot SPWT was predictive of all-cause mortality in adults with radiographic knee OA[39]. The risk of developing radiographic knee OA increases by 8% for every 0.1 m/s decline in walking speed over 1 year after accounting for age, knee injury, BMI, and Physical Activity Scale for the Elderly score[42]. Decline in walking speed over 1 year was associated with a 104% increase in risk of knee replacement in the following year compared to those without any change in walking speed[43].

Measurement error. SEM and/or MDC with a 90% CI (MDC_{90}) were reported for both SPWT and FPWT in adults with knee OA. Table 3 shows the values for the SEM and MDC_{90} for walk tests that were found in adults with knee OA. Specifically, the SEM and MDC_{90} for the 40mSPWT was 0.14 m/s and 0.32 m/s, respectively, in adults with endstage hip and knee OA[28]. SEM and MDC_{90} for the 10-meter FPWT were 0.10 m/s and 0.28 m/s, respectively, in adults with hip or knee OA or following joint replacement[30].

Responsiveness. Tolk, *et al*[25] reported that the 40mFPWT was responsive, given that at least 75% of the hypothesis on the correlation between the change scores in the walk test and anchor question were confirmed. However, we did not find the evidence for responsiveness for SPWT in adults with knee OA.

Appraisal of methodological quality of studies included in this review. We used the COSMIN checklist[23] to evaluate the methodological quality of the included articles and determined that all studies met either an indeterminate or positive rating if the property was assessed. Table 4 displays the rating for each specific property reported by the articles. Twelve individual articles were appraised for methodological quality for the following measurement properties: reliability, construct validity, measurement error, and responsiveness only. For reliability, we rated 8 articles as positive (66.7%), 1 as indeterminate (8.3%), and 3 could not be rated as they did not include the appropriate metric (25%). For construct validity, 4 articles were appraised as positive (36.4%) and 1 article was appraised as indeterminate (9.1%), while the remaining 7 articles did not report on construct validity (54.5%). For measurement error, 6 articles were rated as

Table 1. Reliability and validity of walk test in adults with knee osteoarthritis (OA).

Study	Sample Size, n	Patient Population	Test Distance	Instruction	No. Trials	Use of Assistive Devices	Test-retest or Intra-/interrater Reliability: ICC or Spearman r (95% CI)	Comparator for Construct Validity	Construct Validity, r (95% CI)
Motyl, *et al*[34]	15	Mild to moderate OA	20-m	Walk tests were conducted at a self-selected pace[a]	· 2 trials/session[b] · 2 sessions/visit · 2 visits 8–20 days apart	Participants who used assistive devices were not included in the study	Within day[c]: · Day 1, session 1 0.94 (0.83–0.98) ·Day 1, session 2 0.90 (0.72–0.97) · Day 2, session 3 0.97 (0.91–0.99) Between day[c]: · Session 1 and 3 0.78 (0.45–0.92) · Session 2 and 3 0.95 (0.85–0.98)		
Gill, *et al*[26,27]	82	People awaiting hip/knee replacement surgery	50-ft	"Go as fast as you can safely walk"	4 trials[b]	Use of walking aid was allowed but effects on measurement properties NA	0.97 (0.90–0.98)[26 d]	· 30-CST[27] · SF-36 PF[27] · SF-36 PCS[27] · WOMAC function[27]	· −0.64 (−0.75 to −0.49) · −0.39 (−0.56 to −0.19) · −0.38 (−0.55 to −0.17) · 0.42 (0.23 to 0.58)
Kennedy, *et al*[28]	21	Endstage hip and knee OA	40-m	"Walk as quickly as you can without overexerting yourself"	3 assessments	Use of walking aid was allowed but effects on measurement properties NA	0.91 (0.81–0.97)		
Fransen, *et al*[29]	41	Adults with knee OA	8-m	First 5 trials: "walk at a pace that you consider to be normal" Next 5 trials: "walk at a pace that you consider to be fast"	· 5 trials at normal pace and next 5 trials at fast pace[b] · 45–60 s pause between each trial	None of the participants used a walking aid for indoor ambulation	First 5 trials: 0.93 (0.88–0.96)[d] Next 5 trials: 0.93 (0.90–0.96)[d]		
Stratford, *et al*[35]	93	Patients awaiting total hip or knee arthroplasty	20-m	"Walk as quickly as you can without overexerting yourself"	NA	Use of walking aids was permitted but effects on measurement properties NA	–	Lower Extremity Functional Scale	0.44 (0.26–0.59)
Marks[32]	15	Knee OA	13-m	"Walk with ordinary shoes at their normal comfortable walking pace"	· 2 trials/session · 2-min rest pause between trials · 2 session 1 week apart	0 participants used walking aids	Within day: 0.98[e] Between day: 0.80[e]	Lequesne Index of Severity for Knee OA	0.65

TTable 1. Continued.

Study	Sample Size, n	Patient Population	Test Distance	Instruction	No. Trials	Use of Assistive Devices	Test-retest or Intra-/interrater Reliability: ICC or Spearman r (95% CI)	Comparator for Construct Validity	Construct Validity, r (95% CI)
Dobson, *et al*[30]	51	Hip or knee OA, or following joint replacement	40-m	"Walk as quickly but as safely as possible, without running"	· 1 trial/session · 2 sessions 1 week apart	Participants ambulated independently in the community (i.e., no walking aids)	Within-rater reliability 0.92 (0.82–0.96)		
Dobson, *et al*[30]	51	Hip or knee OA, or following joint replacement	10-m	"Walking as quickly as possible, without running"	1 trial/session 2 sessions 1-week apart	Participants ambulated independently in the community (i.e., no walking aids)	Within-rater reliability 0.88 (0.80–0.93)		
Tolk, *et al*[25]	30 (reliability), 85 (validity)	Knee OA patients indicated for total knee arthroplasty	4 × 10-m	"Walk as quickly but as safely as possible, without running"	For reliability assessment: 2 trials 20 min apart	2 participants used walking aids during the test	0.93 (0.85–0.96)	· KOOS-PS · OKS · Quadriceps strength	· −0.25 · 0.32 · 0.64
Villadsen, *et al*[33]	20	Severe hip or knee OA	20-m	1st two trials: "walk with their usual pace" Next 2 trials: "walk at the maximal pace in which they felt secure"	2 trials at usual pace and next 2 trials at fast pace	NA	1st two trials: 0.93 For next 2 trials: 0.98		
Holm, *et al*[31]	40	Radiographic and/or symptomatic knee OA	40-m	"Walk as fast as possible without compromising safety"	· 1 trial/session · 2 sessions 3 days apart	3 participants used canes while performing the walk test	Between 2 sessions: 0.98 (0.96–0.99)		
Luc-Harkey, *et al*[36]	76	Symptomatic and radiographic tibiofemoral OA	20-m	"Walk as quickly as possible from one set of cones to the other and to continue walking through the finish line before stopping"	3 trials	Participants who used assistive devices were not included in the study		· Quadriceps strength (involved limb) · Bilateral quadriceps strength	· 0.54[f] · 0.32[f]

95% CI are reported in table if they were reported in the evidence. [a] "If participant began to walk at a pace that was obviously not their normal self-selected walking speed as determined by the assessor (e.g., running or jogging), the test was immediately stopped"[34]. [b] Practice trial recommended. [c] The effect estimates were computed using Spearman correlation, specifically for within-session reliability. [d] Reliability improved when first trial was removed. [e] 95% CI was not reported, but SE was reported (SE: 0.46 for within day and 1.10 for between day). [f] Represents beta coefficient obtained from the regression model, when walking speed was dependent variable and comparator was independent variable. 30-CST: 30-second chair stand test; ICC: intraclass correlation coefficient; KOOS-PS: Knee injury and Osteoarthritis Outcome Score–Physical Function Short Form; NA: not available; OKS: Oxford Knee Score; PCS: physical component summary scale; SF-36 PF: 36-Item Short Form Health Survey physical function scale; WOMAC: Western Ontario and McMaster Universities Arthritis Index.

Table 2. Predictive validity of self-paced walk test in community-dwelling older adults and adults with knee osteoarthritis (OA).

Study	Sample Size	Patient Population	Walk Test	Outcome
Purser, *et al*[38]	1858	Community-dwelling adults	8-ft	Walking 0.1 m/s slower was associated with a greater incidence of radiographic and symptomatic knee OA
Master, *et al*[39]	4215	Adults with radiographic knee OA	20-m	Walking 0.2 m/s slower was associated with an increased mortality risk
Master, *et al*[39]	1244	Adults with radiographic knee OA	8-ft	Walking 0.2 m/s slower was associated with an increased mortality risk
Master, *et al*[40]	4229	Adults with or at risk of knee OA	20-m	Walking < 1.2 m/s was associated with an increased mortality risk, irrespective of decline over the past year
Master, *et al*[41]	1925	Adults with or at risk of knee OA	20-m	Walking 0.1 m/s slower indicates inability to walk at least 6000 steps per day
Herzog, *et al*[42]	1460	Adults without radiographic knee OA	20-m	Every 0.1 m/s decline in walking speed over 1 year increases the risk of developing radiographic knee OA
Harkey, *et al*[43]	4264	Adults with or at risk of knee OA	20-m	1-year decline in walking speed was associated with an increased risk of future incident knee replacement

Table 3. SEM and ability to detect change of walk test in adults with knee osteoarthritis (OA).

Study	Sample Size, n	Patient Population	Walk Test	SEM	MDC_{90}
Kennedy, *et al*[28]	21	Endstage hip and knee OA	40-m SPWT	0.14 m/s	0.32 m/s
Dobson, *et al*[30]	51	Hip or knee OA or following joint replacement	10-m FPWT	0.10 m/s	0.28 m/s
Dobson, *et al*[30]	51	Hip or knee OA or following joint replacement	40-m FPWT	0.07 m/s	0.19 m/s
Gill, *et al*[26]	82	People awaiting hip/knee replacement surgery	50-ft FPWT	1.32 s	3.08 s
Tolk, *et al*[25]	30	Knee OA patients indicated for total knee arthroplasty	4 × 10-m FPWT	0.10 m/s	
Villadsen, *et al*[33]	20	Severe hip or knee OA	20-m SPWT		1.7 s
Villadsen, *et al*[33]	20	Severe hip or knee OA	20-m FPWT		0.9 s
Holm, *et al*[31]	40	Radiographic and/or symptomatic knee OA	40-m FPWT	0.2 m/s	

FPWT: fast-paced walk test; MDC_{90}: minimal detectable change at 90% CI; SEM: standard error of measurement; SPWT: self-paced walk test.

Table 4. Appraisal of the methodological quality of the included studies using the COSMIN checklist.

First Author	Sample Size, n	Walk Test	Reliability	Construct Validity	Measurement Error	Responsiveness
Motyl, *et al*[34]	15	20-m SPWT	?	NR	NR	NR
Gill, *et al*[26]	82	50-ft FPWT	+	NR	+	NR
Gill, *et al*[27]	82	50-ft FPWT	NR	+	NR	NR
Kennedy, *et al*[28]	21	40-m FPWT	+	NR	+	NR
Fransen, *et al*[29]	41	8-m SPWT 8-m FPWT	+	NR	NR	NR
Stratford, *et al*[35]	93	20-m FPWT	NR	+	NR	NR
Marks[32]	15	13-m SPWT	+	+	NR	NR
Dobson, *et al*[30]	51	40-m FPWT 10-m FPWT	+	NR	+	NR
Tolk, *et al*[25]	30 (reliability and measurement error), 85 (validity), 70 (responsiveness)	4 × 10-m FPWT	+	?	+	+
Villadsen, *et al*[33]	20	20-m SPWT 20-m FPWT	+	NR	+	NR
Holm, *et al*[31]	40	40-m FPWT	+	NR	+	NR
Luc-Harkey, *et al*[36]	76	20-m FPWT	NR	+	NR	NR

+: positive rating; ?: indeterminate rating; COSMIN: COnsensus-based Standards for the selection of health Measurement INstruments; FPWT: fast-paced walk test; NR: not reported; SPWT: self-paced walk test.

positive (50.0%) and 6 articles did not receive a rating (50.0%). Only 1 article, which was rated positive (100%), assessed responsiveness in adults with knee OA.

Discussion

In this narrative review, we found that there were inconsistencies in the testing protocol for fixed-distance walk tests up to 40 meters. However, regardless of the variability in distance and instructions used to conduct the test, they were reliable in the knee OA population. FPWT have good construct validity and were responsive, whereas SPWT have good predictive validity. Specifically, slow walking speed (measured using self-paced fixed-distance walk tests) was associated with an increased risk of mortality in knee OA and increased the risk of developing radiographic and symptomatic knee OA. Good measurement properties, in terms of reliability and validity, were observed across the different testing protocols. Hence, clinicians and researchers can likely select a testing protocol that can safely and consistently be performed in a clinical or research setting, and be assured that it will likely perform well. We have summarized methods, interpretation, pros/cons, and the application of fixed-distance walk tests in an infographic (Figure 1).

We found that the reliability of the walk test was good in adults with varying severity of knee OA[26,28,34], regardless of the distance and instructions used to conduct the test. However, the reliability may be affected by the number of trials. For both SPWT and FPWT, reliability improved when the first trial was removed[26,29,34]. The first trial may serve as a practice trial and may facilitate the adults with knee OA to get acclimated to the test; this may explain the improvement in the reliability. Therefore, it is recommended to administer practice trials in clinical and research settings to obtain reliable values for both SPWT and FPWT.

Walk tests are relatively easy for clinicians and researchers to administer and can be conducted in most clinical/research settings. The equipment needed includes a marked walkway, stopwatch, and tape measure. Further, scoring on most tests allows the use of assistive devices by patients if needed. However, it is important to note that the protocol used to conduct the walk test and information regarding the scoring needs to be documented and kept consistent for repeated measurements. The respondent and administrative burden is minimal, given that tests can be completed in less than 5 minutes, and no specialized training is needed to conduct the test. Further, they can be administered and adapted to any language. Normative comfortable walking speed values based on age range from 20–79 years are published[44]. A recent study showed reference values (by sex, age, Kellgren–Lawrence grade, or BMI) for walking speed measured using the 20-minute walk test[45]. Given walk tests are a performance-based measure, they are not subject to the same limitations as using patient-reported physical function measures, such as recall bias[46]. Though the evidence on the MCID for the walk test is not established in the knee OA population, previous studies in older adults have shown that the SPWT has the ability to detect clinically meaningful change. Specifically, Kwon, *et al*[47] found the change of 0.08 m/s on the 4-meter SPWT as clinically meaningful change in sedentary adults aged 70–89 years.

Strengths and limitations. The major strengths of walk tests are that they are valid, have good test-retest reliability in adults with knee OA, and have good predictive validity for health outcomes in older adults. This test has shown to predict health outcomes, including the ability to be physically active, and mortality in adults with knee OA. Further, it is easy to administer and interpret, requires little equipment and/or training, and is thus inexpensive. However, there are several limitations. First, there is little consensus regarding the distance to be used for the test and whether participants were instructed to turn around while testing. This, in turn, can affect the acceleration and deceleration phases needed to complete the walk test. Prior studies caution against using walking speed values interchangeably for short- versus standard-distance walk tests (i.e., 4-m vs 20-m or 10-m)[48,49,50]. Thus, we caution against generalizing the evidence regarding walking speed measured using different test distances and instructions. Second, prior studies have shown that age, race, psychological factors (e.g., depression), and disease severity are associated with slower walking speed[51,52,53,54]. Therefore, patient-specific factors should be accounted for when interpreting walking speed values. Third, there are limited construct validity studies for SPWT; however, the predictive validity of the SPWT is strong. On the contrary, construct validity studies for the FPWT are extensive, but there is limited evidence on predictive validity in the knee OA population. Therefore, further research is needed to investigate the psychometrics for both SPWT and FPWT. Last, the focus of this review was on a fixed-distance walk test ≤ 40 meters. Therefore, future research or review on measurement properties on fixed-duration walk tests (e.g., 6MWT) or fixed-distance walk test > 40 meters in knee OA population is needed.

Summary

Regardless of test distances, walk tests are recommended to objectively assess walking difficulty in adults with varying degrees of knee OA (mild to endstage knee OA) for clinical and research purposes. However, there is a need to highlight the distance used to measure walking speed as well as whether the walk test was conducted at a comfortable or fast pace in research studies so the thresholds indicative of poor health outcomes can be applied appropriately. Healthcare providers should stick with the testing protocol (best suited as per the space availability) and use it over time to ensure the walk test's reliability and ability to interpret change. Further, when possible, a practice trial may be considered to acclimatize the patients to the fixed-distance walk test.

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