Decline of functional performance in females with knee osteoarthritis with advancing age

การลดลงของความสามารถทางกายในเพศหญิงที่มีภาวะข้อเข่าเสื่อมตามอายุที่มากขึ้น

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ABSTRACT

Background: Declined functional abilities were commonly found in people with knee osteoarthritis (KOA). However, reports of functional performance levels in females with KOA are limited.

Objective: To explore functional performance regarding balance ability, lower limb strength, gait speed, and walking endurance in females with KOA; additionally, to compare functional performance among a decade of age groups.

Methods: Eighty-eight female participants were tested for their functional ability using the timed up and go test (TUG), five times sit-to-stand test (FTSST), 10-meter walk test (10MWT), and 2-minute walk test (2MWT). The results were reported using descriptive analysis and compared the differences among age groups using one-way ANOVA.

Results: The participants demonstrated the average performances in TUG, FTSST, 10MWT, and 2MWT were 10.80 ± 1.54 seconds, 13.83 ± 2.80 seconds, 0.98 ± 0.17 m/s, and 110.99 ± 17.73 meters, respectively. Those aged 70–79 years had significantly poorer functional performance than other groups (p-value < 0.05), particularly in the TUG, 10MWT, and 2MWT.

Conclusion: Females with KOA was more notable with advancing age. The findings might be helpful to consider the program for functional improvement in order to delay or minimize the functional decline as a consequence of the KOA condition.

Keywords: balance ability, lower limb strength, walking ability, walking endurance, knee osteoarthritis

บทคัดย่อ

ที่มาและความสำคัญ: ความบกพร่องของความสามารถทางกายมักพบในผู้ที่มีภาวะข้อเข่าเสื่อม อย่างไรก็ตาม การรายงานระดับความสามารถทางกายในเพศหญิงที่มีภาวะข้อเข่าเสื่อมยังมีจำกัด

วัตถุประสงค์: เพื่อศึกษาความสามารถทางกายด้านการทรงตัว ความแข็งแรงของรยางค์ขา ความเร็วในการเดิน และความทนทานของร่างกายในเพศหญิงที่มีภาวะข้อเข่าเสื่อม และเปรียบเทียบความสามารถทางกายระหว่างช่วงอายุละ 10 ปี

วิธีการวิจัย: อาสาสมัครเพศหญิงจำนวน 88 คน ได้รับการทดสอบ timed up and go test (TUG), five times sit-to-stand test (FTSST), 10-meter walk test

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(10MWT) และ 2-minute walk test (2MWT) รายงานผลโดยใช้สถิติเชิงพรรณนา และเปรียบเทียบความแตกต่างระหว่างกลุ่มโดยใช้สถิติ one-way ANOVA

ผลการวิจัย: อาสาสมัครมีคะแนนเฉลี่ยในทดสอบ TUG, FTSST, 10MWT และ 2MWT เท่ากับ 10.80 ± 1.54 วินาที 13.83 ± 2.80 วินาที 0.98 ± 0.17 เมตร/วินาที และ 110.99 ± 17.73 เมตร ตามลำดับ โดยผู้ที่มีอายุระหว่าง 70–79 ปี มีความสามารถทางกายต่ำกว่ากลุ่มอื่นอย่างมีนัยสำคัญทางสถิติ (p-value < 0.05) โดยเฉพาะการทดสอบ TUG, 10MWT และ 2MWT

สรุปผล: ผู้ที่มีภาวะข้อเข่าเสื่อมเพศหญิงมีความบกพร่องของความสามารถทางกายมากขึ้นตามอายุ ผลการศึกษาเป็นประโยชน์ในการออกแบบโปรแกรมเพิ่มความสามารถทางกายเพื่อชะลอหรือลดความเสื่อมจากการมีภาวะข้อเข่าเสื่อม

คำสำคัญ: ความสามารถในการทรงตัว ความแข็งแรงของรยางค์ขา ความสามารถในการเดิน ความทนทานในการเดิน ภาวะข้อเข่าเสื่อม

Introduction

Knee osteoarthritis (KOA) is widely reported as the major cause of functional disability due to the destruction of articular cartilage and joints[1]. The evidence supports that the female gender is at higher risk of developing KOA due to differences in anatomy and biomechanical configuration and was reported to experience more severe symptoms and disability compared to the male gender[1,2]. KOA altered the biomechanical pattern, which resulted in a decline in functional ability, including balance ability, lower limb strength, gait speed, and walking endurance[3–5]. As a consequence of functional decline, females with KOA tend to have less physical activity due to pain, walking difficulty, and psychological distress, which eventually increases the risk for developing comorbidities[1,6]. The presence of comorbidities in KOA population were strongly associated with a higher risk of disability and mortality risks[1,5]. Thus, assessing these functional aspects is crucial to preventing or delaying the functional decline as well as minimizing the consequences of KOA.

Those functional performances were essential to executing daily tasks yet were repeatedly reported to decline following the onset of KOA and aging[3,4,7]. Evidence supported that common functional tests to assess balance ability, lower limb strength, gait speed, and walking endurance in older adult population included the timed-up and go test (TUG), five times sit-to-stand test (FTSST), 10-meter walk test (10MWT), and 2-minute walk test (2MWT), respectively[9,10]. Moreover, these tests showed high reliability and validity when applied to KOA population[11–13]. Besides, those measures were feasible to apply because they were simple, quick, required less instrumentation, were inexpensive, could be administered in various settings, and were relatively safe to complete without exacerbating the symptoms of KOA. The performance values of those functional tests in older adult population have been repeatedly reported in general and in specific countries across age or sex categories[8,10,14]. Furthermore, the available data reporting functional performance in individuals with KOA mainly were derived from Western populations, which have different anthropometric and demographic characteristics (lifestyle, physical activity levels, and sociocultural norms)

from Thai population[15,16]. Moreover, functional performance tended to decline with aging as natural physiological changes, and the presence of KOA made it decline more seriously. KOA is a degenerative joint disease that progresses slowly over the years and is postulated to have a constant annual incidence within the 10-year age strata[17]. To the best of our knowledge, no available study reported the performance values of those functional tests in females with KOA among Thai population, which limited the interpretability regarding how broad the deviation of functional performance was in females with KOA compared to healthy older adults[8]. Thus, this study primarily explored functional performance in balance ability, lower limb strength, gait speed, and walking endurance in females with KOA. Additionally, this study provided data on functional performance in decades of age categories as a secondary objective to facilitate clinical relevance by comparing them among age groups. The findings of this study might be helpful in interpreting the performance of females with KOA by comparing them in a decent manner to provide better insight when designing and monitoring the treatment for females with KOA.

Methods

Study design and participants

This study was cross-sectionally conducted among KOA population in several communities around Khon Kaen province, Thailand. The sample size was estimated using data from a pilot study (30 individuals) with α error set to 0.05; the precision of estimation was defined from 5% of mean. Accordingly, the minimum required sample for this study was 72 individuals. This study had been approved by the Khon Kaen Ethics Committee for Human Research with the identifying code HE65213. All the participants voluntarily enrolled in the study and signed the informed consent form prior to the study.

Participants were female adults aged 50–79 with unilateral or bilateral KOA. They were diagnosed with KOA using the American College of Rheumatology (ACR) classification criteria for KOA[18]. However, participants whose pain intensity exceeded 7 out of 10 scores on the numeric rating scale (NRS) and could not perform the tests independently were excluded. Furthermore, they were excluded if they had other inflammatory conditions in the lower limbs, such as rheumatoid arthritis, gout, psoriatic arthritis, or other systematic inflammatory diseases. Participants with radicular back pain, neurological impairments, or a history of lower limb surgery were also excluded.

Study protocol

The participants were recruited for the study through the community leaders, who had been informed of the research's objectives and procedures. The community leaders helped to publicize the time and location of the research being conducted. The research was conducted in two phases, including screening and functional testing. In the screening phase, individuals interested in participating in the study were screened for their KOA condition using the ACR classification criteria and confirmed their eligibility using a screening questionnaire. Those who

passed the screening phase were appointed for the functional performance tests the next day.

Prior to data collection, all researchers (four physical therapists) underwent comprehensive training from an expert with over three years of experience conducting the tests. The researchers demonstrated their proficiency in administering the tests by obtaining excellent intraclass correlation coefficients (ICC = 0.98–1.00) from intra- and inter-rater reliability. The protocol for the tests is as follows:

The TUG is used to measure the time required to complete several functional tasks, including sit-to-stand, walking, turning, and sitting down, which reflect mobility and balance ability. This test shows high reliability when applied to people with KOA[11]. The participants were instructed to sit on the chair (43-cm in height) with their hands hanging freely beside their bodies, knees in 90 degrees of flexion, and ankles in a neutral position. The researcher gives the verbal instructions: “Please rise from the chair without using your hands, directly walk along the 3-meter line to the marked cone at a maximum but safe pace, take a turn after the marked cone, walk to the chair, and sit down back in the chair”. They were measured in seconds using a stopwatch. The average score of three trials was recorded[8].

The FTSST represents the ability to sit and stand, which depends on lower limb muscle strength and balance control. Participants were asked to sit in a chair (43 cm in height) with their arms crossed over their chest, their back resting on the chair backrest, their knees bent at 90 degrees of flexion, and their ankles in a neutral position. The verbal instruction, “Please stand up and sit down five times as quickly as possible, stand upright completely when you stand up, and lean your back on the chair backrest when you finish five repetitions” was given clearly. The scores were recorded for three trials, and the average score was noted[19].

The 10MWT is applied to assess gait speed over a short distance by instructing the participants to walk on a 10-meter walkway at their comfortable and safe pace. The researcher recorded the time required to cover the 4-meter distance in the middle of the 10-meter walkway to allow for the acceleration and deceleration phases during the gait cycle[20]. The average velocity (meter per second; m/s) of three trials was recorded.

The 2MWT is an alternative to the 6-minute walk test to assess functional capacity and is increasingly used because it is less time-consuming and better tolerated by patients with different health conditions[10,12]. The test was conducted by instructing the participants to walk on a 4x6 meter walkway and cover the distance as much as possible at their preferred pace until they were told to stop after 2 minutes. The participants were permitted to rest in a standing position at any time during the test and resume walking as soon as they felt comfortable, but the time would continue[12]. During the test, the participants were allowed to use walking aids, and the researcher walked alongside without interfering with the participants. The standardized encouragement phrases like “you are doing well, one minute left” were given after the first minute had passed. The

participants were instructed to stop at their end point when two minutes had passed. The test was performed in one trial, and the total distance covered was recorded in meters[12].

The participants were assessed for their functional performance in a random sequence, and they were evaluated for blood pressure, heart rate, and other symptoms, such as dizziness or fatigue, before performing the functional tests. Their pain intensity was assessed before, between trials, and after the tests to ensure their safety. The safety belt and sandal sports shoes in various sizes were prepared and worn by all participants during the tests. Furthermore, they were encouraged to rest between each test or trial as needed.

Statistical analysis

All the analyses were performed using the data analysis software SPSS version 28.0.1.0 (IBM Corp. released 2021.Armonk, NY: IBM Corp). The descriptive statistics were applied to describe the participants' demographic characteristics, health information, and outcome variables. The data were presented as a number, percentage, mean, standard deviation (SD), and range with 95% confidence interval. The histogram and boxplot were observed to identify potential outliers. The cases that were seen to deviate more than 2SD from the mean or fall outside of either the upper or lower hinge of the boxplot were eliminated since values that deviate greatly from the mean can considerably alter the results[21]. The functional performances among age groups (50–59, 60–69, and 70–79 years) were also compared using one-way ANOVA, and the post-hoc (Scheffe) test was applied for each age group's pairwise comparison. The significant level was set at 0.05.

Results

Of the 298 female adults interested in participating in the study, 201 were excluded for reasons explained in Figure 1. Moreover, nine participants were excluded as outliers due to their scores in the functional tests were greater than 2SD. Outliers were observed in the TUG test (n=7), FTSST (n=5), 10MWT (n=2), and 2MWT (n=4) boxplot hinges at either the lower or upper end. Therefore, 88 female adults were eligible for the study. They were additionally categorized based on decade of age: 50–59 years (n=17), 60–69 years (n=45), and 70–79 years (n=26).

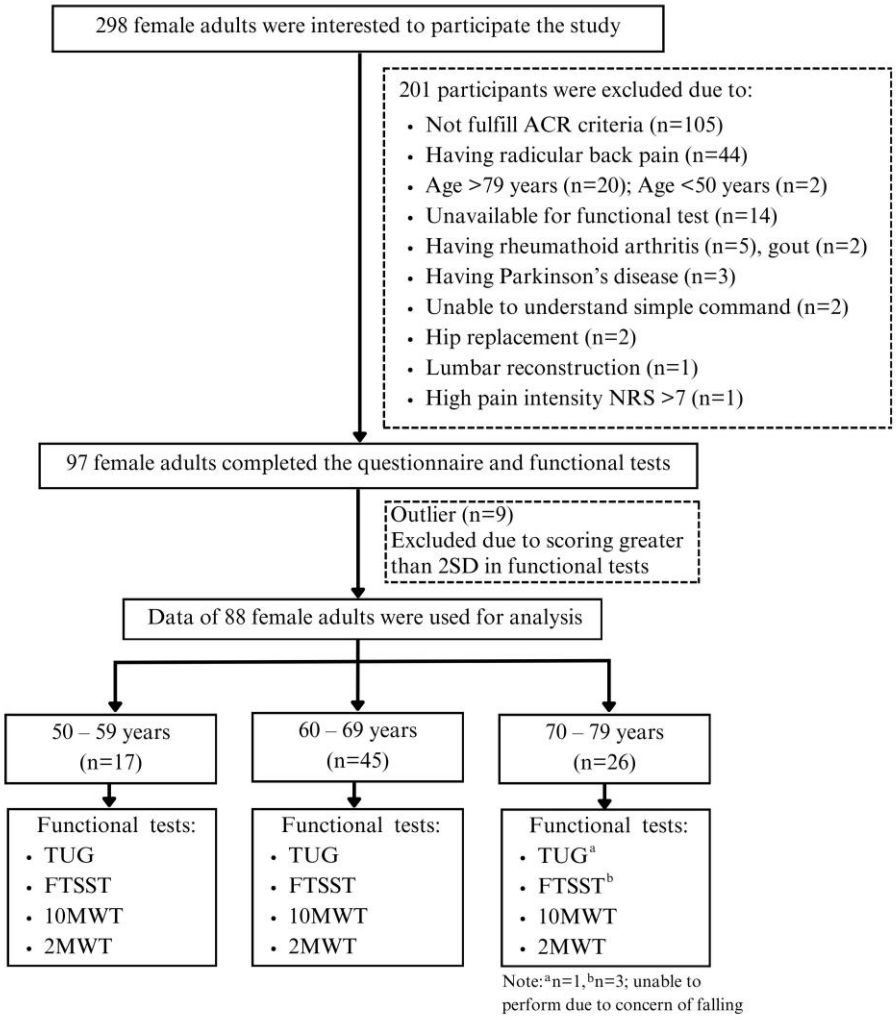

Figure 1 Participants' flowchart

The details of the participant's characteristics are reported in Table 1. No significant differences were found in all demographic characteristics among decades of age, except for BMI and weight. The mean duration of experience KOA was 3.67±4.01, 3.54±3.44, and 4.90±6.92 years for the 50–59, 60–69, and 70–79 age groups, respectively. Furthermore, the bilateral KOA lesion was dominant among participants in every age group. The number of comorbidities ranged from 1–3 diseases per participant, including hypertension (n=42), hyperlipidemia (n=26), diabetes (n=19), allergies (n=5), thyroid disease (n=3), heart disease (n=2), and renal disease (n=1). Five participants reported using walking aids. However, they used it occasionally, only when walking long distances in outdoor areas. The details of demographic characteristics are shown in Table 1.

Table 1 Demographics characteristics of participants

Variable	All (n=88)		50–59 years (n=17)		60–69 years (n=45)		70–79 years (n=26)		*p*-value
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	
Age (years)	65.76 ± 6.15	51 – 79	57.06 ± 2.41	51 – 59	64.89 ± 2.79	60 – 69	72.96 ± 2.76	70 – 79	N/A
Weight (kg)[a]	64.11 ± 10.45	43.5 – 98.5	66.4 ± 12.19	47.4 – 98.5	66.75 ± 9.03	50.5 – 87.5	58.05 ± 9.32[+,†]	43.5 – 78.6	0.001*
Height (m)[a]	1.53 ± 0.05	1.41 – 1.66	1.55 ± 0.05	1.43 – 1.62	1.53 ± 0.05	1.41 – 1.66	1.52 ± 0.06	1.43 – 1.66	0.298
BMI (kg/m^2)[a]	27.24 ± 3.85	19.47 – 38.96	27.59 ± 4.49	19.47 – 38.96	28.43 ± 3.58	21.1 – 38.37	24.96 ± 2.86[†]	20.8 – 32.46	<0.001*
NRS (score)[b]	4.84 ± 1.50	2 – 7	4.47 ± 1.41	2 – 6	5.22 ± 1.36	2 – 7	4.42 ± 1.67	2 – 7	0.071
KOA lesion[§,c]: Bilateral, n (%)	57 (64.8)		10 (58.8)		33 (73.3)		14 (53.8)		0.216
Comorbidities[§,c]: Yes, n (%)	56 (63.6)		8 (47.1)		28 (62.2)		20 (76.9)		0.133
Falls history[§,c]: Yes, n (%)	30 (34.1)		4 (23.5)		15 (33.3)		11 (42.3)		0.441
Walking aid[§,c]: Yes, n (%)	5 (5.7)		0 (0)		3 (6.7)		2 (7.7)		0.522

Note: *Indicates significant difference (*p*-value < 0.05). [§]Data were presented in number (percentage). Data were compared using [a]one-way ANOVA, [b]one way Kruskal-Wallis test, and [c]Chi-Square. Superscripts indicate the group(s) with significant differences from the indicated group, where [+] = 50–59, [†] = 60–69, and [‡] = 70–79 years. The categorised variables were grouping as follows: KOA lesion: bilateral/unilateral, comorbidities: yes/no, falls history: yes/no, walking aid: yes/no. BMI=body mass index, NRS=numerical pain rating scale, KOA=knee osteoarthritis, SD=standard deviation, CI=confidence interval.

Table 2 shows the functional performance in balance ability, lower limb strength, gait speed, and walking endurance using the TUG, FTSST, 10MWT, and 2MWT, respectively. The participants demonstrated a significant decline in functional performance, including balance ability, gait speed, and walking endurance with advancing age ($p < 0.05$). The result of lower limb strength performance using FTSST did not reveal any significant differences among age groups. There were one and three participants in 70–79 group were unable to perform TUG and FTSST, respectively, due to concern about falling. All the participants performed the tests independently and voluntarily without using walking aids.

Table 2 Functional performance of the participants

Functional test	n	Mean ± SD	Range	95% CI	*p*-value
TUG (seconds)					
All	87	10.80 ±1.54	7.33 – 14.84	10.47 – 11.13	<0.001*
50 – 59 years	17	9.7 ± 1.36	7.33 – 11.92	9.00 – 10.40	
60 – 69 years	45	10.78 ± 1.47^{+}	8.38 – 13.91	10.34 – 11.23	
70 – 79 years[a]	25	11.57 ± 1.37^{+}	8.23 – 14.84	11.00 – 12.13	
FTSST (seconds)					
All	85	13.83 ± 2.80	8.14 – 21.55	13.22 – 14.44	0.074
50 – 59 years	17	12.45 ± 1.97	8.14 – 15.29	11.44 – 13.47	
60 – 69 years	45	14.23 ± 2.98	8.80 – 20.71	13.34 – 15.13	
70 – 79 years[b]	23	14.06 ± 2.77	8.99 – 21.55	12.86 – 15.26	
10MWT (m/s)					
All	88	0.98 ± 0.17	0.49 – 1.34	0.95 – 1.02	0.035*
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	
2MWT (meters)					
All	88	110.99 ± 17.73	41.25 – 163.03	107.23 – 114.75	0.046*
50 – 59 years	17	119.66 ± 18.85	84.00 – 163.03	109.96 – 129.35	
60 – 69 years	45	110.56 ± 15.08	79.82 – 140.7	106.03 – 115.09	
70 – 79 years	26	106.06 ± 19.74^{+}	41.25 – 144	98.09 – 114.04	

Note: *Indicates significant difference (*p*-value < 0.05), and data were compared using one-way ANOVA, and Post-hoc (Scheffe) analysis was applied to compare every pairwise of age groups. [a](n=1) and [b](n=3) were unable to perform the test due concern of falling. Superscripts indicate the group(s) with significant differences from the indicated group, where $^{+}$ = 50–59, † = 60–69, and ‡ = 70–79 years. TUG=timed-up and go test, FTSST=five times sit-to-stand test, 10MWT=10-meter walk test, 2MWT=2-minute walk test.

Discussion

The present study reported the functional performances of females with KOA, including balance ability, lower limb strength, gait speed, and walking endurance, which were tested using the TUG, FTSST, 10MWT, and 2MWT, respectively. Additionally, the performances were reported based on decades of age (50–59, 60–69, and 70–79 years). The results showed that functional performances in balance ability, gait speed, and walking endurance significantly deteriorate as age increases, particularly in females KOA at 70–79 years. A similar finding was reported from the study conducted among people with KOA in the USA population, which reported that greater age was associated with poor objective physical performance[16]. Moreover, a prior study conducted among well-functioning elderly in Thai population also reported similar trends to the present study[8]. These findings provided the actual performance of females with KOA, which objectively shows the deviations in functional performance when compared with the reference value in their population peers. Furthermore, the findings might be beneficial for the health practitioner when assessing the performance of females with KOA by facilitating extensive comparability with more similar characteristics of patients, such as a similar age range, which helps to draw better interpretations when managing or monitoring KOA condition.

The TUG performance of females with KOA was 10.80 ± 1.54 seconds. This performance was poorer when compared to the established reference value in healthy older adults[14,22]. The reference value of TUG varied based on the characteristics of older adults in specific geographical areas. In Thai population, well-functioning female older adults performed TUG better than females with KOA in this study[8]. Furthermore, the findings of this study showed that TUG performance was significantly prolonged with age (p<0.05). Previous studies have confirmed that timed up and go performance declines with age in older adults[22]. The mean score of TUG in the age group 50–59 years was 9.7±1.36 seconds, which is significantly better than those in the age groups 60–69 and 70–79 years (10.78±1.47 and 11.57±1.37 seconds). Moreover, the physical decline due to aging and the presence of KOA deteriorated their TUG performance even more, resulting in poorer performance compared to the reference value of their healthy peers[14,22]. The TUG times in the present study were shorter than those reported among females with KOA in a previous study, which ranged from 10.9±2.8, 12.1±3.6, and 13.6±3.3 seconds for age groups 50–59, 60–69, and 70–79 years, respectively[23]. However, a direct comparison cannot be drawn due to the different protocols applied, and the other factors, such as psychological distress (anxiety and depression), that could potentially interfere with the performance were included in the previous study[23]. A significant difference was found between age groups <60 years (50–59 years) and ≥60 years (60–69 and 70–79 years), while no significant difference was found between the 60–69 and 70–79 groups. We speculate that in addition to KOA symptoms and the aging process[23], factors such as comorbidities[24] and fall

history[15] might contribute to functional performance decline in those 60–69 and 70–79 age groups. Simultaneously, a study by Svinøy and co-workers reported that participants with arthritis and comorbidities required significantly longer durations to perform TUG after age 65 years[25]. Thus, considering these factors when managing KOA conditions might provide a better interpretation. Furthermore, a prior study established the cut-off score ≥ 9.44 seconds in TUG to predict fall risk in older adults, placing the female with KOA in the present study at risk for future falls[26]. Therefore, targeting physical functions in an early treatment strategy is necessary to manage or prevent the excessive loss of physical function before the disease progresses and induces further problems in females with KOA.

The FTSST shows no significant difference in lower limb muscle strength among age categories in females with KOA. The mean BMI of participants in this study was 27.24±3.85 kg/m^2, interpreted as obesity based on BMI classification for Asians across age groups. The literature suggested that clinically important improvements in KOA symptoms and function could be achieved with weight loss of at least 10% of baseline body weight[1] or at least two units of BMI to reduce the risk of symptomatic KOA[28]. Accordingly, the difference in weight or BMI between the 50–59 and 60–69 age group does not reach the clinically important level to achieve change in physical function and KOA symptoms, while the 70–79 age group might be exposed to other factors such as decline of muscle mass due to aging[29]. It might explain the reasons for the non-significant differences in functional performance among each group. Similar findings were reported by Thaweewannakij and colleagues, which show no significant difference between the 60–69 and 70–79 groups among Thai older adults[8]. Growing evidence of FTSST reference values was available for older adults with various characteristics of participants[8,14,19]. The FTSST performance of females with KOA was poorer than that of female older adults in similar age ranges[8,14,19]. Moreover, the FTSST performance of females with KOA in the present study is below the suggested cut-off score (11.7 seconds) to be physically active and reduce the risk of mortality in KOA population[30]. In contrast to the TUG, which shows a gradual decline in performance as age increases, the FTSST results show that participants in the 70–79 group required slightly less time than those in the 60–69 group. A similar trend was reported by Harkey and colleagues, which showed that females with KOA who were >69 years old could perform the FTSST faster than those who were <69 years old[16]. However, that study reported the FTSST in speed (chair stands/min) and provided the data in percentile, limiting the comparability with the present study. This finding might reflect that particular characteristics of participants contribute to the performance of FTSST. Participants in the group 70–79 years have a significantly lower BMI and lower pain intensity than those in other age groups. BMI and pain intensity were reported to correlate with FTSST performance strongly[31]. However, the ratio of potential influence between those factors is

unknown in the present study as we did not include the associated correlation in our analysis. Thus, including FTSST in routine assessment while considering the individual factors (age, BMI, and pain intensity) in females with KOA might provide a better interpretation for clinicians in making treatment plans for this population.

Regarding the 10MWT, females with KOA in the present study walked slower than healthy female adults in a similar age range[8]. Prior studies confirmed that people with KOA demonstrated slower gait speeds than those without KOA[32]. People with KOA tend to adopt a compensatory walking strategy to reduce joint stress on the knee joint and minimize discomfort during walking. Thus, this compensation indeed results in a slower gait speed[33]. Furthermore, White et al. reported that people with KOA were exposed to a nine times higher risk of experiencing a faster decline in gait speed compared to those without KOA[32]. In addition, females with KOA demonstrated significantly slower gait speeds as age advanced. A similar trend was reported in a previous study conducted among well-functioning Thai older adults, which showed declining gait speed with aging[8]. The present study found a significant difference in gait speed between the 50–59 and 70–79 groups ($p<0.05$). Similarly, a study by Hall and colleagues found that a significant decline in gait speed was observed beginning in the 70–79 age groups in healthy adults[34]. The previous study confirmed that age correlated the most with gait speed in individuals with KOA[35], and the presence of KOA symptoms accelerated the decline in gait speed by 2.75% per year, which placed this population at risk for experiencing a premature aging process[32]. Furthermore, gait speed was associated with functional limitation, health-related outcomes, survival rate, and mortality in older adults[36]. Previous studies conducted among Thai population suggested a gait speed of >0.8 m/s was necessary to walk independently without a walking device[37], and a gait speed of >0.65 m/s was required for older adults with mobility limitations to be able to fully engage in community activities[38]. Additionally, Master and co-workers suggested that people with KOA required at least 1.12–1.25 m/s in gait speed to be physically active and reduce the risk of mortality[30]. Unfortunately, the average gait speed in the present study was 0.98 m/s, which is lower than the suggested gait speed and might decline even more in the future as age advances and KOA symptoms progress. Thus, assessing gait speed in females with KOA in the early stages should be a concern, mainly when designing treatment programs to improve or delay the progression of functional decline in this population.

In the aspect of walking endurance, this is the first study to assess the 2MWT performance of females with KOA. The present study chooses to apply 2MWT rather than 6MWT by considering the feasibility of conducting it in KOA conditions with an appropriate duration without exaggerating participants' symptoms. The participants in this study demonstrated poor walking endurance in 2MWT with a mean performance of 110.99±17.73 meters compared to the healthy older females[10]. Furthermore, this study found that the ability of

females with KOA to walk long distances decreased with age, which is consistent with the finding in a prior study[39]. However, the performance in 2MWT was generally reported among older adult population, which restricted the comparability of our finding[10,40]. In the present study, the females with KOA in the younger age group (50–59 years) could cover significantly longer distances than other groups. However, the performance of females with KOA is still lower compared to the performance in 2MWT of healthy older females[10,40] with 140.9–176.4 meters in the 50–79 age group[10]. The characteristics of KOA were postulated as the causes of this poor walking endurance, as the prior study stated that knee pain was causally related to the functional limitation that results in walking difficulty and increases the risk of mortality[5]. Aging is inevitable, and the structural damage of KOA is irreversible. However, addressing this progressive functional decline might help delay the adverse health outcomes from KOA and reduce premature aging in society.

There were some limitations in the present study. Firstly, although the findings clearly showed the decline in functional performance with age, there were other factors that might affect the level of functional performance, such as BMI, pain distribution, type of lesion, and psychological distress (activity avoidance and concern of falling). Secondly, this study recruited participants with symptomatic KOA, which may limit the generalization to asymptomatic or radiologic KOA. Lastly, although the predetermined sample size for this study was met, the number of participants was relatively small once they were classified into their respective age groups. However, the previous study derived data on the functional performance of individuals with KOA across age groups from 117 participants, with 28–55 participants in each age group[15]. Consequently, the number of samples in this study was nearly the previous report; however, further study with a larger sample size is recommended. The findings of this study should be interpreted with caution due to the small sample size in the age groups and may not be generalizable to a larger population. Therefore, future research could evaluate the limitations of the present study in order to make further progress.

Conclusion

In conclusion, females with KOA showed a continuous decline in functional performance including balance ability, gait speed, and walking endurance with aging. Despite the decline due to aging, poor functional performance in these individuals might be more prominent due to numerous factors associated with KOA conditions. This finding could help clinicians interpret functional performance in females with KOA, which might be benefit in clinical decision-making when designing treatment programs and care needs for this population.

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Conflict of interest

The author declares no conflict of interest in this study.

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