Efficacy of Exercise in the Sitting Position Compared with Exercise in the Standing Position in Obese Patients with Knee Osteoarthritis

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ABSTRACT

Background: *Knee osteoarthritis (OA) is a degenerative condition that causes pain, swelling, and stiffness, affecting a person's ability to move freely. Non-weight-bearing therapeutic exercise programs provide better pain reduction and improve joint function compared with conventional exercise programs. This study compared the effectiveness of therapeutic exercises in sitting versus standing positions in reducing pain, improving knee function, and enhancing quality of life in obese patients with OA.* ***Methods:*** *Fifty-four obese women aged 50–80 years were randomly assigned to one of two exercise program groups, either sitting or standing. Members of each group participated in a 12-week intervention consisting of aerobics, hip stretching and strengthening, and balance exercises. Sessions lasted 45 minutes, three times per week, increasing by 30 minutes every four weeks. Pain was assessed using the Numerical Rating Scale, knee function was measured with the Knee Injury and Osteoarthritis Outcome Score, and quality of life was assessed with the 12-Item Short Form Survey. Measurements were taken at baseline and every four weeks during the intervention.* ***Results:*** *When compared with the standing position group, the sitting position group showed significantly less pain and better knee function as determined by NRS and KOOS, as well as better physical quality of life ($p<0.05$). In contrast, the standing position group had a better mental quality of life.* ***Conclusion:*** *Therapeutic exercises in a sitting position are more effective in reducing pain, improving knee function, and enhancing physical quality of life in OA. However, standing exercises contribute more to mental well-being.*

Keywords: *Knee osteoarthritis, exercise therapy, obesity, weight-bearing exercise program.*

INTRODUCTION

Osteoarthritis (OA) of the knee, commonly referred to as degenerative joint disease of the knee, is usually caused by gradual articular cartilage loss as well as wear and tear. It causes pain, swelling, and stiffness, affecting a person's ability to move freely.[1,2] Diagnosis of OA is achieved following symptoms of pain in the knee accompanied by at least three clinical criteria, namely, age over 50 years, less than 30 minutes of morning stiffness, crepitus or sounding joints during activity, pain felt in the bone area, enlargement of the bone, and lack of warmth of the knee joints when held.[3]

Management of OA consists of several modalities that can be grouped into three categories: non-pharmacologicalmanagement, pharmacological management, and surgical interventions. Non- pharmacological treatments include conventional exercise programs, such as weight-bearing therapeutic exercises and non-weight-bearing therapeutic exercises.

Although all exercise benefits knee OA,[4] conventional exercise programs, such as weight-bearing therapeutic exercises, often impose additional stress on the joints despite enhancing functionality and reducing pain.[5] Conversely, non-weight-bearing therapeutic exercises do not add extra strain to the joints but still provide benefits in alleviating pain and improving joint functionality.[6]

A recent study found that both weight-bearing and non-weight-bearing therapeutic exercises result in similar reductions in pain and improvements in functional ability, but weight-bearing exercises showed better quality of life and overall improvement assessed through the Knee Injury and Osteoarthritis Outcome Score (KOOS).[7] Patients in the weight-bearing exercise group also showed fewer side effects, especially those with other comorbid joint pain. The study demonstrated that seated therapeutic exercise programs (without weight-bearing) were more effective in reducing pain, improving joint function, and enhancing quality of life compared with existing conventional therapeutic exercise programs. Previous studies stated that non-weight-bearing therapeutic exercises can be performed in obese patients with knee OA who find it difficult to perform exercises that place considerable strain on their knees.

Non-weight-bearing therapeutic exercise programs have previously been shown to provide better pain reduction and joint function improvement compared with conventional exercise programs.[8] Therefore, in this study, we compared the effectiveness of a therapeutic exercise program in seated and standing positions in reducing pain using the Numerical Rating Scale (NRS) indicator, improvements in knee function using the KOOS indicator, and enhancements in quality of life using the 12-Item Short Form Survey (SF-12) indicator.

METHODS

This study was a single blind, randomized controlled trial. Fifty-four women with obesity and knee OA enrolled in this study and were distributed randomly into two equal groups. Patients performed therapeutic exercise either in a sitting position or in a standing position. The inclusion criteria were age 50–80 years old with Body Mass Index (BMI) >25 kg/m^2 and diagnosed with knee OA according to the American College of Rheumatology criteria with baseline pain on NRS of 4–6. Patients with a history of knee surgery, unable to walk without any type of cane or walker, unstable psychiatric condition, pregnancy, and advanced-stage osteoporosis were all excluded. The participants' flowchart is described in **Figure 1**. A consent form was read and signed by every patient before intervention.

Ethics Committee Approval

The Ethical Committee of the Faculty of Medicine, Universitas Indonesia, had granted ethical approval for this study (No.KET/963/UN2.F1/ETIK/PPM.00.02/ 2023).

Outcome Measurement Knee Pain

Knee pain was evaluated using the NRS and ranged from 0 to 10, with a higher score indicating more pain.

Knee Function

Knee function was assessed using the KOOS, which has been validated for evaluating knee osteoarthritis in the Indonesian population.[7]
The questionnaire contains 42 items that assess five dimensions: pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life.

Quality of Life

The SF-12 was used to evaluate quality of life. It has been validated as a health-related quality of life measure in the Indonesian population.[8] The outcomes are a physical component score and a mental component score ranging from 0– 100.

Intervention

The sitting group performed aerobic exercise in a sitting position involving hip stretching and strengthening exercise, and balance exercise. For the first four weeks, the duration of each session was 45 minutes, consisting of 30 minutes of aerobic exercise, ten minutes of hip stretching and strengthening exercise, and 5 minutes of balance exercise. The exercise is described in **Table 1**. Over the next four weeks, the duration of each session was increased to 75 minutes, consisting of 45 minutes of aerobic exercise, 20

minutes of hip stretching and strengthening, and 10 minutes of balance exercise. The duration was increased again in the last four weeks to 105 minutes, consisting of 60 minutes of aerobic exercise, 30 minutes of hip stretching and strengthening, and 15 minutes of balance exercise.

The standing group performed treatments that differed only in the aerobic exercise, which was performed in a standing position with the same duration as aerobic exercise in the sitting group. The hip stretching and strengthening exercise and the balance exercise were performed in the same way as for the sitting group. Both groups performed the exercise 3 times/week for 12 weeks.

Data Analysis

Baseline characteristics between the two groups were analyzed using Student's T-test. The distribution of the data was analyzed with the Shapiro–Wilk Test. NRS, KOOS, and SF-12 scores were analyzed by the Mann–Whitney U-test as the distribution of the data was abnormal.

RESULTS

Patient Characteristics

After enrollment, 5 patients from the sitting group and 5 patients from the standing group did not complete the program for personal reasons. Both groups' baseline characteristics are described in **Table 2**.

Comparison of sample characteristics in the study

This study showed that the standing group experienced a significant decrease in several health parameters. The average waist circumference decreased from 99.1 cm to 93.8 cm, body weight from 68.5 kg to 62.8 kg, and BMI from 30.8 kg/m^2 to 28.2 kg/m^2. However, the sitting group did not show significant changes in these parameters. Comparisons of the groups are shown in **Table 3**.

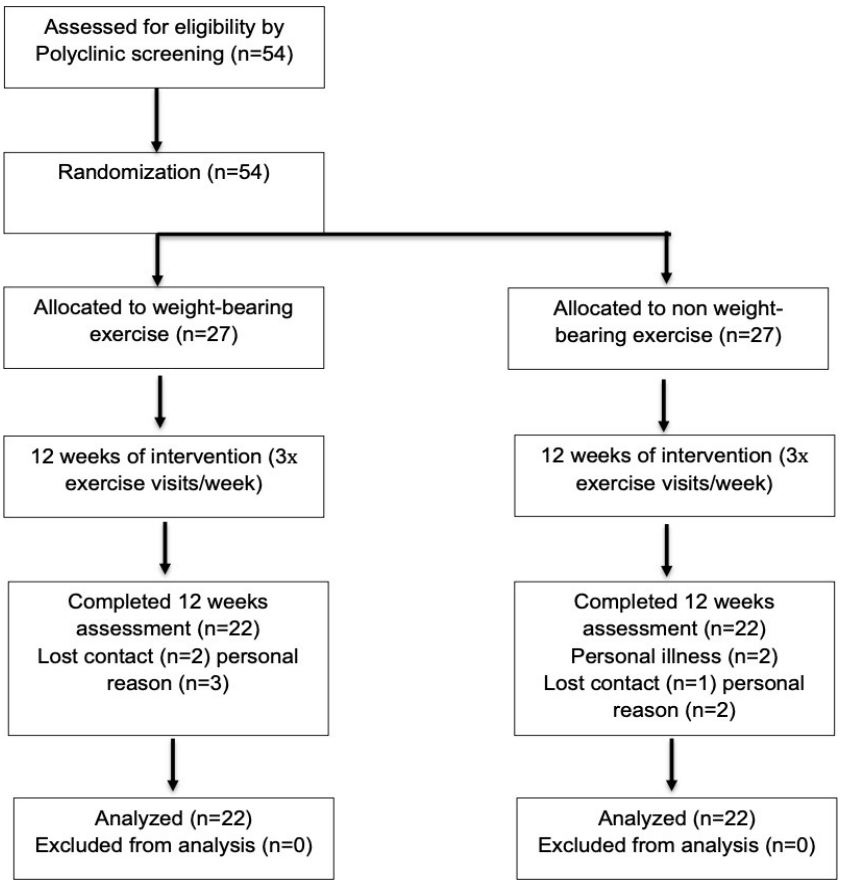

Figure 1. Study design and protocol

Table 1. Exercise description

Description		
Aerobic		
Standing position: stand up straight Repeat each move for 2 × 8 counts (Repeat until the time runs out)	March in place March in place with moving hands March in place March forward to backward	Walk in place Walk in place, arm moved forward, then upwards Walk in place Walk forward 4 steps, then backward 4 steps
Sitting position: sit back on the chair with knee flexed 90° and the foot on the ground Repeat each move for 2 × 8 counts (Repeat until the time runs out)	Arm and leg raise Hip clap with seated walking Seated jumping jack Elbow flexed with seated walking Seated walking with arm crossed on the chest	Knee extension with contralateral shoulder extension, then alternately Hip raised while the contralateral hand is touching, then alternately for the next count Hip abduction with hands clapped above the head, then back to the starting position, alternately Hip raised with elbow flexed until touching the hip, then the contralateral for the next count Hip raised with arm crossed on the chest
	Stretching and Strengthening	
Week 1–4: each move duration 30 seconds Week 5–8: each move duration 100 seconds Week 9–12: each move duration 150 seconds	Quadriceps (right and left) Hamstring (right and left) Triceps surae Hip adductors Quadriceps (right and left) Hamstring and triceps surae Hip abductors (right and left) Hip adductors	Position: Supine with a small ball below the knee Instruction: Push the ball with the back of the knee using contracted quadriceps for 10 seconds, Position: Supine with ball between flexed knees Instruction: Flex the knee for 10 seconds, then rest for 10 seconds without full extension Position: Supine Instruction: Flex the foot with the hand, pulling a medium-resistance elastic band Position: Supine with hip flexed 45° and knee flexed 90° Instruction: Ball placed between the knees Position: lateral decubitus Instruction: Flex the knee with the hand pulling the foot until touching the gluteus Position: Supine with hip flexed 90° and knee fully extended Instruction: Flex the foot with the hand pulling a medium-resistance elastic band Position: Sitting Instruction: Cross one leg over the other leg with the knee flexed according to the individual patient's tolerance Position: Supine with hip flexed 45° and knee flexed 90° with both feet touching Instruction: Push the hip to the ground with the hands according to the individual patient's tolerance

	Balance	
Week 1–4: each move duration 2.5 minutes Week 5–8: each move duration 5 minutes Week 9–12: each move duration 7.5 minutes	Balance cushion	Starting position: Stand on the balance cushion Progress to standing position with eyes closed until standing on one leg
	Balance board	Starting position: Stand on the balance cushion Progress to standing position with eyes closed until standing on one leg

Table 2. Demographic and baseline clinical characteristics of patients

Variable	Standing	Sitting	P-Value
Age	63.8 (55.6, 72.0)	63.4 (55.7, 71.1)	*P*=0.805
Neck circumference	37.8 (24.4, 51.2)	35.0 (31.8, 38.2)	*P*=0.776
Waist circumference	93.8 (83.8, 103.8)	96.7(87.0, 106.4)	*P*=0.222
BMI (kg/m^2)	29.42 (25.80, 33.04)	30.31 (26.56, 33.96)	*P*=0.585
NRS	4.9 (1.0, 3.8)	4.7 (3.9, 5.6)	*P*=1.000
KOOS	62.35 (51.8, 72.9)	58.6 (42.1, 75.0)	*P*=0.869
- Pain	69.47 (49.9, 88.9)	64.8 (47.5, 82.0)	*P*=0.533
- Symptoms	74.03 (58.2, 89.8)	66.2 (46.1, 86.3)	*P*=0.628
- Function in daily living	65.11 (50.9, 79.3)	59.2 (42.8, 75.5)	*P*=0.860
- Function in sport and recreation	52.95 (36.4, 69.4)	48.8 (23.4, 74.2)	*P*=0.814
- Quality of life	51.14 (41.0, 61.28)	53.3 (30.3, 76.3)	*P*=0.336
- SF-12 Physical	35.00 (28.2, 41.8)	37.1 (30.5, 43.7)	*P*=0.519
- SF-12 Mental	50.09 (41.7, 58.4)	52.6 (44.4, 60.8)	*P*=0.100

Table 3. Comparison of clinical characteristics of patients

	Standing			Sitting		
	Pre	Post	P-Value	Pre	Post	*P*-value
Neck circumference (cm)	36.1	37.7	0.621	34.5	34.9	0.442
Waist circumference (cm)	99.1	93.8	0.040	95.3	96.6	0.646
Weight (kg)	68.5	62.8	0.043	66.1	68.5	0.264
BMI (kg/m^2)	30.8	28.2	0.044	29.0	30.0	0.286

Effectiveness of Therapeutic Exercise Program

In this study, the effectiveness of therapeutic interventions was evaluated by comparing outcomes between a sitting group and a standing group over 12 weeks. The results indicate that the sitting group experienced notable improvements across multiple measures compared with the standing group. Firstly, in terms of knee pain reduction, the sitting group demonstrated a significant decrease in pain scores at week 12, with scores dropping from 4.7 at baseline to 2.1, whereas the standing group only saw a slight decrease from 4.9 to 3.2 (U=102, Z=–3.50, *P*<0.0001).

Additionally, the sitting group exhibited substantial improvements in knee function as assessed by the KOOS scores. At week 12,

the sitting group's KOOS scores increased significantly from 58.6 to 82.0, whereas the standing group showed a less substantial improvement, with scores ranging from 62.35 to 73.70 (U=156.6, Z=-2.01, *P*=0.045). Furthermore, when considering physical health-related quality of life measured by SF-12 (physical scores), the sitting group consistently outperformed the standing group. By week 12, the sitting group's SF-12 Physical scores had risen notably from 37.1 to 48.2, whereas the standing group's scores increased from 35.00 to 44.36, indicating a more substantial improvement in the sitting group (U=156, Z=-2.02, *P*=0.043). Even in terms of mental health-related quality of life, although both groups showed improvements, the sitting group maintained a higher average score throughout the study duration (U=150, Z=-2.16, *P*=0.031).

In summary, the sitting group exhibited superior outcomes across various measures compared with the standing group, including reduced knee pain, improved knee function, and better physical health-related quality of life. These findings suggest that therapeutic interventions involving sitting may be more effective in managing knee pain and enhancing overall health-related quality of life compared with interventions involving standing.

DISCUSSION

Exercise is almost always recommended for treating knee OA.[9] Based on the study characteristics, this research involved 54 patients divided into two groups, namely the standing and sitting groups. Each group had 22 participants who completed the study and attended all scheduled examinations. The NRS instrument revealed that after undergoing therapeutic exercise programs for 12 weeks, patients in the sitting group experienced a decrease in average pain from 4.7 to 2.1, while those in the standing group experienced a decrease from 4.9 to 3.2. This suggests that both sitting and standing exercises are beneficial in reducing pain in obese patients with OA, as both exercises improve upper leg strength.[10] However, there was a difference in the degree of pain reduction between the two positions, with slightly greater reduction observed in patients who performed sitting exercises. This finding is consistent with previous research by Sara Khan et al., indicating

Table 4. Statistical analysis of the effectiveness of the therapeutic exercise program

Group	Baseline	Week 4	Week 8	Week 12
		NRS		
Sitting	4.7±0.8	3.4±1	2.8±1.1	2.1±0.8
Standing	4.9±1.0	3.2±1.4	3.0±1.5	3.2±1.2
The sitting group showed a significant decrease in knee pain scores compared with the standing group at week 12 (U=102, Z=-3.50, *P*<0.0001)				
		KOOS		
Sitting	58.6±16.5	67.5±7.5	72.5±10.1	82.0±9.8
Standing	62.35±10.55	71.61±5.7)	75.01±9.2	73.70±16.7
The sitting group showed a significant increase in KOOS scores compared with the standing group at week 12 (U=156.6, Z=-2.01, *P*=0.045)				
		SF-12 Physical		
Sitting	37.1± 13.2	40.3±11.5	42.4 ±13.3	48.2±8.5
Standing	35.00±6.8	37.38±6.7	41.79±7.7	44.36±6.2
The standing group showed a significant increase in SF-12 Physical scores compared with the sitting group at week 12 (U=156, Z=–2.02, *P*=0.043)				
		SF-12 Mental		
Sitting	52.6±8.2	57.7±3.4	57.9±3.3	55.2 ± 11.0
Standing	50.09±8.3	50.13±7.8	52.68±8.4	58.47± 10.8
The sitting group exhibited a significant increase in SF-12 Physical scores compared with the standing group at week 12 (U=150, Z=–2.16, *P*=0.031)				

that non-weight-bearing exercises are more effective in reducing pain and physical function in knee OA compared with weight-bearing exercises.[11] Additionally, it aligns with the study by Perez et al., where aerobic exercises in a non-weight-bearing position (sitting) had a positive impact on knee pain and disability compared with standing aerobic exercises.[5] Furthermore, Bennel et al. suggested that weight-bearing exercises increase the risk of injury and discomfort in the knees, while non-weight-bearing exercises may be more beneficial for pain reduction and improving knee function.[12] Overall, aerobic exercises improve muscle strength and flexibility, providing better support and stability to the knee joints. Strength training exercises can also build muscles around the knees, reducing pressure on them and possibly reducing pain.[11]

In terms of knee function assessed by the KOOS instrument, the sitting group showed significantly better knee function compared with the standing group, with dimensions of pain, Activity Daily Living (ADL), and quality of life indicating the sitting group's considerable superiority over the standing group, while the symptom and sports and recreation dimensions did not show significant differences.

These results provide additional support for the findings of this study, which show that therapeutic exercises in both sitting and standing positions provide improved symptom values from week 4 compared with baseline. Interestingly, there was no significant difference in symptom values between the sitting and standing groups after 12 weeks of treatment. This may be because low-intensity aerobic exercise provides similarly effective therapeutic effects on knee OA regardless of whether the exercise is done sitting or standing. Interestingly, both groups still experienced knee pain even at the end of the study. Perhaps the lingering pain was why patients in both groups were still unable to exercise properly, as indicated by the lack of significant differences in the sports and recreation component of the KOOS instrument at week 12 compared with baseline, in both the sitting and standing groups. More time may be needed to start exercising and recreational activities after knee pain has subsided.

In another study comparing non-weight-bearing exercise with weight-bearing exercise for 12 weeks in obese patients with OA (Bennel et.al), the results contrasted with those of this study. That study did not show significant differences in primary outcomes such as knee pain and function between the weight-bearing and non-weight-bearing groups. In secondary outcomes, knee function scores assessed by KOOS and quality of life assessed using a quality of life (QoL) instrument in the weight-bearing group were even better than those in the non-weight-bearing group, which also contrasts with the findings of our study.

Improvements in the physical aspects of SF-12 showed similar results to KOOS results, indicating the sitting group was significantly better after 12 weeks of intervention. In contrast to physical scores, SF-12 mental scores showed that the standing group was significantly better than the sitting group, possibly due to the significant weight loss associated with improved psychological quality of life, as energy expenditure in the standing position is higher than when sitting.[13,14] This finding differs from that of a previous study by Peres-Huerta et al, which showed no statistically significant difference between the mental and physical aspects SF-12 in either the standing or sitting groups.[5,12,13]

Limitation the Study

This study compared the effectiveness of therapeutic exercise programs in sitting and standing positions in obese patients with genu osteoarthritis. The strengths of this study include routine evaluation every 4 weeks. In addition, the research participants did not undergo other therapy or take pain relief medicines, so they did not influence the intervention. The limitation of this study lies in the sample being entirely female, which reduces the generalizability of applying the research findings clinically and hinders the comparison of responses to therapeutic exercise programs between both genders. Uncontrolled biological factors and external variables may affect the interpretation and clinical relevance of research findings.

CONCLUSION

This study demonstrates that therapeutic exercises performed by obese patients with knee OA, whether in standing or sitting positions, reduce knee pain, improve knee function, and significantly enhance quality of life. Therapeutic exercises in the sitting position significantly showed lower pain scores, higher knee function, and higher physical quality of life compared with therapeutic exercises in the standing position. However, the standing group showed higher average scores in mental quality of life compared with the sitting group.

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CONFLICT OF INTERESTS

This study was conducted with no potential or actual conflict of interest.

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