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The Validity, Reliability, Measurement Error, and Minimum Detectable Change of the 30-Second Fast-Paced Walk Test in Persons with Knee Osteoarthritis: A Novel Test of Short-Distance Walking Ability

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Objective. To develop and establish the reliability, validity, measurement error, and minimum detectable change of a novel 30-second fast-paced walk test (30SFW) in persons with knee osteoarthritis (OA) that is easy to administer and can quantify walking performance in persons of all abilities.

Methods. Twenty females with symptomatic knee OA (mean age [SD] 58.30 [8.05] years) and 20 age- and sex-matched asymptomatic controls (57.25 [8.71] years) participated in the study. Participants completed questionnaires of demographic and clinical data, the Knee Injury and Osteoarthritis Outcome Score (KOOS), and the 36-item Short Form Health Survey (SF-36) followed by 30SFW performance. Participants returned 2-7 days later and performed the 30SFW again.

Results. The knee OA group reported function that was worse than controls (all KOOS subscales; $P < 0.0001$). The 30SFW intrarater and interrater reliability were excellent [$ICC_{(2,1)}$ = 0.95-0.99]. Knee OA participants walked a shorter distance in the 30SFW than controls (mean [SD]: OA 44.4 m [9.5 m]; control 58.1 m [7.8 m]; $P < 0.0001$). Positive strong correlations were found between the 30SFW and the KOOS–Activity of Daily Living, SF-36-Physical Functioning, and SF-36-Physical Health Composite scores ($P < 0.0001$). A nonsignificant, weak correlation between 30SFW and SF-36-Mental Health scores was present ($r = 0.32$, $P = 0.05$).

Conclusion. The 30SFW has excellent intrarater and interrater reliability. The 30SFW demonstrated excellent known groups, convergent, and discriminant validity as a measure of short-distance walking ability in persons with knee OA. Clinicians and researchers should consider using the 30SFW to quantify walking ability in persons with knee OA and assess walking ability change.

INTRODUCTION

Knee osteoarthritis (OA) is a growing public health problem and a leading contributor to disability worldwide (1). Approximately 14 million adults in the United States have symptomatic knee OA, which is a cause of pain, reduced walking ability, and participation restriction (2,3). The presence of symptomatic knee or hip OA was the strongest contributor to self-reported walking difficulty of all chronic health conditions in adults 55 years or younger (4). Reduced walking ability is proposed to cause reduced physical activity, which is a risk factor for death that is due to cardiovascular disease (5–7).

Because reduced walking ability may result in disability and early mortality, it is critical that health care providers and researchers have valid, reliable, and easily administered outcome measures of walking ability. Although patient-reported outcome measures for physical function are available, patient-reported results for walking ability are determined predominantly by pain intensity rather than physical walking performance (8,9). Measurement of actual walking ability with reliable, valid physical performance measures (PPMs) is critical to quantitatively assess walking ability in persons with knee OA. Currently, there is no PPM of walking ability that is reliable and valid in persons with knee OA across the spectrum of pain severity (10,11).

Current PPMs for short-distance walking are based on time to walk a set distance and cannot be used by those unable to complete the required distance (floor effect) (12). Importantly,

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SIGNIFICANCE & INNOVATIONS

- Symptomatic knee osteoarthritis (OA) is one of the strongest contributors to reduced walking ability, a cause of reduced physical activity, and participation restriction. Therefore, it is vital that clinicians and researchers have valid and reliable physical performance measures (PPMs) of walking ability for persons with knee OA that do not require large time or space requirements.
- This study shows that the 30-second fast-paced walk test (30SFW) is a reliable and valid measure of short-distance walking ability in persons with knee OA. The 30SFW is the first PPM to evaluate short-distance walking ability with evidence for both reliability and validity as well as minimum detectable change.
- The 30SFW is feasible for use in clinical, research, and community settings to quantify walking ability for persons with knee OA. This PPM requires minimal time, space, and special equipment.

current PPMs for walking distance are difficult to conduct in clinical settings because of the requirement for straight, unobstructed walkways of 20 m or more in length (12). The Osteoarthritis Research Society International (OARSI) recommended that a PPM of short-distance walking based on time be developed and validated for persons with knee OA (12). Such a PPM would be useful as a measure of an individual's walking ability and to assess response to interventions. The objective of this study was to develop and establish the reliability, validity, measurement error, and minimum detectable change (MDC) of a novel 30-second fast-paced walk test (30SFW) for persons with knee OA that is easy to administer and can quantify walking performance in persons of all abilities. We hypothesized that 1) the 30SFW would demonstrate excellent intrarater (test-retest) and interrater reliability evidenced by an intraclass correlation coefficient (ICC) that is 0.91 or greater; 2) that the 30SFW would demonstrate convergent construct validity evidenced by strong correlations ($r \geq 0.60$) between 30SFW scores and patient-reported physical function scores; 3) that the 30SFW would demonstrate discriminant construct validity evidenced by weak correlations ($r \leq 0.39$) between 30SFW and a patient-reported mental health score; and 4) that the 30SFW would demonstrate known groups construct validity evidenced by a significant difference ($P < 0.05$) in scores on the 30SFW between knee OA and asymptomatic control groups (13).

METHODS

Participants. Twenty participants with symptomatic knee OA and 20 age- and sex-matched asymptomatic control subjects participated in the study. An a priori power analysis based on $ICC_{2,1}$ for intrarater and interrater reliability indicated that a minimum of 16 participants were required in order to achieve an optimal ICC of 0.91 and a minimally acceptable level of reliability of 0.70 at the 0.05 significance level and power of 0.80. For the validity analysis, a minimum of 15 participants were required in order to achieve a Pearson correlation coefficient of 0.85 and a minimally acceptable correlation of 0.5 at a significance level of 0.05 and power 0.80. In order to account for potential dropouts, 20 participants with knee OA and 20 asymptomatic control participants were recruited (Table 1). Inclusion criteria for the knee OA group were as follows: age 40-75 years, self-reported physician's diagnosis of knee OA, knee pain in one or both knees most days of the month for at least one month in the previous year, and the ability to walk without an assistive device. Inclusion criteria for the control group were as follows: age 40-75 years, no physician-diagnosed knee OA, no reported knee pain on most days of the month for 1 month in the previous year, and the ability to walk without an assistive device. Exclusion criteria for both groups included pregnancy, known OA of other lower-extremity joints, history of lower-extremity arthroplasty or osteotomy, other neuromusculoskeletal or systemic conditions that may cause knee pain or limit walking performance, knee injections within the previous 30 days, and any medical or physical condition that would make walking quickly contraindicated. Participants were recruited from the Thomas Jefferson University (TJU) Hospital and Mercy Fitzgerald Hospital physical therapy clinics as well as through advertisements at TJU and the University of the Sciences in Philadelphia. The study was approved by the Institutional Review Boards of the University of the Sciences, Mercy Fitzgerald Hospital, and TJU. The research was performed in accordance with the Declaration of Helsinki, and all participants signed a written informed consent prior to inclusion in the study.

Patient-reported outcome measures. Construct validity testing was performed by comparing 30SFW scores to participant scores on three subscales of two patient-reported outcome measures (PROMs). The Knee Injury and Osteoarthritis Outcome Score (KOOS) is a knee-region–specific PROM for use with persons with knee OA or injuries that may cause knee OA (meniscal or anterior cruciate ligament tears, etc) (14). The KOOS has five subscales, including the Activity of Daily Living (ADL) subscale (KOOS-ADL); each subscale is scored out of 100, and higher scores indicate better status. The KOOS has been shown to be reliable and valid to assess health status in persons with knee OA (15).

The Rand Medical Outcomes Study 36-item Short Form Health Survey (SF-36) is a general quality-of-life PROM with eight subscales, including physical functioning (SF-36-PF) and mental health (SF-36-MH) subscales (16). A Physical Health Composite Summary score of the SF-36 (SF-36-PHC) can be calculated using scores from four subscales (physical functioning, role limitations due to physical health, bodily pain, and general health) (17). The SF-36 has been shown to be reliable and valid as a measure

Table 1. Demographic characteristics of participants

Descriptor	OA (n = 20)	Control (n = 20)	*P* Value[a]
Age, y			
Mean ± SD	58.30 ± 8.05	57.25 ± 8.71	0.63[b]
Range	44-72	44-74	
Race			
African American/Black	10 (50.00%)	5 (25.00%)	
Asian	0 (0%)	1 (5.00%)	
Caucasian	10 (50.00%)	14 (70.00%)	0.19[c]
Average pain[d]			
Median (IQR)	5 (3, 7)	0 (0, 0)	<0.0001[e]
Current pain[d]			
Median (IQR)	4.5 (1, 6)	0 (0, 0)	<0.0001[e]

Abbreviation: IQR, interquartile range; OA, osteoarthritis
[a]All *P* values are two-sided; [b]*P* value from two-sample *t* test; [c]*P* value from Fisher's exact test; [d]Numeric pain rating, 0-10 with 0 = no pain and 10 = maximal pain; [e]*P* value from Wilcoxon rank-sum test.

of quality of life and perceived function in persons with knee OA (18,19). Each subscale and composite summary score is scored out of 100, with higher scores indicating better status.

Study instrument and procedure. Six physical therapists and one physical therapist assistant conducted all tests and were trained in the procedure by the principal investigator. After signing the written consent form, participants completed questionnaires of demographic and clinical data, the KOOS, and the SF-36. Participants then performed the 30SFW test, in which examiners used a standardized script of verbal instructions. Participants stood with the front of their shoes on a starting line and were instructed as follows: "Walk the farthest distance you can by walking at a fast, but safe, speed for 30 seconds. I will tell you when to begin and keep walking until I say 'Stop.' To tell you when to begin, I will count down from 3. Are you ready? 3-2-1-Go!" Participants performed one practice trial at a moderate pace; two scored trials at a fast pace were performed with a 5-minute rest between scored trials. Participants rated any knee pain before and after each scored trial with a numeric pain rating (0-10, 0 = no pain, 10 = maximal pain). The numeric pain rating scale has been found to be a valid and reliable measure of pain intensity in adults with arthritis (20). The distance walked in 30 seconds was measured with a measuring wheel from the starting line to the front of the foot that was in contact with the ground at 30 seconds and was farthest from the start. The 30SFW test result was the greater distance walked of the two scored trials. Participants returned 2-7 days following the first session and performed the 30SFW according to the same procedure and with the same examiner as at the first session. A second examiner measured the distance walked in each scored trial at one of the two test sessions.

Statistical analysis. The Rand SF-36 subscale and composite summary scores were calculated with custom formulas in an Excel (Microsoft) spreadsheet and are available in an appendix to an article by Laucis et al (17). Descriptive statistics were used to summarize demographic characteristics, pain measurements, KOOS scores, and SF-36 scores. Qualitative data were reported as percentages and numeric counts; quantitative data as means ± SD or median and interquartile range (IQR). Comparisons between groups were performed using Student's *t* tests if the data were normally distributed based on the Shapiro-Wilk test or by using the Wilcoxon rank-sum test if otherwise. Intrarater and interrater reliability were assessed using $ICC_{2,1}$ (21). Measurement error was assessed as the standard error of measurement (SEM) and calculated as $SD \times \sqrt{1 - ICC}$ (21). The MDC was calculated at the 95% confidence level (MDC_{95}) with the formula $SEM \times 1.96 \times \sqrt{2}$. Convergent and discriminant construct validity were examined using Pearson's correlation coefficient and were evaluated using the guidelines by Evans (correlation levels: negligible = 0.00-0.19, weak = 0.20-0.39, moderate = 0.40-0.59, strong = 0.60-0.79, very strong = 0.80-1.00) (22).

Convergent validity was assessed by the presence of a hypothesized $r \geq 0.60$ between the 30SFW test score and scores on the KOOS-ADL, the SF-36-PF, and the SF-36-PHC (13). Discriminant validity was assessed by the presence of a hypothesized $r \leq 0.39$ between the 30SFW score and the score on the SF-36-MH (13). Known group validity was assessed by comparison of the 30SFW scores between groups with Student's *t* tests, 2-tailed, $P < 0.05$ (13). All statistical analyses were conducted using SAS software v.9.4 (SAS Institute Inc).

Post hoc analysis to calculate gait speed in meters per second was performed to enable comparison of study findings to previous research.

Table 2. Baseline KOOS subscale scores

Descriptor	OA (n = 20)	Control (n = 20)	*P* Value[a,b]
KOOS Pain			
Median (IQR)	59.72 (38.89, 72.22)	100 (100, 100)	<0.0001
KOOS Symptoms			
Median (IQR)	62.50 (48.21, 73.21)	100 (96.43, 100)	<0.0001
KOOS Activity of Daily Living			
Median (IQR)	63.24 (42.65, 88.24)	100 (100, 100)	<0.0001
KOOS Sport/Recreation			
Median (IQR)	37.5 (25, 50)	100 (100, 100)	<0.0001
KOOS Quality of Life			
Median (IQR)	43.75 (31.25, 62.5)	100 (100, 100)	<0.0001

Abbreviation: IQR, interquartile range; KOOS, Knee Injury and Osteoarthritis Outcome Score; OA, osteoarthritis.
[a]All *P* values are two-sided; [b]*P* value from Wilcoxon rank-sum test.

RESULTS

Participant characteristics. Baseline characteristics showed no significant difference between knee OA and control groups with respect to age or race ($P > 0.05$) (Table 1). The knee OA group had a significantly greater baseline average and current pain compared with the control group ($P < 0.05$) (Table 1). The knee OA group showed significantly lower scores in all KOOS measures ($P < 0.05$) (Table 2) and SF-36 scores except for SF-36 Role Function – Emotional and SF-36-MH ($P = 0.17$ and $P = 0.49$, respectively) (Table 3).

Reliability and measurement error. Intrarater (test-retest, between sessions) and interrater (within session) reliability

Table 3. Baseline SF-36 subscale scores

Descriptor	OA (n = 20)	Control (n = 20)	*P* Value[a,b]
SF-36 Physical Functioning			
Median (IQR)	55 (35, 80)	100 (97.5, 100)	<0.0001
SF-36 Role Function - Physical			
Median (IQR)	62.5 (0, 100)	100 (100, 100)	<0.0001
SF-36 Role Function - Emotional			
Median (IQR)	100 (83.33, 100)	100 (100, 100)	0.17
SF-36 Energy			
Median (IQR)	55 (37.5, 65)	80 (65, 85)	0.0009
SF-36 Mental Health			
Median (IQR)	84 (68, 92)	86 (78, 92)	0.49
SF-36 Social Functioning			
Median (IQR)	75 (62.50, 100)	100 (100, 100)	0.003
SF-36 Pain			
Median (IQR)	57.5 (33.75, 78.75)	90 (90, 100)	<0.0001
SF-36 General Health			
Median (IQR)	67.5 (60, 77.5)	90 (82.5, 95)	0.0001
SF-36 Physical Health Composite			
Median (IQR)	43.97 (33.11, 52.13)	59.52 (55.86, 61.04)	<0.0001
SF-36 Mental Health Composite			
Median (IQR)	49.23 (43.31, 58.56)	57.22 (53.98, 60.52)	0.008

Abbreviation: IQR, interquartile range; OA, osteoarthritis; SF-36 = 36-item Short Form Health Survey. [a]All *P* values are two-sided; [b]*P* value from Wilcoxon rank-sum test.

Table 4. Indicators for interrater and intrarater reliability ($ICC_{2,1}$), standard error of measurement, and minimum detectable change

Descriptor	Interrater $ICC_{(2,1)}$ (95% CI)	Interrater SEM (m)	Interrater $MDC_{.95}$ (m)	Intrarater $ICC_{(2,1)}$ (95% CI)	Intrarater SEM (m)	Intrarater $MDC_{.95}$ (m)
Overall	0.99 (0.99, 1.00)	0.29	0.80	0.97 (0.94, 0.99)	1.87	5.17
OA	0.99 (0.99, 1.00)	0.29	0.82	0.96 (0.87, 0.98)	2.05	5.67
Control	0.99 (0.99, 1.00)	0.28	0.79	0.95 (0.89, 0.98)	1.66	4.61

Abbreviation: CI, confidence interval; MDC, minimum detectable change; OA, osteoarthritis; SEM, standard error of measurement.

of the 30SFW test was examined with $ICC_{2,1}$. The results ranged from $r = 0.95$ to $r = 0.99$ and were found to be excellent. Table 4 presents $ICC_{2,1}$ values with 95% confidence intervals, SEM, and MDC_{95} values.

Convergent and discriminant validity. As hypothesized, there were significant strong positive correlations between the 30SFW test and the KOOS-ADL, SF-36-PF, and SF-36-PHC scores ($P < 0.05$) (Table 5). As hypothesized, the correlation between the 30SFW test and the SF-36-MH score was nonsignificant and weak ($r = 0.32$, $P = 0.05$) (Table 5).

Known groups validity. As hypothesized, the knee OA group walked a significantly shorter distance in the 30SFW compared with the control group ($P < 0.0001$) (Table 6). A very large effect size was found between the two groups (Cohen's *d* [95% CI], session 1: –1.58 [–2.29, –0.87]; session 2: –1.46 [–2.16, –0.76]), indicating a large negative effect of knee OA on distance walked in the 30SFW (Table 6). Prewalk and postwalk numeric pain ratings were significantly higher in the knee OA group than in the control group ($P < 0.0001$). However, the knee OA group prewalk to postwalk pain rating change was not significant ($P > 0.05$) (Table 6).

Post hoc analysis. Distance walked in the 30SFW at session one was divided by 30 seconds to determine gait speed. The mean (SD) gait speed for the knee OA group was 1.48 (0.32) m/s compared with 1.94 (0.26) m/s for the control group, which were significantly different (independent *t* test, 2-tailed, $P < 0.0001$). A very large effect size was found between the two groups (Cohen's *d* [95% CI], –1.58 [–2.29, –0.87]), indicating a large negative effect of knee OA on gait speed.

DISCUSSION

This study examined the 30SFW, a novel PPM of walking ability, in persons with knee OA compared with an asymptomatic control group. As hypothesized, the 30SFW had excellent interrater and intrarater (test-retest) reliability for persons with knee OA as well as asymptomatic individuals. Our hypotheses that the 30SFW as a test of walking performance would demonstrate excellent convergent, discriminant, and known groups construct validity were also supported. In addition, very large effect sizes were found for distance walked in the 30SFW and for gait speed, indicating that the presence of knee OA had a very large effect on distance walked and gait speed in the 30SFW (23).

Table 5. Thirty-second fast-walk test correlation analysis with patient-reported outcome measures

Patient-Reported Outcome Measure	Pearson Correlation	95% Confidence Interval	*P* Value[a]
KOOS-ADL	$r = 0.70$	(0.50, 0.83)	<0.0001
SF-36 Physical Functioning	$r = 0.69$	(0.48, 0.82)	<0.0001
SF-36 Role Function - Physical	$r = 0.60$	(0.35, 0.77)	<0.0001
SF-36 Role Function - Emotional	$r = 0.37$	(0.07, 0.61)	0.02
SF-36 Energy	$r = 0.55$	(0.29, 0.74)	0.0002
SF-36 Mental Health	$r = 0.32$	(0.006, 0.57)	0.05
SF-36 Social Functioning	$r = 0.51$	(0.23, 0.71)	0.0009
SF-36 Pain	$r = 0.69$	(0.48, 0.82)	<0.0001
SF-36 General Health	$r = 0.61$	(0.37, 0.77)	<0.0001
SF-36 Physical Health Composite	$r = 0.73$	(0.55, 0.85)	<0.0001
SF-36 Mental Health Composite	$r = 0.54$	(0.27, 0.73)	0.0004

Abbreviation: KOOS-ADL, Knee Injury and Osteoarthritis Outcome Score – Activity of Daily Living subscale; SF-36 = 36-item Short Form Health Survey.
[a]All *P* values are two-sided.

Table 6. Pain and distance walked measurements

Descriptor	OA (n = 20)	Control (n = 20)	*P* Value[a]
Session 1			
Prewalk NPR Median (IQR)	1.5 (0, 5.5)	0 (0, 0)	<0.0001[b]
Postwalk NPR Median (IQR)	1 (0, 4)	0 (0, 0)	<0.0001[b]
Post-Prewalk NPR Change Median (IQR)	0 (0, 0)	0 (0, 0)	0.65[b]
Post-Prewalk NPR Change Within-group *P* value	*P* = 1.00[c]	...	...
Distance (m) mean ± SD	44.37 ± 9.46	58.06 ± 7.80	<0.0001[d]
Distance effect size – Cohen's *d* (95% CI)			−1.58 (−2.29, −0.87)
Session 2			
Prewalk NPR Median (IQR)	1 (1, 4.5)	0 (0, 0)	<0.0001[b]
Postwalk NPR Median (IQR)	1 (0, 3.5)	0 (0, 0)	<0.0001[b]
Post-Prewalk NPR Change Median (IQR)	0 (0, 0)	0 (0, 0)	0.65[b]
Post-Prewalk NPR Change Within-group *P* value	*P* = 0.81[c]		
Distance (m) mean ± SD	45.80 ± 9.88	58.74 ± 7.71	<0.0001[d]
Distance effect size – Cohen's *d* (95% CI)			−1.46 (−2.16, −0.76)

Abbreviation: CI, confidence interval; IQR, interquartile range; NPR, numeric pain rating; OA, osteoarthritis;
[a]All *P* values are two-sided; [b]*P* value from Wilcoxon rank-sum test (between groups comparison); [c]*P* value from Wilcoxon signed rank test; [d]*P* value from Student's *t* test.

Reliability of walking performance of persons with knee OA is reported to be better for tests of fast-paced walking compared with usual-paced walking (24). A systematic review of PPMs for persons with knee and hip OA reported that there is limited evidence for reliability and measurement error for PPM of fast-paced walking (10). There was limited evidence for intrarater and interrater reliability for a 50-ft fast-paced walk test and for a 40-m fast-paced walk test for mixed populations of hip and knee OA participants who were awaiting total joint replacement (10,25,26). Current OARSI recommendations for a test of short-distance walking ability for persons with knee and hip OA is the 40-m fast-paced walk test, based on expert opinion, limited measurement property evidence, and feasibility of conducting this walk test (12). More recently, the reliability of the 40-m fast-paced walk test has been established for a mixed population of persons with knee and hip OA as well as a population of persons preceding total joint arthroplasty for knee OA (11,27). The reliability values for the 30SFW in the current study are higher than those reported for the 40-m fast-paced walk test (intrarater ICC = 0.92-0.93, interrater ICC = 0.96), yet both studies have excellent reliability (11,27). The higher interrater and intrarater reliability for the 30SFW may be due to differing test procedures. The 40-m fast-paced walk test procedure requires frequent starting and stopping of a stopwatch as participants walk beyond endpoints of a 10-m walkway, turn, and walk back across the walkway for a total of four repetitions. This requires an examiner to start or stop a stopwatch a total of eight times during the timed test, which may be a source of examiner error (28). Additional differing reliability results may be due to differing patient populations. The 30SFW was tested in a population of persons with symptomatic knee OA who were attending physical therapy or who were recruited from nonsurgical physician practices or from the community. The 40-m fast-paced walk test was examined in populations of persons at end-stage OA who were awaiting joint replacement, from a mixed population of persons with knee and hip OA, and a population of persons with end-stage knee OA (11,26,27).

To our knowledge, the current study is the first to report construct validity for a PPM of short-distance walking ability for persons with knee OA, reported to be an important construct to measure for persons with knee and hip OA (12). In addition to excellent convergent, discriminant, and known groups validity, the 30SFW test met 100% of the study hypotheses, demonstrating hypotheses testing construct validity. The systematic review of psychometric properties of PPM for knee and hip OA did not locate any studies with evidence of validity for short-distance walk tests (10). Gill et al

(13) examined the validity of several PPMs and PROMs in persons awaiting knee or hip joint replacement for OA. A 50-foot fast-paced walk test was found to have evidence for convergent validity that was due to moderate to high significant correlations with scores on the 30-second chair stand test, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)-Function subscale, SF-36-PF, SF-36-PHC, and Patient Specific Functional Scale (Spearman rho, $P < 0.01$ for all, $\rho = -0.64$, $\rho = 0.42$, $\rho = -0.39$, $\rho = -0.38$, $\rho = -0.36$, respectively). In the same study, there was also evidence of discriminant validity for the 50-foot fast-paced walk test that was due to nonsignificant weak association with the SF-36-MH (Spearman rho, $\rho = -0.12$, $P > 0.05$) (13). Evidence for known groups validity was reported due to significant differences between participants who required an assistive gait aid versus those who ambulated without an assistive device (independent t test, $P < 0.001$) (13). The results of the 30SFW test in the current study were similar to those found for the 50-foot fast-paced walk test for discriminant and known groups validity tests. However, for convergent validity testing, the correlations between 30SFW scores and the KOOS-ADL, SF-36-PF, and SF-36-PHC scores were all stronger than the correlations reported for convergent validity for the 50-foot fast-paced walk test. Interpreting magnitude of correlation is somewhat arbitrary (22), but the correlation levels reported by Gill et al (13) for their walk test would have been considered weak for the SF-36-PF, SF-36-PHC, and the Patient Specific Functional Scale according to levels proposed by Evans (22). Differing findings for convergent validity between our study and the study by Gill et al (13) may have been due to different test procedures and different patient populations. Participants in the study by Gill et al (13) were a mix of females and males (63% female), the average age was older than that of our participants (mean = 70.3 years [SD 9.8 years]), it contained a mix of persons with knee or hip OA, and the severity of OA was likely worse than that of our participants because they studied persons awaiting joint replacement surgery. More recently, the study by Tolk et al (11) reported that the 40-m fast-paced walk test did not meet the required level of 75% hypotheses test confirmation and thus did not demonstrate construct validity for walking ability (4 of 15 [27%] predefined hypotheses achieved) (11). Different findings for validity between the study by Tolk et al (11) and the current study may have been due to different test procedures, different participant sex (57% female in the earlier study), the older age of their participants (mean = 69.3 years [SD 8.2 years]), and that their participants were all awaiting joint replacement and thus were more likely to have severe knee OA.

Post hoc calculation of gait speed for participants in the current study was performed in order to allow comparison with previous studies that were anchored on distance. Participants in the current study walked faster than those in previous studies that examined gait speed for persons with knee or hip OA when walking 40 m or 50 ft (11,13,25,26). The difference in gait speed between studies may be due to the older average age of participants in previous studies, the fact that participants in previous studies were awaiting joint replacement so likely had more severe OA, the mixed samples of persons with knee and hip OA in previous studies, and different test procedures.

The 30SFW was found to be a reliable and valid PPM of short-distance walking ability in persons with knee OA. This novel PPM is feasible for use in research, in clinical settings, and in the community to quantify actual physical function. Minimal equipment is required; only a course, a stopwatch or timer, a measuring wheel, and tape or cones to mark the course are necessary. The course does not need to be an unobstructed 15-20 m walkway as required by previous PPMs of short-distance walking ability. This is important because smaller clinics, research labs, and community settings may not have this length of unobstructed walkway available. The course can be rectangular or oblong in shape and should not contain turns greater than a 90° angle so that participants do not need to slow down when making a turn. The time to conduct the test is short, making this feasible for busy clinicians and researchers. The time required to perform the 30SFW is the same as the time required to perform the 30-second chair stand test, one of the PPMs recommended by OARSI for use with persons with knee or hip OA (12). Using the reported MDC_{95} for distance walked on the 30SFW, clinicians and researchers can determine if true change has occurred for a patient or research subject, that is, a difference greater than measurement error.

This study has several limitations that must be considered. The sample size was small and no participants used assistive devices. Examiners were not blinded to participant group. Although it was not intended to be a study of only females, potential knee OA participants who met all study criteria were all female. We did not require diagnostic imaging and so are unable to comment on the radiographic degree of OA for study participants. Future research should examine psychometric properties of the 30SFW in males, those who use assistive devices during ambulation, those who have different pathologies, responsiveness, and determination of the minimum clinically important difference.

In conclusion, our findings show that the 30SFW is a reliable, valid measure of short-distance walking ability in persons with knee OA. It is the first PPM to measure this construct with evidence for both reliability and validity. It is feasible for use in clinics, research laboratories, and in the community, requiring little time, space, or special equipment. Clinicians and researchers should consider using the 30SFW to quantify walking ability of patients and research subjects as well as to determine if true change or difference is present.

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AUTHOR CONTRIBUTIONS

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