Balance Ability and Gait Speed in Female with Knee Osteoarthritis

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Abstract. Knee osteoarthritis (KOA) is commonly associated with impairments in balance and walking ability, which progressively worsen with age. This study aimed to describe balance ability using the Single Leg Stance Test (SLST) and gait speed using the 10-Meter Walk Test (10MWT), and to examine the correlation between these measures. A cross-sectional study was conducted among females aged 50–79 years with clinically diagnosed KOA. SLST and 10MWT were assessed and analyzed across three age groups (50–59, 60–69, and 70–79 years). SLST performance declined with advancing age, with mean ± SD values of 17.28 ± 9.40 s, 12.66 ± 8.30 s, and 10.07 ± 5.80 s, respectively. Similarly, gait speed decreased with age, with values of 1.05 ± 0.17 m/s, 1.00 ± 0.17 m/s, and 0.92 ± 0.14 m/s. A significant positive correlation was found between SLST and 10MWT ($r = 0.33$, $p < 0.05$). These findings indicate that females with KOA experience progressive declines in balance ability and gait speed, with a positive association between the two functional measures. Assessing both parameters in clinical practice is essential for early identification of functional limitations and for guiding individualized rehabilitation strategies in this population.

1 Introduction

Knee osteoarthritis (KOA) is widely reported as the major cause of functional disability due to the biomechanical alterations, which results in balance impairment and walking difficulty, particularly in female.[1] Evidence supports that females have a greater risk of developing Knee Osteoarthritis (KOA) than males. Prior study reported that symptomatic KOA was considered to be stronger contributor for walking difficulty. [1], [2] While walking, a person must carry 80 percent of their body weight on one leg for 60 percent of the gait cycle. This implies that the loading stress on the lower leg is four times of body weight.[3] People with KOA are likely to demonstrate compensate gait pattern to support body weight on one leg and produce less discomfort feeling by increasing double support time, wider step width, shorter stride length, and

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adopting a large postural sway, in which certainly result in slower walking speed. Performing activity daily function as well as social activities require proper balance ability and walking speed.[4] Changes in gait pattern affect the ability to overcome obstacles during walking, difficulties in shifting the centre of gravity, and poor standing balance recovery, which increased risk of fall and injury in people with KOA.[4], [5] Thus, they have a threat for future functional dependence and gradually declined the quality of life.

Walking speed and standing balance ability have been established as simple single measures to reflect the general health status, functional capacity, risk of fracture, predicts falls, as well as mortality and survival rates. [6], [7] Single leg stance test (SLST) and 10-meter walk test (10MWT) were widely used to assess standing balance ability and walking speed in KOA population due to its simple, less instrumented, and more feasible to apply in various settings. Despite the advantages of these simple measures, limited studies have reported the score of SLST and 10MWT in female with KOA which difficult to understand the deviation score from the normal value in their peer ages. Thus, this study aim to provide the information regarding balance ability and walking speed in female with KOA. Assessing both parameters in clinical practice is essential for early identification of functional limitations and for guiding individualized rehabilitation strategies in this population

2 Research Method

2.1 Study Design and Participants

This study was cross-sectionally conducted among KOA population in several communities around Khon Kaen province, Thailand. This study had been approved by the Khon Kaen Ethics Committee for Human Research with identifying code HE65213. All the participants enrolled in the study voluntarily and signed the informed consent before initiation of the study. Participants were female adults, who aged between 50 to 79 years with unilateral or bilateral KOA. They were diagnosed as having KOA condition using American College of Rheumatology (ACR) classification criteria if they experienced regular knee pain at least in 1 month, in consort with at least 3 out of 6 the following items: aged >50 years, having morning stiffness of less than 30 minutes, crepitus on active movement, bony tenderness, bony enlargement, and no palpable warmth of synovium. Exclusion criteria included pain intensity exceed 7 out of 10 scores on numeric rating scale (NRS), having any other inflammatory conditions at lower limbs, such as rheumatoid arthritis, gout, psoriatic arthritis, or other systematic inflammatory disease. Participants with radicular back pain, neurological impairments, or history of lower limb surgery were also excluded.

2.2 Study Protocol

The participants were screened their KOA condition, health information, and demographic characteristics. Then, the eligible participants were assessed their functional performance using the functional tests, including the SLST and 10MWT. Regarding the SLST, the participants were instructed to maintain their balance in single support limb while bend the opposite limb at 90^{o} knee flexion for as long as they can, or up to a maximum 30 seconds. They were tested on the affected side or in case of bilateral KOA, more severe and more limited side was chosen. Timing commenced when one leg completely elevated from the floor with correct posture and ended when the elevated leg touched the ground, attempted excessive upper body or trunk movement, shifted of foot stance, or the maximum time was completed. The best performance (in seconds) between two trials were noted. Furthermore, the 10MWT was performed on a 10-meter walkway, which the participants were given verbal instruction to walk from the start line to the end line of

the 10-meter walkway at a comfortable and safe pace. The tester recorded the time required to cover the 4-meter distance in the middle of the walkway. Average velocity (meter/second; m/s) of three trials were recorded. The participants were assessed their blood pressure, heart rate, and any other symptoms, such as dizziness or fatigue before performing the functional tests. Their pain intensity were assessed before, between the trials, and after the tests to ensure their safety. Safety belt and sandal sport shoes in various size were prepared and wore by all participants during performing the tests. Furthermore, they were encouraged to rest as needed between each test or trial.

2.3 Statistical Analysis

All the analyses were performed using data analysis software SPSS version 28.0.1.0 (IBM Corp. Released 2021. Armonk, NY: IBM Corp). Data were reported based on the participants' age category (60-69, 70-79, and 80-89 years). The descriptive statistics was applied to describe the participants' demographics characteristics, health information, and outcome variables. Correlation of both measures reported by Pearson correlation value. Data were presented as number, percentage, mean value, standard deviation, and range with 95% confident interval.

3 Results

Of the 298 female adults who interested to participate the study, 201 were excluded for reasons explained in figure 1. Moreover, nine participants were excluded because of outlier. Therefore, there were 88 eligible female adults, which were categorised into 3 groups based on decade of age: 50-59 years (n=17), 60-69 years (n=45), and 70-79 years (n=26).

The details of participant's characteristics were reported in table 1. The mean duration of experience KOA were 3.67 ± 4.01, 3.54 ± 3.44, and 4.90 ± 6.92 years for age group of 50-59, 60-69, and 70-79 years, respectively. Furthermore, the bilateral KOA lesion was presented dominant among participants in every age group. Nearly half (47.1%) of the participants had knee alignment deformity, including varus (30.6%), valgus (10.6%), and knee hyperextension (5.9%), in which knee deformity was more prevalent among participants in the age of 70-79 years. Each participant was reported the number of comorbidities between 1 to 3 diseases, including hypertension (n=42), hyperlipidaemia (n=26), diabetes (n=19), allergies (n=5), thyroid disease (n=3), heart disease (n=2), and renal disease (n=1). Other demographic characteristics were showed in table 1.

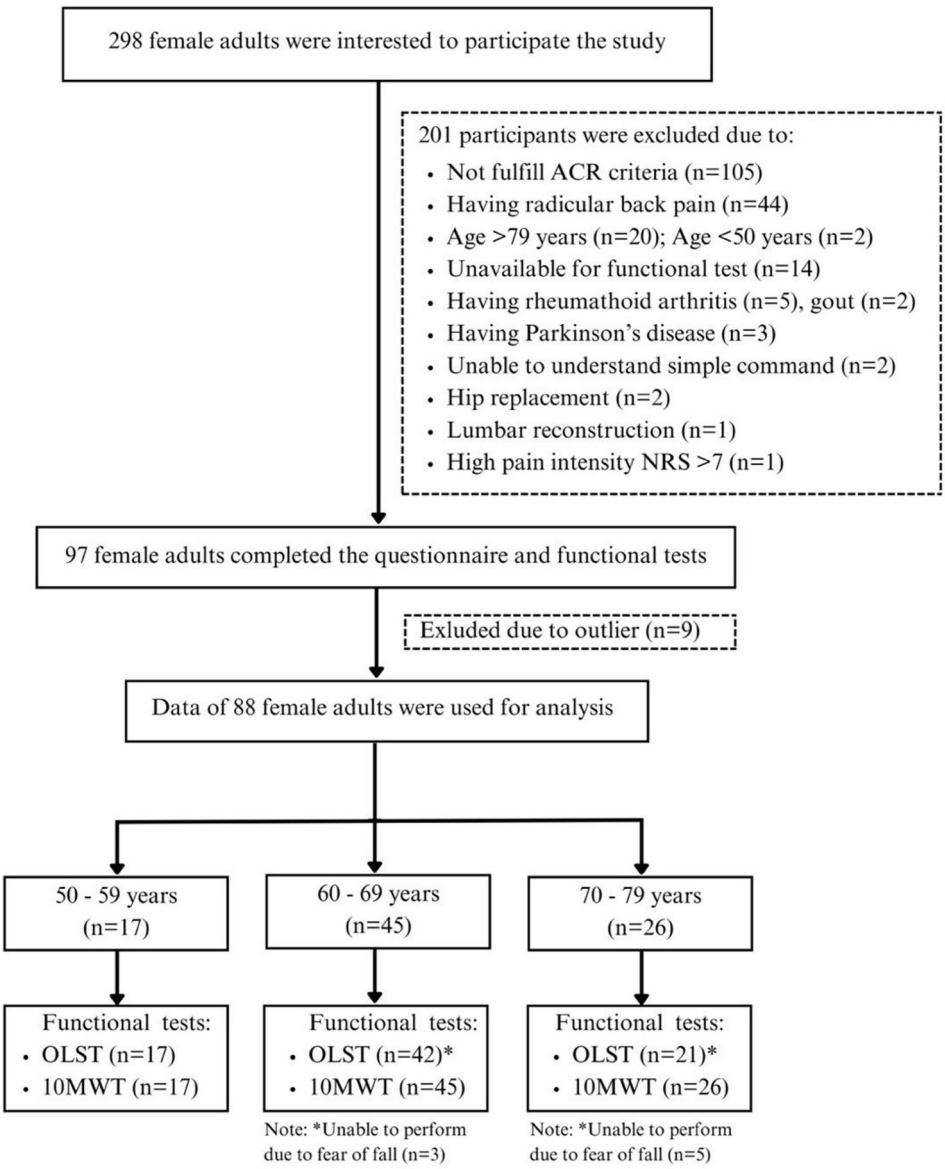

Fig. 1. Participants Flowchart

Table 1. Demographics characteristics of participants by age category

Variable	Age category			
	All (n=88)	**50 – 59 (n=17)**	**60 – 69 (n=45)**	**70 – 79 (n=26)**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Age (years)	65.76 ± 6.15	57.06 ± 2.41	64.89 ± 2.79	72.96 ± 2.76
Weight (kg)	64.11 ± 10.45	66.4 ± 12.19	66.75 ± 9.03	58.05 ± 9.32
Height (cm)	153.26 ± 5.96	155 ± 5.25	153.24 ± 5.89	152.15 ± 6.46
BMI (kg/m^2)	27.24 ± 3.85	27.59 ± 4.49	28.43 ± 3.58	24.96 ± 2.86
Pain intensity	4.84 ± 1.50	4.47 ± 1.41	5.22 ± 1.36	4.42 ± 1.67
KOA duration [n(%)]				
• ≤ 1 year	33 (37.5)	8 (47.1)	17 (37.8)	8 (30.8)
• > 1 to 5 years	35 (39.8)	5 (29.4)	19 (42.2)	11 (42.3)
• > 5 years	20 (22.7)	4 (23.5)	9 (20)	7 (26.9)
KOA lesion [n(%)]				
• Unilateral	31 (35.2)	7 (41.2)	12 (26.7)	12 (46.2)
• Bilateral	57 (64.8)	10 (58.8)	33 (73.3)	14 (53.8)
Knee alignment [n(%)][a]				
• No deformity	45 (52.9)	10 (62.5)	24 (55.8)	11 (42.3)
• Deformity	40 (47.1)	6 (37.5)	19 (44.2)	15 (57.7)
Co-morbidities [n(%)]				
• No comorbidities	32 (36.4)	9 (52.9)	17 (37.8)	6 (23.1)
• Have comorbidities	56 (63.6)	8 (47.1)	28 (62.2)	20 (76.9)
Education level [n(%)]				
• Elementary	71 (80.7)	12 (70.6)	37 (82.2)	22 (84.6)
• Secondary	14 (15.9)	5 (29.4)	6 (13.3)	3 (11.5)
• Vocational	2 (2.3)	-	2 (4.4)	-
• College	1 (1.1)	-	-	1 (3.8)
History of fall [n(%)]				
• No fall	58 (65.9)	13 (76.4)	30 (66.7)	15 (57.7)
• Falls	30 (34.1)	4 (23.5)	15 (33.3)	11 (42.3)
Walking aids [n(%)]				
• Not use	83 (94.3)	17 (100)	42 (93.3)	24 (92.3)
• Use walking aids	5 (5.7)	-	3 (6.7)	2 (7.7)

[a] missing data from 3 participants
BMI=body mass index, KOA=knee osteoarthritis, SD=standard deviation, CI=confidence interval

Table 2 shows the reference values of balance ability and walking speed using the SLST and 10MWT by decade of age category. There were three participants (60-69 years) and five participants (70-79 years), who were unable to perform the SLST due to fear of falling. The participants demonstrated decline of functional performance with advancing age. Furthermore, . A significant positive correlation was found between SLST and 10MWT ($r = 0.33$, $p < 0.05$).

Table 2. Functional performance of the participants by age category

Functional test	n	Mean ± SD	Range	95% CI
SLST (sec)				
All	80	12.96 ± 8.27	2.54–30.00	11.12–14.80
50 – 59 years	17	17.28 ± 9.40	2.54–30.00	12.44–22.11
60 – 69 years[a]	42	12.66 ± 8.30	2.54–30.00	10.07–15.25
70 – 79 years[b]	21	10.07 ± 5.80	2.93–21.49	7.43–12.71
10MWT (m/s)				
All	88	0.98 ± 0.17	0.49–1.34	0.95–1.02
50 – 59 years	17	1.05 ± 0.17	0.68–1.34	0.96–1.14
60 – 69 years	45	1.00 ± 0.17	0.59–1.34	0.94–1.05
70 – 79 years	26	0.92 ± 0.14	0.49–1.25	0.86–0.98

[a](n=3) and [b](n=5) Unable to perform the test due to fear of falling

4 Discussion

This study proposed the reference values of functional performance, in term of balance and walking ability in female with symptomatic KOA using the SLST and 10MWT, respectively. The findings demonstrated that their balance ability and walking speed were declined by advancing age. The present study established the reference values of SLST and 10MWT for female with KOA across 3 categories of age range (50-59, 60-69, and 70-79 years). All of participants were reported the mean performance of SLST and 10MWT as 12.96 ± 8.27 seconds and 0.98 ± 0.17 m/s, respectively. These findings might be beneficial for the health practitioner when interpreting the performance of people with KOA. Reporting the performance score specific for female with KOA across age category can facilitate extensive comparability with more similar characteristics of patients, which help to drawn better interpretation when assessing, managing, or monitoring KOA condition.

The time to complete SLST in present study was decreased with age, which was consistent with the previous studies.[8], [9] They confirmed that the ability to maintain single leg balance was associated with age. Moreover, the findings showed that female with KOA in present study performed a shorter time than healthy female adults in similar age range. [8], [9] Such poorer performance postulated from different characteristics of participants, such as higher BMI, pain, and knee deformity which were naturally reported as the features in KOA condition. The evidence supported that aging, higher BMI, pain, and lower limb muscle weakness established as associated factors for shorter time to perform SLST.[10] In addition, history of falls and fear of falling might contribute to the poorer performance in our participants as well. There were 34.1% of participants reported falls, and those 8 participants who were unable to perform the OLST expressed the fear of falling as the reasons. However, the questions of fear of falling were not counted in our questionnaire. This finding could serve as a recommendation for further research involving the KOA (Knee Osteoarthritis) population. The inability to perform the One-Leg Stand Test (OLST) for at least 10 seconds has been widely proposed as a cut-off score to predict osteoporotic and hip fractures in older women, as well as to predict all-cause mortality and shorter life expectancy. [11] When considering the ability to stand on one leg in the age of 60-69 and 70-79 years (12.66 ± 8.30 and 10.07 ± 5.80 seconds, respectively), they were reported nearly the cut-off value. Thus, including OLST in routine assessment for people with KOA appear to be important while considering numerous factors of KOA altogether affecting their functional performance.

Regarding the 10MWT, the participants demonstrated declined walking speed as age increase. In the present study, females with knee osteoarthritis (KOA) walked significantly slower than functional/healthy female adults in the same age range.[12] Prior studies reported the slower walking speed in people with KOA than those without KOA.[13] People with KOA tend to adopt compensatory walking strategy to reduce joint stress on the knee joint and minimize discomfort feeling during walking. Thus, this compensation certainly results in a slower walking speed. Furthermore, White et al. reported that people with KOA were exposed with nine times higher risk to encounter faster decline in walking speed compared to those without KOA.[13] However, the present study included both unilateral and bilateral types of KOA lesion, which remained unclear for the involvement of this factor for walking speed. People with bilateral symptomatic KOA have faster walking speed than those with unilateral symptomatic KOA, which is assumed that unilateral lesion produces asymmetrical gait pattern. Walking speed was associated with health-related outcomes, survival rate and mortality in older adults. Prior study suggested that walking speed faster than 1.0 m/s reflected healthy status and better life expectancy.[11], [14] Additionally, higher cut-off score of 1.22 m/s was set to reflect the ability of older pedestrians to walking safely and independently. [14], [15] Unfortunately, the mean of walking speed in present study was

0.98 m/s, which placed the female with KOA in displeasing truth. Furthermore, White et al. emphasized that people with KOA experienced faster decrease in walking speed by 2.75% per year.[13] Thus, assessing walking speed in female with KOA should be put into concern, particularly when designing treatment programs to improve or delay the progression of functional decrement in this population.

However, there were some limitations in present study. Firstly, although the findings clearly showed the decline of functional performance with age, there were other factors that might affect the level of functional performance, such as type of lesion, knee alignment, and fear of falls. Secondly, the participants were tested their OLST performance in one side, which were unable to present the OLST performance between less affected and more affected side of KOA. Thirdly, the larger number of sample size was recommended to provide more explorative information in this population.

5 Conclusion

Females with Knee Osteoarthritis (KOA) demonstrated a continuous decline in balance and walking speed as they aged. Despite the decline due to aging process, poor functional performance in these individuals might be more prominent due to other numerous factors of KOA condition. This finding could help the clinicians to interpret their functional performance, which it might be beneficial in clinical decision making when designing treatment programs and care needs for this population.

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