Effect of Programmed Exercise through Telerehabilitation at Home on Visual Analogue Scale, Body Mass Index, and WOMAC among Patients with Obesity and Knee Osteoarthritis: A Quasi-Experimental Study

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ABSTRACT

Background: *This study aims to determine the effectiveness of programmed exercise with telerehabilitation at home in patients with obesity and knee osteoarthritis on visual analogue scale scores, body mass index, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).* ***Methods:*** *This research is a pre–post study in patients with obesity and knee osteoarthritis. Research subjects performed a series of exercise programs at home for 28 days. Before the program, there was an initial assessment from a psychologist and a nutritionist. During the program, there was tele-education, telemonitoring, and teleconsultation from doctors. Twenty-six female subjects participated.* ***Results:*** *Visual analogue scale scores decreased statistically significantly every week, until the end of the fourth week, compared with before the intervention ($p<0.001$). Body mass index and WOMAC scores decreased statistically significantly at the end of the fourth week compared with before the intervention (both $p<0.001$). Further analysis of all WOMAC components in the intervention group, including pain, stiffness, and physical function, also showed a statistically significant decrease ($p<0.001$).* ***Conclusion****: Programmed exercise as part of telerehabilitation at home has been statistically proven to reduce visual analogue scale scores, body mass index, and WOMAC in patients with obesity and knee osteoarthritis.*

Keywords: *Telerehabilitation, Knee Osteoarthritis, Obesity, Body Mass Index, Visual Analogue Scale, WOMAC.*

INTRODUCTION

The prevalence of joint disease in Indonesia was recorded at around 7.3%, and osteoarthritis is the most common joint disease.[1,2] Of these, knee osteoarthritis is identified as the most prevalent.[3] Although often associated with increasing age, this joint disease is strongly influenced by obesity as a modifiable risk factor.[3] Obesity is associated with a chronic state of low-grade inflammation; it is a chronic progressive disease and a well-known risk factor for osteoarthritis. Inflammatory mediators, in particular adipose tissue-derived cytokines (adipokines), play an important role linking obesity and osteoarthritis. A loss of 5 kg in weight is associated with a reduction in the risk for osteoarthritis of more

than 50%.[3]

In the event of both obesity and knee osteoarthritis, severe disability can occur due to disruption of the structure and function of the knee, which may result in decreased performance of the lower limbs during activities.[4] Based on management guidelines issued by the American College of Rheumatology (ACR), intervention takes the form of lifestyle improvements and dietary modification, and a synergistic combination of aerobic–anaerobic programmed exercise may be beneficial in treating obesity and osteoarthritis. This recommendation has been hampered by the presence of the coronavirus disease 2019 (COVID-19) pandemic, which caused the health system to fail due to the many restrictions imposed.[5]

The increasing availability of internet access and communication technology opened up opportunities to provide health services during the COVID-19 pandemic. Health services provided in this way are known as telemedicine.[6] Development of telemedicine in the field of physical medicine and rehabilitation includes teleconsultation, telemonitoring, telehomecare, and teletherapy, which forms a new field, namely telerehabilitation.[7] Telerehabilitation aims to provide added value by eliminating travel time and geographical distance in an effort to equalize health services; it also reduces the risk of disease transmission during a pandemic.[8] There have been several meta-analyses and systematic reviews regarding the effect of telerehabilitation on various conditions in the fields of physical medicine and rehabilitation. Jiang et al., who reviewed 4 individual studies on osteoarthritis, stated that telerehabilitation is recommended for patients after total knee arthroplasty.[9] Cottrell et al, who reviewed 7 individual studies on patients with osteoarthritis, stated that real-time telerehabilitation was comparable to face-to-face services.[10]

Telemedicine services in Indonesia have been specifically regulated by many stakeholders, but their implementation and impact have not been widely studied. The selection of research outcome measurement instruments that we used refers to the concept of disability according to the International Classification of Functioning, Disability and Health (ICF), with consideration of the validity and practicality of implementing the instrument. In this study, the first outcome to be assessed was the Visual Analogue Scale, which assesses pain. The second outcome that was assessed is the Body Mass Index, which assesses a person's nutritional status, obtained from the comparison of weight and height. The third outcome that was assessed is the Western Ontario and McMaster Universities Arthritis Index (WOMAC), which assesses pain and stiffness. All of the instruments collectively can describe both structural and functionaldisorders of the body associated with knee osteoarthritis and obesity.[11]

METHODS

Study Design and Setting

The study was a one-group pre- and post-test design study conducted on outpatients at Dr. Cipto Mangunkusumo Hospital, Jakarta. This study used assessor blinding to collect outcome data, without randomization. If the subjects had bilateral knee osteoarthritis, only unilateral knees were considered and analyzed in the study.

Study Population

This study analyzed primary data on patients undergoing treatment at Dr. Cipto Mangunkusumo Hospital, Jakarta, with a diagnosis of knee osteoarthritis and obesity, conducted between 2021 and 2023. The inclusion criteria were all adult patients, 50–65 years old, admitted to the hospital, diagnosed with knee osteoarthritis grade 1–3 with a VAS score 2–3, with a full range of motion of the joint, without deformity in the knees and other body parts, and obesity degree 1–2. Patients were required to have a family member or caregiver with the following criteria: have an Android-based smartphone; be able to read and write, and have a minimum elementary school education; be able to use the SiapDok RSCM/WhatsApp/Zoom application; and be able to take pictures/videos of program implementation for self-monitoring. A total of 32 patients meeting these criteria were screened for participation. Exclusion criteria were any condition that exemplified balance disorders, depressive disorders, anxiety disorders, cognitive

impairment, history of unstable cardiac and metabolic diseases, or history of knee joint replacement surgery. A comprehensive overview is provided in **Figure 1**.

Data Collection

Data for this study were collected using consecutive sampling methods and were acquired from Dr. Cipto Mangunkusumo Hospital. Case definitions are based on clinical diagnosis, which was based on clinical symptoms and roentgen. Subjects were then screened through anamnesis and physical examination, and samples were selected according to the inclusion and exclusion criteria until the number of samples was met. VAS score measurements were carried out at the initial assessment and at the end of every week via teleconsultation. WOMAC and BMI scores were measured at the initial and final assessments via face-to-face meetings at the institution.

Data Analysis

Identified data were analyzed with IBM SPSS for Windows version 25. Descriptive analysis was carried out to assess the basic characteristics of the research subjects and clinical response, as well as VAS, BMI, and WOMAC. Each variable was analyzed to determine the distribution and percentage. Categorical data are presented in **Table 1**, and numerical data are given as mean (+SD) or median (IQR), depending on the data distribution. The normality of the data was measured by the Shapiro–Wilk test. The distribution was normal if $p>0.05$. The analysis was carried out to find the significant differences in VAS, BMI, and WOMAC. Data collected before and after the programmed exercise were analyzed using a paired *t*-test if the data distribution was normal or a Wilcoxon test if the data distribution was not normal. The Significance limit is $p<0.05$.

Ethical Approval

This study was approved by the institutional review board of the Faculty of Medicine Universitas Indonesia, approval number KET-517/UN2.F1/ETIK/PPM.00.02/2022.

Informed consent was obtained after the patients had received information about the programmed exercise with telerehabilitation, the purpose, and the adverse events.

RESULTS

Recruitment of research subjects was carried out at the Dr. Cipto Mangunkusumo between January 2022 and October 2023. Sampling was carried out among the visiting population, without randomization. The research subjects were patients with knee osteoarthritis who met the inclusion criteria, had not been excluded through the exclusion criteria, and were willing to take part in the research. Twenty-six patients completed the program, exceeding the minimum sample size of 21 research subjects. The level of compliance of research subjects in participating in the program was 95.7%.

Before intervention, the median VAS score was 3 AU, with a minimum of 2 AU and a maximum of 3 AU. The VAS score decreased statistically significantly every week, until the end of the fourth week, compared with before the intervention ($p<0.001$). The median VAS score at the end of the intervention was 1 AU with a minimum of 1 AU and a maximum of 2 AU (Table 2). Based on Allen et al, the Minimal Clinically Important Difference (MCID) value for the VAS score was 0.8 AU.[12] The difference in median values between before the intervention and the week 4 evaluation is 2 AU. This shows that there is a clinically significant difference in values.

Before intervention, the median BMI score was 28.1 kg/m² with a minimum of 25.1 kg/m² and a maximum of 40.7 kg/m². BMI scores decreased statistically significantly at the end of the fourth week compared with before the intervention ($p<0.001$). The median BMI score at the end of the intervention was 27.6 kg/m² with a minimum of 22.8 kg/m² and a maximum of 39.7 kg/m² (Table 3, Table 4). Based on Hsu et al's study, the MCID value for the BMI score is 0.5 kg/m².[13] The difference in median value between before the intervention and the week 4 evaluation is 0.5 kg/m². This shows that there is a difference in values that is not clinically significant.

Before intervention, the median WOMAC score was 56.5 AU with a minimum of 23 AU and a maximum of 76 AU. The WOMAC score decreased statistically significantly at the end of the fourth week compared with before the intervention ($p<0.001$). The median WOMAC score at the end of the intervention was 17,

with a minimum of 11 AU and a maximum of 43 AU (Table 5). Based on Moffet et al's study, the MCID value for the WOMAC score was 21% of baseline.[14] The difference in median WOMAC score values between pre-intervention and the week 4 evaluation is 69% from baseline. This shows that there is a clinically significant difference in values.

Further analysis of all WOMAC components in the intervention group, including pain, stiffness, and physical function, also showed a statistically significant decrease ($p<0.001$).

Table 1. Characteristics of the Patients

Characteristics	All Subject
Age	59.3±4,2
Gender	
Female	26 (100.0)
Physical Activity Level	1.2±.0,8
Last Education	
Elementary - Senior High School	11 (42)
Diploma - Bachelor	15 (58)
Work	
Housewife	18 (69)
Employee	8 (31)
Osteoarthritis Classification	
Kellgren - Lawrence Grade 2	12 (46)
Kellgren - Lawrence Grade 3	14 (54)
Visual Analogue Scale	2.8±0.4
Body Mass Index	28.9±4.0
Obesity 1 (Body Mass Index)	18 (69)
Obesity 2 (Body Mas Index)	8 (31)
WOMAC	
Total	52.7±13.4
Pain	10.5±3.4
Joint Stiffness	4.3±1.9
Functional Limitation	38.2±8.3
Test Load Initial	3.7±1.7
Test Load End of 2nd Week	5.1±1.7
Food Recall Initial	1254.6±206.3
Food Recall End of 2nd Week	1069.2±143.1

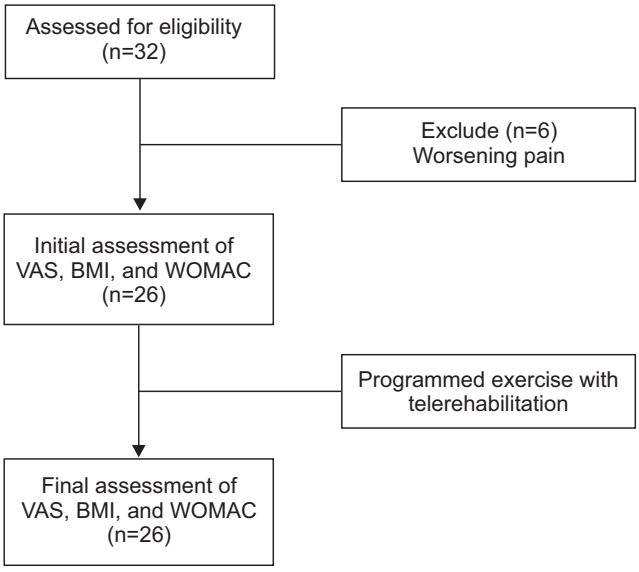

Figure 1. Subjects' recruitment flowchart

Table 2. Changes in Visual Analogue Scale Scores

Characteristics	Median (Min-Max)	P-value
Before intervention	3 (2–3)	
Evaluation week 1	2 (1–3)	<0,001*
Evaluation week 2	2 (1–3)	<0,001*
Evaluation week 3	1 (1–3)	<0,001*
Evaluation week 4	1 (1–2)	<0,001*

*Wilcoxon test // The p-value was compared with the VAS before the intervention

Table 3. Change in Body Mass Index Score

Characteristics	Median (Min–Max)	P-value
Before intervention	28,1 (25,1-40,7)	
Evaluation week 4	27,6 (22,8-39,7)	<0,001*

*Wilcoxon test // The p-value was compared with BMI before intervention

Table 4. Change in Functional Capabilities (WOMAC Score)

Characteristics	Median (Min-Max)	P-value
Before intervention	56.5 (23-76)	
Evaluation week 4	17 (11-43)	<0,001*

*Wilcoxon test // p-values were compared with WOMAC before intervention

Table 5. Changes in Functional Capabilities (WOMAC Components)

Characteristics	Pain	P-value	Joint Stiffness	P value	Functional Limitation	P-value
Before intervention	10.5±3.3	<0,001**	4 (0-7)	<.001*	41 (23–50)	<.001*
Evaluation week 4	5±2.7		2 (0-6)		12 (8–28)	

*Wilcoxon test// p-values were compared with WOMAC components before intervention
**Paired *t*-test // p-values were compared with WOMAC components before intervention

DISCUSSION

One of the added values of telerehabilitation services is increased compliance. Compliance with therapeutic exercises will have an impact on behavior change and strengthening healthy lifestyle habits that will help optimize treatment results. A series of factors that may contribute to the level of compliance includes when patients receive attention from health professionals, especially when exercising at home. In this study, various efforts were made to ensure patient compliance using telemonitoring, so that we obtained a high level of compliance, namely 95.7%. When compared with other studies, Bassett et al showed that compliance rates were higher with a combination of written and verbal information (77%) compared with when only verbal information was given (38%). This is consistent with the findings in this study, where research subjects received both written and verbal information.[15] Makarm et al showed that a high compliance rate of around 82.7% was improved by telephone support once a month during the research process.[16]

The high compliance rate in this study was also supported by motivational education and mapping of stages of behavior change by psychologists. Based on the stages of behavior change, there are 5 stages that a person must go through to adopt new behavior as part of a lifestyle: pre-contemplation, contemplation, preparation, action, and maintenance.[17] Based on the mapping of the stages of behavior change by psychologists on research subjects, there were 4 research subjects (15.5%) entering the contemplation stage (aware that there is a

problem and thinking about solving it but not yet committed to taking action); 4 research subjects (15.5%) entering the preparation stage (aware that there is a problem, have tried to change but were unsuccessful and currently have plans to try again); and the remaining 18 research subjects (69%) were entering the action stage (trying to change behavior, experience or environment to overcome problems).

The level of compliance with the diet plan was monitored by a nutritionist at the end of the second week. The nutritionist calculated the number of calories consumed by the patient using the food recall method, made adjustments to diet prescriptions, and repeated nutritional advice that was presented in the initial session. Based on the initial food recall results, calories consumed were 1254.6 ± 206.3 kcal with a minimum of 1039 kcal and a maximum of 1801.5 kcal, while the food recall at the end of the second week was 1069.2 ± 143.1 kcal with a minimum of 900 kcal and a maximum of 1395 kcal. The number of calories consumed by research subjects decreased along with the intervention provided by nutritionists, by adjusting the circumstances of each research subject.

The results of this study show that the VAS score decreased statistically significantly every week, until the end of the fourth week, compared with before the intervention ($p<0.001$). Based on Allen et al's study, the MCID value for the VAS score is 0.8.[12] The difference in median values between before the intervention and the 4-week evaluation was 2. This shows that there is a clinically significant difference in values. This is in accordance with research by Makarm et al, Odole et al., and Tore et al.[16,17]

The BMI score decreased statistically significantly at the end of the fourth week compared with before the intervention ($p<0.001$). Based on Hsu et al's study, the MCID value for the BMI score is 0.5.[13] The difference in median value between before the intervention and the week 4 evaluation was 0.5. This shows that there is a difference in values that is not clinically significant. If analyzed further, the difference in accumulative weight loss in this research was 2.7%. This is in accordance with research by Bennell et al[19], Bughin et al[20] and Alencar et al.[21]

The results of this study showed that the WOMAC score decreased statistically significantly at the end of the fourth week compared with before the intervention ($p<0.001$). Based on Moffet et al's study, the MCID value for the WOMAC score was 21% of the baseline.[14] The difference in median WOMAC score between pre-intervention and week 4 evaluation was 69% from baseline.

This shows that there is a clinically significant difference in values, and is in accordance with research by Aily et al and Hsu et al.[13,18] In addition to the WOMAC total score, analysis of each component of the WOMAC subscale in terms of pain (5-point difference), joint stiffness (2-point difference) and physical function (21-point difference) all showed a statistically significant decrease. The WOMAC questionnaire has two questions to assess joint stiffness, namely joint stiffness in the morning and joint stiffness that occurs later in the day. The first question is about morning joint stiffness, typical of knee osteoarthritis cases. A possible cause of this stiffness is the "gel phenomenon". In people with osteoarthritis, the viscosity of joint fluid decreases. If the joints are still for a long time, the fluid in the joints will thicken like a gel. The gel consistency makes it difficult for joints to move. After moving the joint again for approximately 20 to 30 minutes, the joint fluid returns to its normal consistency, and joint stiffness decreases. The second question concerns joint stiffness that occurs later in life and relates to compensatory mechanisms for excessive muscle activity to maintain joint stability in knee osteoarthritis. Excessive muscle contraction causes stiffness in the joints. This causes the WOMAC score in the joint stiffness question to tend to be difficult to change (it shows the smallest difference) because this is a natural characteristic of knee osteoarthritis.[22]

We also conducted additional descriptive analysis regarding the characteristics of functional abilities based on the degree of obesity. Grade 2 obesity was characterized by poorer functional ability (mean baseline WOMAC score 59.5 ± 8.5, with a minimum of 45 and a maximum of 72) compared with grade 1 obesity (mean baseline WOMAC score 48.8 ± 14.1 with a minimum of

23 and a maximum of 76). This is in accordance with the theory that obesity is a risk factor for knee osteoarthritis and increased load on the joints.

In this study, there were no major side effects of the program, such as fainting, falls,chest pain, or visits to the emergency room. Minor side effects such as delayed onset muscle soreness (DOMS) or other musculoskeletal complaints were found in approximately 12% of total teleconsultations (26 sessions compared with 208 sessions) or approximately 6 research subjects out of all research subjects. The possibility of major side effects has been prevented by good screening, as outlined in the exclusion criteria in this study.

This research is a pioneer research project at Dr. Cipto Mangunkusumo General Hospital related to telerehabilitation and uses the SiapDok RSCM application developed by PT Telekonsul Digital Indonesia. This application meets eligibility standards and complies with regulations related to telemedicine in Indonesia. Permission to use this application has received from various related parties so that further research using the same application can be accessed more easily in the future.

This research proves that telerehabilitation is no longer a futuristic notion, but offers a great opportunity. Telerehabilitation was not only beneficial during the pandemic period, but can also significantly increase access and equity to rehabilitation services for patients in geographically remote areas or for those who have physical, financial, or logistical difficulties. Although there are difficulties related to barriers due to the technology used, researchers highlight the main advantages associated with the use of telerehabilitation, namely the maintenance of patient motivation to perform therapeutic exercises. The costs incurred by patients for transportation to the hospital are reduced, and the time saved does not have to be spent traveling. Therapeutic practice with telerehabilitation at home can be further enhanced by the development of applications and the support of digital tools, including video feedback and wearable sensors, which will facilitate the optimization of results. Telerehabilitation cannot completely replace conventional face-to-face contact, but in certain circumstances, it is worth developing.

This research has several limitations. First, this study had a relatively small sample size, so it could not represent the entire knee osteoarthritis group. Second, there were technical problems during the teleconsultation session. Similar to the findings of Ross et al, technical problems in this study did not impact the effective time during consultation.[23] When technical problems arose, they tended to be temporary and were resolved quickly with some simple troubleshooting methods, and did not add significantly to the total duration of the teleconsultation.[23]

CONCLUSION

In this study, it was found that programmed exercise with telerehabilitation at home has been statistically proven to reduce visual analogue scale scores, body mass index, and WOMAC in patients with obesity and knee osteoarthritis.

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CONFLICT OF INTERESTS

There is no conflict of interest.

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