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Submission date: 30-Apr-2025 07:53PM (UTC+0530)
Submission ID: 2662089004
File name: Impact_of_stretching_and_strengthening_1_.docx (314.46K)
Word count: 4677
Character count: 26951

Impact of stretching and strengthening combination exercise therapy for knee overuse injury management: A study in recreational runners

Dampak Terapi Latihan Kombinasi Stretching dan Strengthening untuk Manajemen Knee Overuse Injury: Studi pada Pelari Rekreasional

Original Article

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Abstract.

Background Knee overuse injury is one of the common problems in sports, especially in activities with high movement repetitions. Proper treatment is needed to speed up recovery and prevent recurrent injuries. One method that is widely used in rehabilitation is stretching and strengthening combination exercise therapy.

Objectives This study aims to determine the impact of stretching and strengthening combination exercise therapy on knee overuse injury management, especially in reducing pain and increasing knee joint range of motion (ROM).

Methods This study used an experimental design with a pretest-posttest control group design. Participants amounted to 20 people who experienced knee overuse injury, divided into two groups, namely the experimental group who received stretching and strengthening combination exercise therapy treatment, and the control group without treatment. The intervention was carried out for 4 weeks with a frequency of exercise 3 times a week. Measurement instruments include Visual Analog Scale (VAS) for pain and goniometer for ROM. Data analysis used paired sample t-test and independent sample t-test with the help of SPSS version 26.

Results The results showed a significant decrease in pain scores from pretest to posttest in the experimental group, from an average of 5.20 to 2.10. Similarly, the knee ROM increased from an average of 112.50° to 128.80°. Meanwhile, the control group showed no significant changes. Statistical test results showed a significant difference between the experimental and control groups ($p < 0.05$).

Conclusion Stretching and strengthening combination exercise therapy is effective in knee overuse injury management, especially to reduce pain and increase knee ROM. However, this study still has limitations in the relatively short duration of intervention and has not controlled the participants' physical activity outside the training session. Future research is recommended to involve a longer duration and tighter activity control.

Keywords: stretching, strengthening, knee overuse injury, pain, range of motion

Received: February 05, 2025. Accepted: April 25, 2025
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INTRODUCTION

Running is one of the most popular and accessible forms of physical activity for people from all walks of life, including recreational runners [1],[2]. Participation in this activity has increased significantly due to its benefits on cardiovascular health, physical fitness, and stress reduction [3] - [5]. However, despite being classified as a moderate to high-intensity aerobic activity, running carries a high risk of injury, particularly overuse injuries [6]. This type of injury develops slowly due to the accumulation of repetitive mechanical stress on musculoskeletal structures, without sufficient recovery time [7].

One of the areas of the body most susceptible to overuse injury in recreational runners is the knee, considering that the knee acts as the main support for body weight and is the center of movement in running patterns. Several studies report that recreational runners often experience injuries such as patellofemoral pain syndrome, iliotibial band syndrome, and Achilles tendinopathy [8],[9] . Risk factors for these knee injuries may include errors in training programs, muscle weakness around the knee,

imbalance in thigh muscle flexibility, and knee joint stiffness [10],[11]. Therefore, a knee injury prevention and management approach is crucial for runners, especially those who run independently without the assistance of a professional coach [12].

Non-invasive strategies such as exercise therapy are becoming the primary choice in managing knee overuse injuries, due to their effectiveness in reducing pain, increasing range of motion, and improving biomechanical function of the knee joint [13]. The two main approaches in exercise therapy for knee injuries are stretching and strengthening exercises [14]. Stretching exercises increase soft tissue flexibility and reduce muscle and tissue stiffness around the knee, which can decrease pressure on the injured structures [15]. On the other hand, strengthening exercises play an important role in improving knee joint stability, load-bearing capacity and resistance to mechanical stress during running [16].

Several studies support the effectiveness of combined stretching and strengthening interventions in the rehabilitation of overuse injuries, particularly in the knee area. For example, [17] showed that eccentric strengthening exercises in combination with stretching are effective for the management of knee tendinopathy. Meanwhile, [18] found that the combination of the two approaches resulted in significant improvements in pain and function in patients with chronic injuries in the lower extremity area. On the other hand,[19] emphasizes the importance of ankle and lower leg muscle strengthening exercises along with stretching to prevent injuries in long-distance runners

This combination of therapies not only contributes to functional recovery, but also to the prevention of recurrent injuries common in recreational runners, particularly knee injuries [20]. The neuromuscular adaptations resulting from such exercises can improve motion control, muscle strength around the knee, as well as biomechanical efficiency during running [21]. In addition, combined interventions tend to be more comprehensive as they address various aspects of musculoskeletal disorders, such as muscle weakness, soft tissue stiffness, and joint motion limitations [22]. Therefore, this approach is relevant for application in a population of non-athletic runners with knee overuse injury.

However, few studies have specifically evaluated the impact of combination exercise therapy on knee overuse injuries in recreational runner populations [23]. The majority of interventions studied have focused on professional athletes or injuries to other areas of the body. Thus, this study aims to fill that gap through direct observation of the effectiveness of a stretching and strengthening combination exercise program in treating symptoms of knee overuse injury in recreational runners. This study is expected to make a practical contribution in the development of stretching and strengthening-based exercise therapy programs that can be applied independently by recreational runners in preventing and managing knee injuries.

METHOD

Research design

This study uses a quasi-experimental design that aims to analyze the impact of stretching and strengthening combination exercise therapy in the management of knee overuse injuries in recreational runners. This design was chosen to evaluate the effectiveness of the exercise program in reducing pain levels and improving static and dynamic balance in runners who experience complaints in the knee area due to overuse. This research protocol was prepared based on the ethical principles of research that refer to the Declaration of Helsinki. The research has obtained approval from all participants and has signed an informed consent sheet before participating in the research process. The independent variable in this study is the provision of stretching and strengthening combination exercise therapy interventions. While the dependent variables include pain levels, static balance, and dynamic balance in recreational runners with knee overuse injuries.

Participant

A total of 20 recreational runners who experienced knee overuse injury within the last 3 months participated in this study. The characteristics of the participants consisted of an average age of 23.10 ± 1.45 years, height 168.75 ± 5.90 cm, weight 65.40 ± 10.25 kg, body mass index (BMI) 23.00 ± 2.75 kg/m^2, and an average knee injury duration of 2.15 ± 0.80 months. Of the total participants, 14 (70%) were male and 6 (30%) were female. All participants were randomly divided into two groups, namely the

stretching and strengthening combination exercise therapy group (n = 10) and the control group (n = 10).

The inclusion criteria for participants in this study included recreational runners aged 18-30 years, both male and female, who experienced a mild to moderate knee overuse injury (such as patellofemoral pain syndrome, iliotibial band syndrome, or tendinopathy) within the past 3 months. Injury conditions were confirmed through medical history, physical examination, and clinical interview by a physiotherapist or sports medic. Participants must also be able to walk independently without assistive devices, understand the study procedures, and be willing to sign an informed consent form.

The exclusion criteria in this study included a history of knee surgery in the past 1 year, the presence of other musculoskeletal injuries in different areas of the body, balance disorders (e.g. vestibular disorders or severe low back pain), neurological disorders affecting motor control, contraindications to physical activity, and pregnancy. In addition, participants who were unable to follow the entire course of intervention and evaluation, or who were taking pain medication or muscle relaxants (unless in a stable and controlled condition), were also excluded from the study.

Sampling and randomization

To determine the number of samples needed in this study, an a priori power analysis was conducted using the G*Power application version 3.1.9.7 (Heinrich-Heine-Universität Düsseldorf, Germany), with reference to previous research data by [24] . The effect size value obtained from the analysis was 2.00. With a significance level of α = 0.05 and power = 0.95, a minimum sample size of 14 participants was obtained [24]. By considering the potential drop-out or loss of participants by 20%, the sample size was increased to 17 participants. However, to ensure the power of the study remains optimal, the final number of participants in this study was set at 20.

Participants in this study were randomly divided into two groups, namely the stretching and strengthening combination exercise therapy group (n = 10) and the control group (n = 10). The process of group division was carried out using the randomized sampling method, where the allocation of participants into each group was randomized using randomization software to ensure that the distribution of participants in each group was homogeneous and avoid bias.

Study intervention

The participants in this study were randomly divided into two groups, namely the stretching and strengthening combination exercise therapy group (n = 10) and the control group (n = 10). The design of the exercise intervention in this study adapted from an exercise protocol based on references from [25] and has been adapted to the needs of recreational runners who experience knee overuse injury.

The intervention program was provided for 4 weeks, with a training frequency of 3 sessions per week, making a total of 12 training sessions. Each training session lasted for 15 to 30 minutes, depending on the participants' individual abilities and progress. The exercise program in the intervention group consisted of a combination of stretching and strengthening exercises that focused on the muscles around the knee joint, such as quadriceps, hamstring, calf, gluteus, and other knee stabilizer muscles.

The intensity of the exercise is done progressively, where the load or duration of the exercise will be increased gradually each week according to the participants' ability. Meanwhile, the control group did not receive any specific exercise intervention, but was still allowed to carry out normal daily activities.

To evaluate the effectiveness of the intervention, measurements were taken before and after the 4-week intervention period. Parameters measured included pain intensity using Visual Analog Scale (VAS), and range of motion (ROM) of the knee using a Goniometer. In addition, dynamic balance function was also measured using the Y-Balance Test.

Table 1: Exercise and stretching intervention program; adapted from [25]

Sunday	Stretching Exercises	Strengthening Exercises	Duration/Sets	Progression
1	1. Hamstring Stretch 2. Quadriceps Stretch 3. Calf Stretch 4. Glute Stretch	1. Straight Leg Raise (SLR) 2. Mini Squat (partial) 3. Clamshell 4. Ankle Band Resistance	1. Stretch: 20-30 seconds x 2 sets per muscle 2. Strength: 10-12 reps x 2 sets	Mobility focus and light activation

2	1. Hamstring Stretch 2. Quadriceps Stretch 3. Calf Stretch 4. Glute Stretch	1. SLR with Resistance Band 2. Wall Squat (90°) 3. Clamshell with Band 4. Calf Raise	1. Stretch: 20-30 seconds x 2 sets per muscle 2. Strength: 10-12 reps x 2-3 sets	Addition of elastic resistance band
3	1. Hamstring Stretch 2. Quadriceps Stretch 3. Calf Stretch 4. Glute Stretch	1. Bulgarian Split Squat 2. Step Up 3. Glute Bridge with Band 4. Single Leg Calf Raise	1. Stretch: 20-30 seconds x 2 sets per muscle 2. Strength: 12-15 reps x 2-3 sets	Increased body weight & unilateral stabilization
4	1. Hamstring Stretch 2. Quadriceps Stretch 3. Calf Stretch 4. Glute Stretch	1. Lateral Band Walk 2. Single Leg Squat to Chair 3. Hip Thrust 4. Y-Balance Reach Exercise	1. Stretch: 20-30 seconds x 2 sets per muscle 2. Strength: 12-15 reps x 3 sets	Focus on functional strengthening & balance

Outcome measure

Measurement of pain intensity in this study using Visual Analog Scale (VAS). VAS is a pain measurement tool in the form of a 10 cm long horizontal line, with the left end (0 cm) indicating "no pain" and the right end (10 cm) indicating "very severe pain" [26] . Participants are asked to mark the line according to the level of pain felt. Pain scores were obtained by measuring the distance (in cm) from the zero point to the mark given by the participant. The VAS instrument has been shown to have excellent reliability with Intraclass Correlation Coefficient (ICC) values of 0.96 and 0.95 [27].

To measure static balance, the Stand Stork Test was used. The participant was asked to stand with both hands on the waist, then lift one leg and place the sole of his foot on the inner side of the knee of the fulcrum while lifting the heel of the fulcrum. The length of time the participant was able to maintain this position without losing balance was recorded in seconds. This test has high reliability with ICC values ranging from 0.91 to 0.93 [28].

Meanwhile, the Y-Balance Test (YBT) was used to measure dynamic balance. In this test, participants were asked to maintain balance with one leg as a fulcrum, while the other leg was used to reach as far as possible in three directions, namely anterior (ANT), posteromedial (PM), and posterolateral (PL). The maximum reach distance in each direction was measured and normalized based on the participant's limb length. If the participant was unable to maintain the correct technique, such as shifting the weight to the reaching leg or the heel of the fulcrum was lifted, the experiment was repeated. The YBT instrument has good reliability with ICC values ranging from 0.80 to 0.85 [29].

Statistical analysis

Descriptive analysis was used to calculate the mean and standard deviation (SD) of continuous variables such as age, weight, height, body mass index (BMI), limb length, and duration of injury. Frequency distribution was used for categorical variables such as gender and intervention group.
Inferential analysis was performed using paired sample t-test to evaluate the difference between pre-test and post-test results on pain level, static balance, and dynamic balance in each exercise group. In addition, an independent sample t-test was used to compare the difference in intervention effect between the stretching exercise group and the strengthening exercise group, both in the pre-test and post-test results.

RESULTS AND DISCUSSION

Results

The paired sample t-test test was conducted to determine the effect of stretching and strengthening combination exercise treatment in the experimental group on pain levels (VAS), static balance (resistance time), and dynamic balance (anterior, posterolateral, and posteromedial). The results of the analysis in the experimental group showed a significant difference between pretest and posttest on all variables. There was a significant decrease in pain level (VAS) with a pretest mean value of 6.00 (SD = 1.05) to 3.10 (SD = 1.20) at posttest ($t(9) = 10.542$, $p < 0.001$). In addition, there was a significant increase in static balance with a pretest average resistance time of 16.90 seconds (SD = 1.45) to 20.30 seconds (SD = 1.49) at posttest ($t(9) = -9.124$, $p < 0.001$). In dynamic balance, there were

significant improvements in the anterior (t(9) = -6.052, p < 0.001), posterolateral (t(9) = -5.134, p < 0.001), and posteromedial (t(9) = -4.957, p < 0.001) directions.

In contrast, in the control group that was not given the exercise treatment, the results of the paired sample t-test showed no significant difference between the pretest and posttest on all variables measured, both pain (VAS), static balance, and dynamic balance (p> 0.05).

Furthermore, the results of the independent sample t-test were used to compare differences in posttest results between the experimental group and the control group. The results showed that there were significant differences in pain levels (VAS) (t(18) = 6.314, p < 0.001), static balance (t(18) = -6.271, p < 0.001), as well as dynamic balance in the anterior (t(18) = -3.565, p = 0.002), posterolateral (t(18) = -3.313, p = 0.004), and posteromedial (t(18) = -3.266, p = 0.004) directions. These findings indicate that the combined stretching and strengthening exercises were significantly more effective in reducing pain and improving static and dynamic balance compared to the control group.

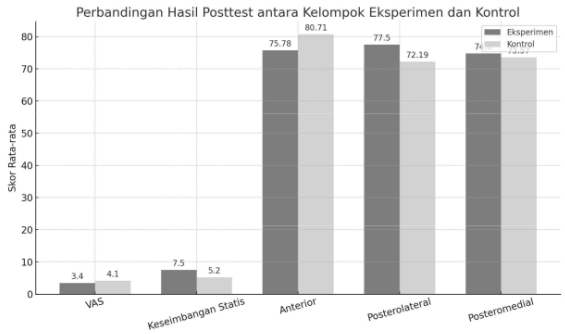

Figure 1. Comparison of posttest results between experimental and control groups

Discussion

This study aims to determine the impact of stretching and strengthening combination exercise therapy on knee overuse injury management, specifically in reducing pain levels and increasing joint range of motion (ROM) in individuals with these conditions. The design of this study used two groups, namely the control group who did not receive exercise treatment, and the experimental group who received a combination of stretching and strengthening exercise interventions.

The results showed that there were significant differences between the experimental group and the control group, both in reducing pain and increasing knee ROM. In the experimental group, stretching and strengthening combination exercise therapy was able to reduce pain levels more significantly than the control group. This finding is in accordance with the theory that stretching can help increase soft tissue flexibility, reduce muscle tension, and increase local blood circulation, thus playing a role in reducing pain [30]. While strengthening exercises help increase muscle strength around the knee and joint stability, thereby reducing overload on joint structures due to overuse [31].

In the control group, there were slight changes in pain and ROM, but these changes were thought to be more due to the natural healing process that usually occurs in cases of overuse injury when the repetitive activity that caused the injury is reduced or temporarily stopped. However, the changes that occurred in the control group were much smaller than the experimental group, so it can be concluded that the stretching and strengthening combination exercise intervention has a significant contribution in accelerating the recovery of knee overuse injury

The effectiveness of the combination of stretching and strengthening is also in line with previous research by [25] , which states that stretching and strengthening exercises in combination can provide optimal benefits in reducing pain and improving musculoskeletal tissue function. In addition, the theory from [32] states that the integration of stretching and strengthening in rehabilitation programs can help improve muscle balance, joint stability, and tissue flexibility, which are very important in the management of overuse injuries.

The advantage of this study is the use of a control group, so that it can objectively compare the effectiveness of exercise interventions on improving the subject's condition. However, this study also has several limitations, including: the relatively short duration of the intervention, the limited sample size, and the absence of follow-up measurements to see long-term effects after the intervention is stopped.

For future research, it is recommended that the duration of the intervention be extended, the number of samples be increased, and follow-up measurements be carried out to see if the improvement results can be maintained for a longer period of time. In addition, variations in exercise types or exercise doses can also be the focus of future research.

Practically, the results of this study provide recommendations that stretching and strengthening combination exercise therapy can be used as an important part of the knee overuse injury rehabilitation program. This approach is effective for reducing pain, increasing ROM, and accelerating the recovery of knee joint function. This intervention can also be used preventively to prevent recurrent injuries, especially in individuals who have a history of knee overuse injury or have a high risk of experiencing such injuries.

CONCLUSION

The results of this study indicate that stretching and strengthening combination exercise therapy has a significant impact in the management of knee overuse injury, especially in reducing pain and increasing knee joint range of motion (ROM). The experimental group that received the exercise treatment showed a better improvement in condition than the control group without treatment, thus reinforcing that the change was a direct effect of the exercise intervention, not merely a natural process. Stretching helps to reduce muscle tension and increase tissue flexibility, while strengthening serves to increase the strength and stability of the muscles around the knee. These findings are in line with the results of previous studies which showed that a combination of these two exercise methods is effective in the rehabilitation of overuse injuries. However, this study has limitations, including the relatively short duration of the intervention and has not controlled for participants' physical activity outside of the training session, potentially affecting the results. Therefore, further research with a longer duration, tighter activity control, and a larger sample is needed to strengthen these findings. Practically, stretching and strengthening combination exercise therapy is recommended as part of a knee overuse injury rehabilitation program to help accelerate recovery and prevent recurrent injuries.

ACKNOWLEDGMENT

With gratitude, the author would like to express his deepest gratitude to all those who have provided support and contributions in the process of completing this research. Special thanks go to previous researchers who have been the main source of literature and references in this study. The authors also appreciate any technical and moral assistance provided in the preparation of this systematic review article.

AUTHOR CONTRIBUTION STATEMENT

The writing of this article involved roles in devising the research concept and design, reviewing and analyzing relevant literature, and drafting the overall manuscript.

CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest

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