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RESEARCH ARTICLE

Correlation of Knee Osteoarthritis Patients' Characteristics and the Results of 30-Second Sit-to-Stand Test with Quality of Life

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Abstract

Pain, joint stiffness, and difficulty performing activities like rising from sitting to standing are signs and symptoms of knee osteoarthritis (OA). These conditions are risk factors for limited mobility and lower quality of life. Knee OA is closely associated with age, women, obesity, and other characteristics. The study's objectives were to determine the correlation of knee OA patients' characteristics with functional mobility using the 30-second sit-to-stand test (30STS) and the correlation of functional mobility with quality of life using the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) index. The research method was descriptive-analytic cross-sectional using medical records of 73 knee OA patients at the Medical Rehabilitation Clinic at Soreang Hospital, Muhammadiyah Hospital, Al Islam Hospital, Al-Ihsan Regional General Hospital West Java Province, Bandung, from March until August 2021. Patients' characteristics such as age (p=0.02), onset (p=0.01), OA grade (p=0,03), and knee deformity (p=0.04) have a negative correlation with functional mobility based on 30STS as well as functional mobility had a negative correlation with various aspects of quality of life, such as pain (p=0.03), stiffness (p=0.02), and functional limitation (p=0.00) subscales based on WOMAC index. Age, the onset of disease, OA grade, and knee deformity significantly correlate to functional immobility. Based on the WOMAC index, functional immobility correlates with the patient's quality of life.

Keywords: 30-second sit-to-stand test, functional mobility, knee osteoarthritis, quality of life, WOMAC index

Introduction

Osteoarthritis (OA) is the most common form of arthritis in the community, and knee OA is one of the most common forms of OA. In 2020, approximately 654.1 million people (40 years and older) have knee OA. The prevalence was 19.2% in Asia, 13.4% in Europe, 15.8% in North America, 4.1% in South America, 3.1% in Oceania, and 21.0% in Africa.[1] Indonesia does not have data on knee OA yet, but according to Indonesia's Basic Health Research (*Riskesdas*) 2018, the prevalence of joint disease based on doctor's diagnosis in 15 years and above population age in Indonesia was 7.3%, West Java province was 8.86%, and Bandung city 9.35%.[2,3]

Knee OA patients often have difficulty performing daily activities, such as walking, climbing stairs, and getting up from sitting to standing.[4] Study of knee osteoarthritis patients show limited function in daily living after having knee osteoarthritis. In Indonesia, where most people have a squatting culture to defecate or urinate, it is difficult for knee OA patients to perform these activities.[4]

To avoid pain and overcome limitations of motion, knee OA patients compensate in their daily activities, resulting in changes in walking patterns, climbing stairs, and sitting to standing. Knee OA patients exhibit increased weight-bearing asymmetry, limited flexion on the affected knee, increased trunk inclination toward the healthy side, more trunk flexion during sitting to standing movements, and lower moment of knee extension due to decreased quadriceps strengths. These conditions cause the sitting to standing movement to become longer. On the other hand, slow sitting to standing may also be a deliberate strategy to reduce acceleration, joint force, and pain. Due to asymmetric loading, the contralateral joint tends to become OA. Knee osteoarthritis patients with obesity experience

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a decrease in the hip and knee range of motion, decreasing peak hip and knee moments.[5]

Functional mobility of knee OA patients is performed by checking the sit-to-stand ability using the 30-second sit-to-stand test (30STS), which assesses the number of repetitions sitting to standing that can be done for 30 seconds. There are several variations of the sit-to-stand (STS) test, apart from the 30STS. The five-repetition sit-to-stand test (FRSTST) assesses the time to perform five times sit-to-stand and 10 times repeated sit-to-stand (10STS), which rates the time to complete ten times sit-to-stand. The 10STS or 30STS test describes more endurance than the FRSTST test.[6]

The Western Ontario dan McMaster Universities Osteoarthritis (WOMAC) index is one of the questionnaires to assess the quality of life. According to the World Health Organization, "quality of life" is an individual's perception of their position in life in the context of the culture and value systems in which he lives and concerning his goals, expectations, standards, and concerns.[7] Higher WOMAC indexes indicate worse pain, stiffness, and functional limitations.

The prevalence of knee OA increases with age and obesity, two of OA patients' various characteristics. Then the ability to rise from sitting to standing effectively is essential to achieve independence and participation in the community. The study analyzes the correlation of knee OA patients' characteristics with functional mobility using the 30-second sit-to-stand test (30STS) and the correlation of functional mobility with quality of life using the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) Index.

Methods

This study is a descriptive-analytic with a cross-sectional method. The data was taken from the medical records of 73 knee OA patients at the Outpatient Medical Rehabilitation Clinic at Soreang Hospital, Muhammadiyah Hospital, Al Islam Hospital, and Al-Ihsan Regional General Hospital West Java Province, Bandung, from March until August 2021. All patients recruited for the study, either new or follow-up with a diagnosis of knee OA, went to the physical medicine and rehabilitation outpatients during the time of study in the respective hospitals and were accepted to be tested for 30STS and filled out the WOMAC index questionnaire.

Patients' characteristics such as age, gender, height, weight, body mass index, waist circumference, hip circumference, waist-hip ratio, onset (duration of experiencing knee OA symptoms), pain intensity (numeric rating scale, NRS), varus/valgus deformity.

Patients' BMI based on the WHO Asian-BMI classification as follows, BMI<18.5 kg/m^2 (lean or underweight), 18.5–22.9 kg/m^2 (normal), 23–27.49 kg/m^2 (overweight) and 27.5 kg/m^2 or above as (obese).[8] The patient's waist circumference cut-off point based on the International Diabetes Federation classification for Asians is >90 cm in men and >80 cm in women, and the waist-hip ratio cut-off point based on the WHO classification for Asians is >0.90 in men and >0.80 in women.[9]

Patients need to meet outpatient inclusion criteria and have primary knee OA. They were excluded if they had one of the following limb contracture, OA hip, OA ankle, balance disorders, vertigo, and low back pain/lumbar radiculopathy.

The STS test is an assessment tool that investigates the ability to stand up from a sitting position. Using a standardized chair, the subject needs to change status from sitting to standing repetitively in 30 seconds.[4]

WOMAC index is a self-administered measure of health status that assesses dimensions of pain, stiffness, and function (either separately or as an overall index) in patients with hip or knee OA. Three subscales (pain, stiffness, and physical function) and a total (WOMAC index) reflect overall disability.[10]

The frequency distribution was analyzed by assessing the mean-median difference, standard deviation, minimum to maximum values, skewness, kurtosis, and the Shapiro-Wilk test for all variables. Variables that meet the assumption of a normal distribution are analyzed for their correlation using Pearson correlation. In contrast, Spearman correlation is used to analyze the correlation of variables that do not meet the assumption of a normal distribution. The correlation will be accepted if the p-value <0.05 and also analyze the r value to know which correlation meets the negative or positive criteria.[11] Statistics analysis using Stata version 15.0 (Stata Corp., Texas, USA).

This study has been approved by the Health Research Ethics Committee of Al Islam Hospital Bandung number 019/KEPPIN-RSAI/09/2021.

Results

Of 74, unfortunately, a participant was deceased, so a total of 73 participants took part in this study. The subjects were 54 women (74%) and 19 men (26%).

The variables of age, weight, height, body mass index (BMI), waist circumference, hip circumference, waist-hip ratio, and 30STS meet the assumption of a normal distribution. Set and numeric rating scale (NRS) do not meet this assumption. In this study, participants were, on average, 65.53+9.76 years, which was included in the older adult category (Table 1). The mean value of BMI is 27.93+6.21 kg/m^2 (category obese 1), waist circumference is 90.74+12.43 cm (abdominal obesity), waist-hip ratio is 0.89+0.06 (abdominal obesity), and numeric rating scale is 5.67+1.62 (moderate pain intensity). The median for the numeric rating scale was 6, with the highest pain score of 8. Overall the result for the functional immobility test using 30STS has a mean of 8.41 with a standard deviation of 3.24. It means that in 30 seconds, subjects can do eight times sit-to-standing activities.

Table 1 Knee OA Subject Characteristics

Characteristics	Median	Range	Mean±SD
Age (year)	67	44–92	65.53±9.76
Weight (kg)	63.1	40–92.4	63.43±12.45
Height (cm)	150.5	136–169	151.95±7.27
Body mass index (kg/m^2)	26.95	15.8–48.7	27.93±6.21
Waist circumference (cm)	94	58–110	90.74±12.43
Hip circumference (cm)	104	72–133	102.14±11.85
Waist-hip ratio	0.9	0.74–0.98	0.89±0.06
Onset (years)	2	1 week–20 years	4.61±6.31
Numeric rating scale	6	0–8	5.67±1.62
30STS (times/30 second)	8	0–16	8.41±3.24

Table 2 Correlation of 30STS with Knee OA Characteristics

Characteristics	r	p
Age (year)	−0.28	0.02
Weight (kg)	0.09	0.43
Height (cm)	0.09	0.41
Body mass index (kg/m^2)	0.06	0.60
Waist circumference (cm)	−0.09	0.47
Hip circumference (cm)	0.04	0.76
Waist-hip ratio	−0.24	0.07
Onset (years)	−0.29	0.01
Numeric rating scale	−0.14	0.23

Note: p<0.05 significant

Table 2 shows a negative correlation between

Table 3 Distribution of 30 STS in Gender, Deformity, and OA Grade

	Median	Mean±SD	p
Female	8	8.37±3.06	0.85
Male	8	8.52±3.79	
Non-deformity	9	9.12±2.74	0.04
Deformity	8	7.54±3.61	
Valgus	6	4.02±5.86	0.06
Varus	8	8±3.44	
OA grade 1	7.5	9±3.37	0.03
OA grade 2	9	9.05±2.53	
OA grade 3	8	8.25±3.12	
OA grade 4	5	4.75±3.61	

Note: p<0.05 significant

Table 4 Frequency Distribution and Correlation of WOMAC Index

	WOMAC Index	
	Median	**Mean±SD**
Pain	9	9±9.08
Stiffness	2	2.66±31.72
Activity difficulties	33.5	31.72±16.09

Table 5 Correlation of 30STS and WOMAC Index

	r	**p**
Pain	−0.25	0.03
Stiffness	−0.28	0.02
Activity difficulties	−0.33	0.00

Note: p<0.05 significant

age (p=0.02) and onset (duration) of knee OA (p=0.01) with 30STS results. Each increase in age and onset (time) of OA symptoms separately will be accompanied by a decrease in the 30STS score. From the r value, it can be seen that the onset of the disease has a higher r value than age.

Table 3 shows no significant difference in the mean of 30STS between the men and women groups. Both deformity and OA grading significantly differ in the result of 30STS. Females have a lesser amount of sit-to-stand in 30 seconds, and grade 4 osteoarthritis also has the least amount of sit-to-stand. There are no differences between valgus of varus in this study.

Table 4 shows that the highest score of the sub-component WOMAC index was in activity difficulties 31.72+16.09. The lowest mean was in the score of stiffness.

Pearson correlation was used to see the correlation between 30STS and the WOMAC index. Table 5 shows a significant correlation in each component of the WOMAC index.

Discussion

Participants in this study were included in the category of abdominal obesity based on the waist circumference cut-off point and the waist-hip ratio cut-off point for Asians,[9] in the category of obesity based on the mean BMI,[8] and in the category of moderate pain intensity. This study did not separate the characteristics by gender, including anthropometric traits.

The participants had experienced symptoms related to knee OA for an average of 4.61+6.31 years. It is not the same as the study by McCarthy et al.,[12] the average duration of experiencing symptoms is 0.5–2 years. The systematic review and meta-analysis by Blagojevic et al.[13] indicate increased BMI, history of a knee injury, presence of hand OA/Heberden's nodes, female gender, older age, intensive physical activity, certain physical, occupational activities (e.g., kneeling, squatting) and increased bone mineral density to be risk factors for the onset of knee OA in older adults. In this study, the abovementioned factors were not investigated.

In a community, the proportion of people with knee OA tends to increase due to aging and rates of obesity or overweight. Women, especially those 55 years old, tend to have more severe OA in the knee but not elsewhere. The prevalence of knee OA in men is lower than in women.[14] Osteoarthritis is an inevitable result of aging and the wear and tear of joints. The aging process of articular cartilage increases the risk of degeneration, including articular surface fibrillation, decreased size and aggregation of proteoglycan aggrecans, increased collagen cross-linking, and the loss of tensile strength and stiffness. These changes are most likely due to the aging process of chondrocyte function, which reduces the ability of cells to maintain tissue.[15] Knee osteoarthritis is not only a result of aging but the disease itself.[16] Excessive load on the joints due to obesity can affect the biomechanical pathways. Increased central fat affects gait and balance, which are associated with radiographic knee osteoarthritis. However, the increased mechanical load is not the only pathophysiology of OA. Metabolic factors, such as elevated blood glucose were associated with radiographic knee osteoarthritis regardless of age and BMI. Inflammatory mediators also play a role in the pathophysiology of knee OA. Interleukin-6 and other inflammatory mediators are produced in central obesity or abdominal fat accumulation conditions.[17]

The 30STS results from Table 1 and Table 3 show that participants in this study have an average risk of falling according to the Centers for Disease Control and Prevention (CDC) scores.[18] STS performance is associated with disability, falls, hip fractures, and death among older adults. The STS performance is correlated with muscle strength and power of the lower limbs. It does not represent an estimate of muscle strength or

power.[19]

Sitting to standing consists of two phases; phase 1: from the beginning of the movement to the lift of the buttocks (buttock off/seat off) and phase 2: from the buttock off until motion termination. Sitting to standing activity is a series of movements which include: (1) Movement of the mass center of the body (MCB) forward and then upwards, and the upper body segment leans forward and shifts the MCB. It is on the broad base of support (BOS) formed by the buttocks, thighs, and legs, toward the narrower BOS formed by both legs, without losing balance.The position association between MCB and BOS is used as a postural stability index. (2) Sitting to standing shifts the MCB forward and upward, which requires joint movement and a high hip and knee extension moment to lift the MCB against gravity. Thus, anthropometric factors, which are weight and height, need to be considered. (3) Leg extension from sitting to standing is produced by some monoarticular leg muscles and the articular hamstring muscles.[20] The rectus femoris muscle is active isometrically, transferring the moment from the hip joint to the knee joint, directing the ground reaction force backward, and controlling balance after the seat.[21]

This study shows a negative correlation between age, onset (duration) of knee OA, waist-hip ratio (WHR) and the 30STS results. Each increase in age, onset (duration) of OA symptoms, and WHR will be accompanied by a decrease in the 30STS score. It is considered that increasing age changes fat distribution; waist circumference increases with age. Waist circumference is greater in older than younger adults up to age 70 in both sexes.[22] The combination of obesity and knee OA causes the joint range of motion of the affected knee and hip to decrease, resulting in biomechanical changes during sitting and standing movements.[5] In this study, although the average BMI indicates obese one and waist circumference indicates abdominal obesity, the WHR is the one that correlates with 30STS, even though the correlation is weak.

In contrast to this study, Verlaan et al.'s[5] study on healthy people, obese and non-obese knee OA patients, found that in the sitting to the standing motion of three groups, the extension phase was the longest, followed by the leaning phase and the momentum phase. The time from sitting to standing was not significantly different between the three groups. In the obese knee OA group, a decrease in knee and hip joint range of motion was associated with lower maximal knee moment and hip extension moment compared to the control group. In obese knee OA, the vertical Ground reaction force (GRF) is reduced, and the medial GRF is increased, indicating the use of compensatory mechanisms to reduce the load on the knee in obese knee OA patients.

Different test methods were performed by Bohannon et al.[6] on subjects ranging from adolescents to older adults (those who are 14 until 85 years. They were able to walk without the use of assistive devices. They had no heart or blood vessel problems, blood, lung, or bone/joint resistance to standing up from a chair or climbing stairs) indicating that the time to perform FRSTST was lower in stronger, younger, shorter, and lighter subjects. It means the stronger, younger, shorter, and lighter a person, the faster they can do five repetitions of STS.

In Table 2, the onset/duration of experiencing OA has a negative (significant) correlation with 30STS, in which the more prolonged the onset, the smaller the 30STS, but it is found that the degree of pain, indicated by a numeric rating scale did not correlate with the 30STS outcome. In contrast, Turcot et al.'s[22] study shows a weak correlation between knee pain and the average time to complete the STS task.

Table 3 shows no significant difference in the median of 30STS between the men and women groups. Perhaps because the number of samples of male participants was less than women. Although women's knees are retrained smaller and have less cartilage than men's tend to cause joint problems.[24]

Table 3 shows a negative correlation between deformity (p=0.04) and OA grade (severity) (p=0.03) with the 30STS results. Each increase in OA severity (grade) and the presence of deformity will be accompanied by a decrease in the 30STS score. The median value of 30STS was significantly different between the deformity and non-deformity groups. The non-deformity group had a median value of 30STS which was greater than the deformity group (p=0.04). Valgus deformity had a median 30STS lower than the varus. There is a significant difference in the median value of 30STS between OA grades 1 to 4, and the lowest median is OA grades 4. While the median value of 30STS between OA grades 1 to 3 is not so different. Like this study, Kocak et al.'s[25] research found knee function scores measured by

the sit-to-stand test were lower in osteoarthritis patients than in healthy controls. The scores in grades 1 and 2 knee patients were similar, although they were higher than in grades 3 and 4. In the sit-to-stand test, osteoarthritis patients showed lower independent status than healthy controls. Kocak et al.'s[25] research findings suggest that radiographic severity does not correlate with functional disability, which may be due to population heterogeneity, radiographic data, and clinical criteria for evaluation.

Thicker articular cartilage is considered healthier cartilage. Cartilage thinning is associated with the development of knee osteoarthritis.[25] As OA progresses, the cartilage diminishes and breaks down. Full-thickness cartilage loss (FTCL) is typical in the medial and patellofemoral knees. According to the Kellgren-Lawrence system, the OA grade has the highest correlation with confirmed cartilage loss in patients after total knee arthroplasty.[24] In this study, the OA grade was based on the Kellgren-Lawrence system. The OA of the patellofemoral joint is very common and is a significant source of pain and impaired function. The prevalence of OA of the patellofemoral joint (PFJ) is as high/higher than OA of the tibiofemoral joint (TFJ).[26] Peak knee flexion moment and flexion moment impulse during the second half of standing are associated with the development of PFJ OA. Reduced flexion moment and vastus muscle force indicate reduced quadriceps performance in individuals showing the progression of PFJ OA.[19] This may cause a decrease in 30STS results, as well as knee OA with varus and valgus deformities, respectively, increasing the risk of progression of biomechanical stress in the compressed compartment and reducing the risk of progression in the non-load-bearing compartment.[27]

In this study, all categories of WOMAC Index had a significant correlation with 30STS, although the correlation was weak (Table 5). The results of the 30STS showed a reasonably reliable and valid indicator of lower body strength in older adults living in a generally active society.[27] Turcot et al.'s[23] study showed a correlation between the pain sub-scores of the WOMAC index questionnaire and the average time to complete the STS task. Between the total score of the WOMAC index questionnaire and the average time to complete the STS, a positive but not significant correlation was observed between the WOMAC index function and time to perform the STS task. Furthermore, another result of Katia Turcot's study showed that decreased functional capacity was associated with reduced knee flexor moment and was closely associated with quadriceps weakness recognized in knee OA.

It has been mentioned above that in this study, the lower the 30STS result, the higher the WOMAC value, meaning that the pain, stiffness, and functional limitations were higher. The results of 30STS were representative of the patient's condition, such as the increasing age associated with cartilage aging and joint wear and tear. WHR (abdominal/central/visceral obesity) causes excessive load on joints and decreased range of motion of the knee and hip joints, resulting in impaired sitting to standing patterns. The reduced extension moments and the release of inflammatory mediators by fat cells affect the pathogenesis of OA. In addition, various risk factors influence the onset of OA; an increase in OA grade and deformity is associated with progressive cartilage depletion and suggests a decrease in quadriceps performance. These biomechanical and metabolic changes affect sitting to standing performance, which correlates with the WOMAC domains, i.e., pain, stiffness, and activity difficulties.

In the physical function domain, there are questions about the difficulty of descending and ascending stairs. Some participants admitted that they were afraid when descending and climbing stairs and even reported that they had not done ascending and descending stairs for a long time. Some participants who experienced mild pain showed low sitting to standing performance. There are psychological factors that must also be investigated. In this study, knee OA patients aged >75 years were 18%. It is also necessary to consider sensorimotor, balance, and psychological factors, which will affect the performance of sitting-standing.[29]

The WOMAC Indonesia questionnaire has been validated and reliable for use on the Indonesian population. The pain and stiffness subscales are very well-received, but there are some problems with the function subscales. Some patients experience some ambiguous terms, such as the term "toilet". Indonesian habit of using a toilet is by squatting rather than sitting. "Rising from bed" in Indonesian has the perception of waking up (opening their eyes) instead of getting out of the bed. "Lying in bed" has a biased meaning

to sleeping. "Lying" or sleeping for Indonesians has almost the same meaning. Similarly, "getting in/off the bath, wherein Indonesia, it is rare to find a bathtub, so additional information is needed. Getting out/into the bath (stepping as high as +50 cm)". For some Indonesians, the term "sit" means sitting on the floor rather than on a chair.[30] So that in giving the questionnaire, it is necessary to provide additional information.

Based on this study's results, an exercise program is needed to increase the quadriceps muscle's maximum concentric and eccentric strength, co-activation of the lower knee muscles, and better joint coordination, which may be beneficial in improving functional ability in OA patients. It is also essential that obesity needs to be an important target for restoring healthy sit-to-stand biomechanics. In addition, OA patients need to develop adaptive activities and self-care tools to protect their joints (joint protection). Finally, to improve the functional ability of knee OA patients, it is necessary to have an examination and treatment related to decreased psychological and neurological function.

Conclusion

Age, the onset of disease, OA grade, and knee deformity have a significant correlation to functional immobility and also a correlation of functional immobility with the patient's quality of life based on the WOMAC index.

Conflict of Interest

There is no conflict of interest in this study.

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