The comparative effectiveness of active and passive stretching post-massage: effects on knee injury recovery

Eficacia comparativa de los estiramientos activos y pasivos después del masaje: efectos en la recuperación de lesiones de rodilla

Authors

Arif Kurniawan [1]
Ahmad Nasrulloh [2]
Sulistiyono [3]
Ali Satia Graha [4]
Hadwi Prihatanta [5]

[1, 2, 3, 4, 5] Universitas Negeri Yogyakarta

Corresponding author:
Arif Kurniawan
arifkurniawan@uny.ac.id

How to cite in APA

Kurniawan, A., Nasrulloh, A., Sulistiyono, Graha, A. S., & Prihatanta, H. (2025). The comparative effectiveness of active and passive stretching post-massage: effects on knee injury recovery. *Retos*, *69*, 723–736. https://doi.org/10.47197/retos.v69.112244

Abstract

Introduction: Individuals experiencing post-knee injury require rehabilitation therapy to alleviate pain, enhance range of motion (ROM), and improve overall knee function. Massage and stretching are non-pharmacological interventions commonly employed in physical therapy for post-injury rehabilitation.

Objective: This study aimed to 1) determine the effectiveness of active stretching after massage in reducing pain, increasing ROM, and improving knee function; 2) determine the effectiveness of passive stretching after massage for thesame outcomes; and 3) compare the effectiveness of active and passive stretching after massage in achieving these outcomes. Methodology: This pseudo-experimental study utilized a two-group design, involving 42 participants with post-knee injuries, randomly divided into two groups of 21. Group A received active stretching after massage, while Group B received passive stretching after massage. Each session lasted 30 minutes. Pain measred using the VAS, ROM with a goniometer, and functional via the KOS. Data analysis involved paired t-tests, Wilcoxon tests, independent t-tests, and Mann-Whitney U tests. Results: Both active and passive stretching post-massage significantly reduced pain, increased ROM, and improved function (p<0.05). However, passive stretching demonstrated greater effectiveness than active stretching in all outcomes (p<0.05). Discussion: These results are consistent with prior studies. Rehman et al. (2021) found massage and active stretching effective for pain reduction. Jeong et al. (2017) reported improved ROM and pain relief with massage and passive stretching. Nishikawa et al. (2015) noted superior hamstring flexibility with passive stretching Conclusions: Passive stretching post-massage is likely more effective than active stretching for knee injury recovery. However, treatment choice should consider patient-specific factors, injury severity, and clinical judgment.

Keywords

Massage; active stretching; passive stretching; post-injury; knee.

Resumen

Introducción: Las personas que sufren una lesión de rodilla requieren terapia de rehabilitación para aliviar el dolor, aumentar el rango de movimiento (ROM) y mejorar la función general de la rodilla. El masaje y los estiramientos son intervenciones no farmacológicas comúnmente empleadas en fisioterapia para la rehabilitación post-lesión.

Objetivo: Este estudio buscó 1) determinar la efectividad del estiramiento activo después del masaje para reducir el dolor, aumentar el ROM y mejorar la función de la rodilla; 2) determinar la efectividad del estiramiento pasivo después del masaje para obtener los mismos resultados; y 3) comparar la efectividad del estiramiento activo y pasivo después del masaje para lograr estos resultados. Metodología: Este estudio pseudoexperimental utilizó un diseño de dos grupos, con 42 participantes con lesiones de rodilla, divididos aleatoriamente en dos grupos de 21. El grupo A recibió estiramiento activo después del masaje, mientras que el grupo B recibió estiramiento pasivo después del masaje. Cada sesión tuvo una duración de 30 minutos. El dolor se midió mediante la escala visual analógica (EVA), el ROM con un goniómetro y la función mediante la escala de ortopedia (KOS). El análisis de datos incluyó pruebas t pareadas, pruebas de Wilcoxon, pruebas t independientes y pruebas U de Mann-Whitney. Resultados: Tanto el estiramiento activo como el pasivo posterior al masaje redujeron significativamente el dolor, aumentaron el ROM y mejoraron la función (p < 0,05). Sin embargo, el estiramiento pasivo demostró mayor efectividad que el estiramiento activo en todos los resultados (p < 0,05). Discusión: Estos resultados son consistentes con estudios previos. Rehman et al. (2021) encontraron que el masaje y el estiramiento activo eran efectivos para reducir el dolor. Jeong et al. (2017) informaron una mejora del ROM y del alivio del dolor con el masaje y el estiramiento pasivo. Nishikawa et al. (2015) observaron una mayor flexibilidad de los isquiotibiales con el estiramiento pasivo.

Conclusiones: El estiramiento pasivo posterior al masaje es probablemente más efectivo que el estiramiento activo para la recuperación de lesiones de rodilla. Sin embargo, la elección del tratamiento debe considerar factores específicos del paciente, la gravedad de la lesión y el criterio clínico.

Palabras clave

Masaje; estiramiento activo; estiramiento pasivo; post-lesión; rodilla

Introduction

Sports injuries can occur during training, competition, or in the aftermath of physical activity (Utomo et al., 2022). Minor injuries like muscle stiffness and fatigue typically resolve without requiring specialized medical attention. However, severe injuries such as muscle tears, tendon ruptures, ligament sprains, or fractures necessitate immediate medical intervention (Napitupulu, 2021). Ankle, muscle, and knee dislocations, along with sprains and strains, constitute a significant proportion of sports injuries (Sanusi et al., 2020).

Based on a six-month observation period from April to September 2022 at the Mafaza sports injury therapy workshop, involving 2,500 patients, a notable finding emerged that 18% (450 individuals) presented with knee joint injuries. This observation highlights the prevalence of knee injuries among individuals seeking sports injury therapy and underscores their significant impact on athletic performance and overall well-being.

The knee joint is a complex structure subjected to substantial forces during physical activity (Gao et al., 2019). This high load can exceed the tissue's capacity, resulting in injury. Injuries can affect both the skeletal structures (tibia, femur, patella) and the soft tissues (cartilage, ligaments, tendons, and muscles) that comprise the knee joint (Bahr et al., 2012).

The average number of sports injuries was significantly higher during matches (13.8 injuries per 1000 athletes) compared to training (4 injuries per 1000 athletes). Lower extremity injuries accounted for over 50% of all sports injuries. Ankle ligament sprains were the most prevalent, affecting approximately 15% of all athletes. Furthermore, the study period witnessed a significant increase in the incidence of head injuries (7% annual increase) and ACL (anterior cruciate ligament) injuries (1.3% annual increase) (Setyaningrum, 2019).

The ACL, a crucial ligament within the knee joint, stabilizes the tibia and prevents excessive anterior translation and rotational movements (Diwakar, 2018). ACL injuries are common, with an annual incidence rate of 68.6 per 100,000 individuals (Sanders et al., 2016). These injuries are frequently associated with sports involving jumping, pivoting, and sudden changes in direction (Sadeqi et al., 2018). Notably, non-contact ACL injuries are prevalent, accounting for 70-80% of all ACL injuries% (Acevedo et al., 2014).

ACL injury is the most common knee injury experienced by athletes. This injury generally occurs in sports that involve zigzag movements, changes in direction of motion, and sudden changes in speed (acceleration-deceleration) such as soccer, basketball, volleyball, and futsal. The majority of injuries that occur are non-contact with knee valgus and twisting mechanisms. This situation often occurs when athletes dribble the ball or the knee is in the wrong position when landing. Trauma can also cause ACL tears, especially direct trauma to the knee with the direction of force from the side. ACL tears of more than 50% or total tears can cause knee joint instability. Athletes will feel their knees often "shake", pain and swelling repeatedly so that their sports performance decreases. Knee joint instability will also cause further injuries in the form of damage to the joint cushion/meniscus and joint cartilage. Many athletes end up having to end their careers due to ACL injuries so this injury is often called a career ending injury (Zein, 2015).

ACL injuries have significant long-term consequences for young athletes, including knee instability, meniscal tears, cartilage damage, and the development of osteoarthritis (Acevedo et al., 2014). Moreover, ACL injuries can have a significant psychological impact, leading to distress, limitations in sports participation, and fear of re-injury (Chan et al., 2017).

Other than caused by ligaments such as ACL, PCL, MCL, and LCL injuries, injuries in the knee joint can also be caused by muscle injuries or muscle disorders in the knee joint. Muscle injuries are recognized as one of the most common injuries in the sports and athletic population and account for more than 30% of all injuries to professional footballers. Although the frequency and impact are considerable, there is still a lack of uniformity in the categorization, description, and assessment of muscle injuries. In determining muscle injuries or muscle disorders using a three-level classification that takes into account the level of pain, disability, swelling, and ecchymosis as well as the presence of palpable defects and matches each level with the alleged quantitative involvement of muscle fibers (Grassi et al., 2016: 39). Following a knee injury, patients typically experience impairments in movement and function. Muscle strength can decline significantly in the first week after injury, with a reported decrease of 3-4% per day. Studies have shown that the rate of recovery may be slower than the rate of muscle strength loss, emphasizing the importance of early exercise therapy. Stretching can help prevent repetitive injuries (Williams & Wilkins, 2013).

Rehabilitation following a knee injury often involves both pharmacological and non-pharmacological interventions. Pharmacological approaches may include the use of Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), muscle relaxants, opioids, and antidepressants (Putri et al., 2020). Additionally, non-pharmacological interventions primarily focus on physical therapy, including massage therapy and exercise therapy (Wahyuni et al., 2016).

Massage therapy aims to alleviate sports injuries through manual techniques applied to the athlete's body in a relaxed state (Tama et al., 2021). Techniques such as friction and effleurage are employed to manipulate the muscles of the foot, ankle, calf, and Achilles tendon (Graha & Harsanti, 2015).

Sports therapy applied is stretching. Stretching is a crucial component of sports therapy, aimed at increasing muscle flexibility and joint range of motion. The Crossfit Journal Article (2016) emphasizes effectiveness of stretching in improving muscle and joint flexibility, thereby reducing pain and enhancing joint mobility. Furthermore, stretching can improve blood flow and bone strength (C. Rahmiati & Yelni, 2017).

The above theory is supported by the results of research conducted by Suhartono (2013), that "From 16 respondents, the probability value (P) = 0.000, which means that there is an effect of stretching exercise therapy on the level of knee joint pain and the level of mobility in the elderly". Stimulus stretching exercise therapy will reach the brain first so that it closes the pain gate and the perception of pain does not appear, with regular exercise can provide benefits for body fitness, and joints will be able to move well, especially in the ability to mobilize (Jabbour & Sales, 2014).

Stretching is an action to stretch the muscles so that the muscles become flexible, and readiness occurs in the body before activities are carried out. One of them is the static stretching method, which is stretching in the form of stretching muscles that are carried out slowly until tension occurs and reaches pain or discomfort in the muscles (Kusworo et al., 2018: 52).

Many stretching techniques are used in clinical practice, including ballistic stretching, static stretching, and proprioceptive neuromuscular facilitation techniques. Among stretching methods, active and passive stretching techniques are easy to apply and useful as home exercises (Nishikawa et al., 2015: 3167). The provision of active stretching and passive stretching, although both in the form of stretching, have differences in application and benefits.

Active stretching is a method of stretching or stretching that is commonly performed on postural muscles as a flexibility exercise that is actively carried out by clients or patients. Active stretching is stretching that is done without outside help, relying only on the strength of each muscle. Passive stretching is stretching with outside help, namely the help of others or therapists, to achieve the maximum stretching position (F. Rahmiati et al., 2013).

Active stretching increases the flexibility of tense muscles while improving the function of opposing muscles. Conversely, passive stretching is characterized by the addition of stretch stimulation to muscle contractions that are independent of the subject. Active stretching is characterized by a reciprocal innervation mechanism used to relax antagonistic muscle contractions, while passive stretching is characterized by the addition of external stretch stimulation to muscle contractions (Nishikawa et al., 2015: 3167).

Active and passive stretching have their advantages and disadvantages in applying it. Active stretching offers the advantages of ease of performance, improved movement performance, and enhanced motor function. However, its effectiveness may be limited due to self-imposed limitations on the extent of stretch. Passive stretching, while requiring assistance, allows for greater range of motion and is beneficial for individuals with limited mobility, such as bedridden patients or those recovering from surgery. The disadvantage of passive stretching is that it requires the help of a therapist or someone else. The results of the current study indicate that passive stretching is useful for increasing muscle flexibility (Nishikawa et al., 2015: 3169).

Based on the background information and observations, muscle disorders following knee injuries pose a significant health concern, impacting athletic performance, work productivity, and overall well-being. This study aims to investigate the comparative effectiveness of active and passive stretching techniques following massage in the rehabilitation of knee injuries, focusing on pain reduction, ROM recovery, and functional improvements.

Method

The therapy model used to manage knee injuries employs effleurage and petrissage techniques. Effleurage involves applying pressure with the palms and thumbs to the central pain points or muscles surrounding the injured knee. This technique promotes muscle relaxation, reducing tension and pain. Petrissage techniques utilize the palm and fingers to target deeper muscle layers, alleviating tension and pain. Finally, active stretching by yourself and passive stretching assisted by a therapist are incorporated to enhance flexibility, improve muscle elasticity, and promote joint repositioning.

Figure 1. Effleurage

Figure 2. Petrissage

Table 1. Research treatment intervention

No	Component	Description
1.	Frequency	3 times - 24 hours, 48 hours, and 72 hours
2.	Intensity	Adjusted to the subject's muscle thickness
3.	Time	Massage 15 minutes, stretching 30 minutes
4.	Type	Massage effleurage and petrissage technique, active and passive stretching

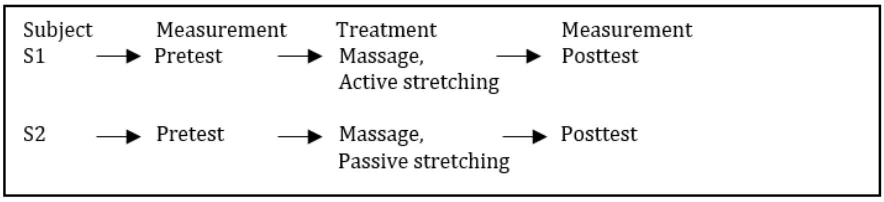
Participants

Patients experienced pain, decreased joint range of motion, and reduced knee joint function after an injury. This study employed purposive sampling, selecting participants based on specific inclusion and exclusion criteria. A total of 42 individuals were included in the study, with 21 participants in each group. The inclusion and exclusion criteria were as follows: 1. Inclusion criteria: a) Non-specific post-injury knee sufferers, b) Mild to moderate pain, c) Slight swelling, d) Stiffness in muscles and joints, e) Willing to be a respondent, f) Male sex, g) Aged 20-40 years, h) Decreased movement function and range of motion, i) In the duration of sub-acute (5 days - 4 weeks) and chronic (<4 weeks) injuries. 2. Exclusion criteria: a) Moderate to large swelling, b) Fractures and open wounds, c) Still in the acute phase (1-3 days), d) Strain or sprain (grades 2 and 3).

Procedure

This research employed a quasi-experimental study using a two-group experimental design. This research model utilized two sample groups with different treatments. The sample was measured before the treatment was administered to obtain pretest data. After obtaining the pretest data, the treatment was administered to the samples, followed by a re-measurement to obtain posttest data. This approach facilitated the identification of differences after the treatment was applied. The first group received a massage and active stretching treatment for the knee joint, while the second group received a massage and passive stretching treatment for the knee joint.

Figure 3. Research Design



Instrument

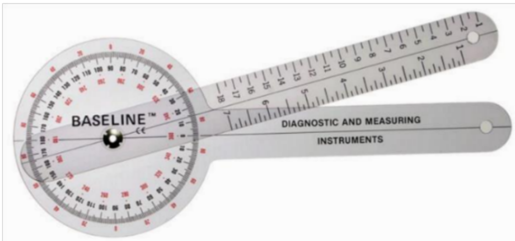
The data collection process required the use of specific measurement tools. The instruments used in this study include:

1. VAS (Visual Analogue Scale). The VAS instrument is a tool used to measure the degree of pain felt. The scale used uses a range of 0- 100. VAS has a validity value of r= 0.941 and ICC reliability = 0.97, so this instrument is valid and reliable for use in the data collection process (Alghadir et al., 2018). Measurement was by using an easy-to-use Android VAS application. People were asked to open the VAS application and then slide the button according to the pain they feel. The heavier the pain, the patient will shift the button toward a larger scale. The pain level values experienced by the sample were seen from the range of 0-10 (no pain), 10-30 (mild pain), 30-70 (moderate pain), 70-90 (severe pain), and 90-100 (very severe pain). The complete order of use of the VAS is contained in the appendix.

Figure 4. Visual Analogue Scale

2. Goniometer Helmi (2012: 54) argues that a goniometer is an arc specifically designed to evaluate joint movement. In determining the ROM, there are three recording systems used: the first with a 0-180 degree system, the second with a 180 - 0 degree system, and the third with a 360-degree system. With the 0 - 180 degree recording system, the upper and lower limb joints are in the 0-degree position for flexion, extension, abduction, and adduction movements when the body is in an anatomical position. Body position where the extremity joint is midway between medial (internal) and lateral (external). Rotation is 0 degrees for rotation ROM. The ROM starts at 0 degrees and moves towards 180 degrees. This kind of recording system is the most widely used in the world. It was first formulated by Silver in 1923 and has been assisted by numerous authors, including Cave and Roberts, Moore, the American Academy of Orthopaedic Surgeons, and the American Medical Association. Two other recording systems, namely the 180 - 0 degree system measured in the anatomical position, ROM starts from 180 degrees and moves towards 0 degrees. The 360-degree system is also measured in the anatomical position, flexion and abdominal movements start at 180 degrees and move towards 0 degrees, and extension and adduction movements start at 180 degrees and move towards 360 degrees. Both recording systems are more difficult to understand than the 0 - 180 degree recording system, and also, the two recording systems are rarely used. The validity of the test was 0.97, and the reliability of the test was 0.51 (Gunawan & Imanudin, 2019: 5).

Figure 5. Goniometer



3. KOS (Knee injury Outcome Survey) Instrument is a measuring instrument used to determine the ability score of knee joint function. This measuring instrument is in the form of a questionnaire containing 42 questions, which are divided into 6 question sections, namely: symptoms, stiffness, pain, daily activities, sports and recreational activities, and quality of life. In this instrument, there are five answers to each question. Overall, a higher COST score indicates high function, and a low-COST score indicates low function in the knee joint. This instrument has a Cronbach alpha validity value of 0.84 to 0.97 and reliability r = 0.91 to 0.99, so it is valid and reliable to be used for data collection.

Data analysis

The normality test is one of the prerequisite tests in data analysis. The normality test aims to determine whether or not the data is normally distributed. A normality test is important to determine the next calculation process. Before conducting the data difference test, it is necessary to analyze whether the data is normally distributed or not. If, in the normality test, the data is normally distributed, the calculation uses parametric calculations. If the data is not normally distributed, the calculation uses non-parametrics. The data is normally distributed if the p-value is >0.05 if the p-value is >0.05, and if the p-value is <0.05, then the data is not normally distributed.

A homogeneity test was carried out to find out whether the data were homogeneous or not. Systolic and diastolic pressure data were then analyzed using the Levene Test. If p> 0.05, then the data variant is said to be homogeneous. If the p-value < 0.05, the data variant is said to be non-homogeneous

The different test analyses used the Paired t-test, Wilcoxon, independent t-test, and Mann-Whitney with a different test significance level of 0.05. The test will produce a t value and a probability value (p) that can be used to prove whether or not there is a significant difference between the pretest and post-test at the 5% level. How to see the significance level by looking at the p-value. If p0.05, then there is no significant difference.

Results

The results of this study will discuss a general discussion of the measurement results data, including the minimum value, maximum value, mean, and standard deviation from the pretest and posttest values of massage effleurage and petrissage technique treatment with active stretching and massage effleurage and petrissage technique with passive stretching. The following is a description of the pretest data for active stretching and passive stretching after massage treatment presented in Table 1.

Table 2. Pretest data on active and passive stretching treatments

Indicator	Treatment	Min	Max	Mean	SD
Pain	Active Stretching	45	90	65.19	12.95
	Passive Stretching	45	100	66.86	14.28
Flexion ROM	Active Stretching	110	131	123.57	6.24
	Passive Stretching	40	132	112.48	25.08
Extension ROM	Active Stretching	0	6	2.62	1.71
	Passive Stretching	0	7	2.62	1.77
Function	Active Stretching	17.33	80.19	42.22	19.27
	Passive Stretching	15.26	76.36	36.89	16.86

Based on the table above, it can be seen that the minimum, maximum, mean, and standard deviation values in the pretest data have a difference, but the difference that appears is not so large.

The following is a description of the pretest data for active stretching and passive stretching after massage effleurage and petrissage technique treatment presented in Table 2.

Table 3. Posttest data on active and passive stretching treatments

Indicator	Treatment	Min	Max	Mean	SD
Pain	Active Stretching	21	59	41.48	12.04
	Passive Stretching	10	65	37.57	14.84
Flexion ROM	Active Stretching	120	135	129.67	4.12
	Passive Stretching	100	135	127.86	9.82
Extension ROM	Active Stretching	2	8	4.52	1.61
	Passive Stretching	2	9	5.19	1.83
24 hours function	Active Stretching	29.45	83.85	51.08	16.87
	Passive Stretching	27.31	98.75	52.47	15.04
48 hours function	Active Stretching	48.65	84.96	63.62	12.33
	Passive Stretching	54.46	98.75	69.06	10.72
72 hours function	Active Stretching	56.08	89.18	76.03	9.61
	Passive Stretching	61.21	98.75	84.68	8.67

Based on the table above, it can be seen that the posttest value of both active stretching treatment after massage effleurage and petrissage technique and passive stretching after massage effleurage and petrissage technique is not so large.

Table 4. Normality test results of active stretching data after massage

	Shapiro-Wilk		
Pain	Data	Sig.	Description
	Pretest-Posttest Difference	0.597	Normal
	Shapiro-Wilk		
Flexion ROM	Data	Sig.	Description
	Pretest-Posttest Difference	0.037	Abnormal
	Shapiro-Wilk		
Extension ROM	Data	Sig.	Description
	Pretest-Posttest Difference	0.001	Abnormal
	Shapiro-Wilk		
Function	Data	Sig.	Description
	Pretest-Posttest Difference (24 hours)	0.432	Normal
	Pretest-Posttest Difference (48 hours)	0.338	Normal
	Pretest-Posttest Difference (72 hours)	0.780	Normal

The results of the normality test of the sample group data with the Active Stretching treatment after massage in the table above show that the pain indicators, for 24-hour, 48-hour, and 72-hour functions have a p-value>0.05, so it can be concluded that the data are normally distributed. Therefore, the analysis used is parametric analysis.

The data on the flexion and extension ROM indicators have a p-value of <0.05, indicating that the data is not normally distributed. Therefore, the analysis used in the indicator is non-parametric.

Table 5. Normality test results of passive stretching data after massage

	Shapiro-Wilk		
Pain	Data	Sig.	Description
	Pretest-Posttest Difference	0.694	Normal
	Shapiro-Wilk		
Flexion ROM	Data	Sig.	Description
	Pretest-Posttest Difference	0.000	Abnormal
	Shapiro-Wilk		
Extension ROM	Data	Sig.	Description
	Pretest-Posttest Difference	0.04	Abnormal
	Shapiro-Wilk		
Function	Data	Sig.	Description
	Pretest-Posttest Difference (24 hours)	0.376	Normal
	Pretest-Posttest Difference (48 hours)	0.320	Normal
	Pretest-Posttest Difference (72 hours)	0.150	Normal

The results of the normality test of the sample group data with the Passive Stretching treatment after massage in the table above show that the pain indicators for 24-hour, 48-hour, and 72-hour functions have a p-value>0.05, so it can be concluded that the data are normally distributed. Therefore, the analysis used is parametric, analysis.

The data on the flexion and extension ROM indicators have a p-value of <0.05, indicating that the data is not normally distributed. Therefore, the analysis used in the indicator is nonparametric analysis.

Table 6. Homogeneity test of active and passive stretching data after massage

Indicator	LevencyStatistic	df 1	df 2	Sig	Keterangan
Pain	0.517	1	40	0.476	Homogeneous
Flexion ROM	2.075	1	40	0.158	Homogeneous
Extension ROM	0.223	1	40	0.640	Homogeneous
24 hours function	1.438	1	40	0.238	Homogeneous
48 hours function	1.653	1	40	0.206	Homogeneous
72 hours function	0.750	1	40	0.392	Homogeneous

Based on the table above, it can be seen that the significance value of each indicator has a p-value>0.05. If the p-value is >0.05, it can be concluded that the data are homogeneous.

Table 7. Hypothesis test results of active stretching treatment after massage

Indicator	Analysis	Sig.	Description
Pain Pretest-Posttest	Paired t-test	0.000	Significant
Flexion ROM Pretest-Posttest	Wilcoxon	0.000	Significant
Extension ROM Pretest-Posttest	Wilcoxon	0.000	Significant
24 hours Function Pretest-Posttest	Paired t-test	0.000	Significant
48 hours Function Pretest-Posttest	Paired t-test	0.000	Significant
72 hours Function Pretest-Posttest	Paired t-test	0.000	Significant

The results of the Hypothesis Test on the Active Stretching treatment indicator after massage effleurage and petrissage technique obtained a significance value on each indicator of 0.000. This value shows less than 0.05 or p<0.05, so it can be concluded that there is a significant difference between pretest and posttest data in the active stretching treatment group after massage effleurage and petrissage technique.

Table 8. Hypothesis test results of passive stretching treatment after massage

Indicator	Analysis	Sig.	Description
Pain Pretest-Posttest	Paired t-test	0.000	Significant
Flexion ROM Pretest-Posttest	Wilcoxon	0.000	Significant
Extension ROM Pretest-Posttest	Wilcoxon	0.000	Significant
24 hours Function Pretest-Posttest	Paired t-test	0.000	Significant

48 hours Function Pretest-Posttest	Paired t-test	0.000	Significant
72 hours Function Pretest-Posttest	Paired t-test	0.000	Significant

Hypothesis test on Passive Stretching treatment indicators after massage effleurage and petrissage technique obtained a significance value of 0.000 on pain indicators, flexion ROM, extension ROM, and function. This value shows less than 0.05, so it can be concluded that there is a significant difference in each indicator of passive stretching treatment after massage effleurage and petrissage technique.

The last Hypothesis Test aims to determine the difference in the efficacy of active stretching and passive stretching treatments after massage effleurage and petrissage techniques. The technique used was to compare the posttest value of each active stretching treatment indicator after massage with the posttest value of each passive stretching treatment indicator after massage effleurage and petrissage technique. The results of the independent difference test produced the significance, which can be seen in the table below.

Table 9. Hypothesis test of active and passive stretching after massage

Indicator	Analysis	Sig.	Description
Pain	Independent t-test	0.033	Significant
Flexion ROM	Mann-Whitney	0.001	Significant
Extension ROM	Independent t-test	0.011	Significant
24 Hours Function	Mann-Whitney	0.000	Significant
48 Hours Function	Mann-Whitney	0.002	Significant
72 Hours Function	Independent t-test	0.011	Significant

Based on the table above, it can be seen that each indicator for both Active Stretching After Massage effleurage and petrissage technique and Passive Stretching After Massage effleurage and petrissage technique has a significance value of $p<0.05$. Therefore, it can be concluded that there is a significant difference between the Active Stretching After Massage effleurage and petrissage technique and Passive Stretching After Massage effleurage and petrissage technique treatments in terms of pain, flexion ROM, extension ROM, and function at 24, 48, and 72 hours.

Table 10. Data on differences in the effectiveness of active stretching and passive stretching treatments after massage

Indicator	Treatment	Pretest	Posttest	Difference	Percentage (%)
Pain	Active Stretching	65.19	41.48	23.71	36.37
	Passive Stretching	66.86	37.57	29.29	43.80
Flexion ROM	Active Stretching	123.57	129.67	6.1	4.93
	Passive Stretching	112.48	127.86	15.38	13.67
Extension ROM	Active Stretching	2.62	4.52	1.9	72.51
	Passive Stretching	2.62	5.19	2.57	98.09

24 hours Function Pretest-Posttest

Treatment	Pretest	Posttest	Difference	Percentage(%)
Active Stretching	42.22	51.08	8.86	20.98
Passive Stretching	36.89	52.47	15.58	42.23

48 hours Function Pretest-Posttest

Treatment	Pretest	Posttest	Difference	Percentage(%)
Active Stretching	42.22	63.62	21.4	50.68
Passive Stretching	36.89	69.06	32.17	87.20

72 hours Function Pretest-Posttest

Treatment	Pretest	Posttest	Difference	Percentage(%)
Active Stretching	42.22	76.03	33.81	80
Passive Stretching	36.89	84.68	47.79	129

Based on the table above, it can be seen that the percentage difference between the pretest and posttest on the indicators of each treatment obtained different values. In the indicators of pain, Flexion ROM, Extension ROM, 24-hour, 48-hour, and 72-hour functions showed that the percentage of Passive Stretching was higher compared to Active Stretching. Thus, it can be concluded that passive stretching treatment after massage is more effective than active stretching treatment after massage to reduce pain and improve ROM and motion function after a knee injury.

Discussion

The discussion of the results will be based on the research problem, purpose, and hypotheses. Three key findings emerged:

1. The first research problem addressed whether active stretching after massage is effective in reducing pain and improving ROM and motion function after knee injury. The study's purpose was to determine the effectiveness of this intervention. Data analysis revealed that active stretching after massage significantly reduced pain, increased ROM (flexion and extension), and improved overall function, as evidenced by a significance value of 0.000 ($p<0.05$) for these indicators. This finding supports the first hypothesis. Stretching is a physiological technique that reduces muscle tension by decreasing sympathetic nerve activity, thereby restoring bodily balance. Active stretching involves self-generated muscle movements to increase flexibility (Ginitng et al., 2022). Nishikawa et al., (2015) demonstrated the effectiveness of active stretching in increasing hamstring flexibility. These findings align with Atkins & Eichler (2013: 5), who stated that massage therapy offers several benefits, including pain reduction, improved function, edema reduction, relaxation promotion, and facilitated healing across various medical conditions. Furthermore, Boonperm et al., (2022: 897) further emphasized the positive impact of knee massage and exercise on knee condition and quality of life by easing muscle contractions, enhancing blood circulation, and strengthening muscle tissue, thereby improving knee range of motion. Rehman et al., (2021) also reported that massage therapy, including sports massage and active stretching techniques effectively reduce muscle pain in the anterior tibial muscle.
2. The second research question is: Is passive stretching after massage effective in reducing pain, increasing ROM, and improving functional movement after a knee injury? With the second research objective being to determine the effectiveness of passive stretching after massage in reducing pain, increasing ROM, and improving functional movement after a knee injury. The results of data analysis calculation showed that active stretching treatment after massage was effective in reducing pain, increasing ROM, and function after a knee injury, as evidenced by a significance value of 0.000 or $p<0.05$ in pain indicators, flexion ROM, Extension ROM, and function. This is the first research hypothesis that active stretching after massage effectively reduces pain and increases ROM and motion function after a knee injury. The results of research conducted by Nishikawa et al., (2015) showed that active stretching is effective in increasing hamstring flexibility. Another research revealed that stretching is an activity to stretch muscles to increase muscle flexibility and range of joint movement (Monayo & Akuba, 2019: 2). The Crossfit Journal Article (2016) suggests that stretching is very effective in improving muscle and joint flexibility so that it can provide a decrease or loss of pain in the joints. The case is defined as patterned and directed soft tissue manipulation carried out using fingers, hands, forearms, elbow bows, knees, and/or feet with or without the use of emollients, rubs, heat, and cold, hand-held tools, or other external applications for therapeutic changes (Kennedy et al., 2016). As a therapeutic modality, massage is used to relieve pain, swelling, muscle sprain, restricted movement, tension, and anxiety associated with several disorders, which attack muscles, nerves, cardio-respiratory and other systems. It is widely used by sportsmen and ordinary people as an aid to promote recovery from strenuous sports activities (Sinha, 2010). Research conducted by Kaur & Sinha (2020: 525) revealed that massage or massage improves the flexibility of the hamstring muscles without having a detrimental effect on player performance. In addition, the results of research conducted by Jeong et al., (2017) showed massage and passive stretching effectively increase ROM and reduce pain by showing ($p<0.05$). Furthermore, massage therapy or sports massage and passive stretching techniques are also proven effective in reducing muscle pain in the anterior tibial muscle (Rehman et al., 2021).
3. The last problem formulation is whether there is a difference in the effectiveness of active and passive stretching after massage in reducing pain, increasing ROM, and movement function after knee injury? With the last research objective being to determine the comparison

of the effectiveness of active and passive stretching after massage in reducing pain, increasing ROM, and improving functional movement after a knee injury.

4. The calculated results indicate that there were significant differences (p<0.05) between the Active Stretching After Massage and Passive Stretching After Massage groups in terms of pain, flexion ROM, extension ROM, and functional outcomes at 24, 48, and 72 hours. These findings align with the final hypothesis, suggesting that active and passive stretching post-massage yield different effects on pain reduction, ROM improvement, and functional recovery following knee injury. It was supported by the research conducted by Rahmiati & Yelni (2017) that stretching enhances the range of motion and muscle/joint flexibility, influencing both physical and daily activities. Joseph et al. (2018) explained that injuries often lead to muscle stiffness and spasms, causing pain, reduced flexibility, and impaired function. Physiological stretching improves blood circulation, increasing oxygen supply to cells, thereby alleviating pain, enhancing range of motion, and promoting functional recovery (Ibrahim & Akindele, 2018). Combining stretching with massage can optimize healing outcomes. The combination of massage therapy and coupled with stretching movements will provide a better muscle relaxation effect than just being given to achieve massage. Massage has more effects, such as increasing blood flow, reducing muscle tension, feeling better, and neurological stimulation of tissues (Mustafalo, 2022). Massage can affect the decrease in systolic blood pressure, diastolic blood pressure, pulse rate, respiratory frequency, and temperature. Of the various existing massages, the benefits of sports massage have the effect of relieving stress, increasing tissue elasticity, and eliminating lactic acid buildup (Fitriyah Ningsih et al., 2016: 136). Research conducted by Nishikawa et al., (2015) showed that there was a significant increase in hamstring flexibility in the active and passive stretching group compared to the control group. The passive stretching group showed significantly greater improvement in hamstring flexibility than the active stretching group.

Conclusions

After conducting a series of research, the following conclusions were drawn:

1. Active stretching after massage is effective in reducing pain, increasing ROM, and improving function after a knee injury. Data analysis revealed that active stretching after massage significantly reduced pain, increased ROM (flexion and extension), and improved overall function, as evidenced by a significance value of 0.000 (p<0.05) for these indicators. The data showed a decrease in pain of 36.37%, an increase in ROM flexion of 4.93%, ROM extension of 72.51%, and functional improvement of 24 hours 20.98%, 48 hours 50.68%, and 72 hours 80%.

2. Passive stretching after massage is effective in reducing pain, increasing ROM, and improving function after a knee injury. The results of data analysis calculation showed that active stretching treatment after massage was effective in reducing pain, increasing ROM, and function after a knee injury, as evidenced by a significance value of 0.000 or p<0.05 in pain indicators, flexion ROM, Extension ROM, and function. Passive stretching after massage the data shows a decrease in pain of 43.80%, ROM flexion 13.67%, ROM extension 98.09, and functional improvement 24 hours 42.23%, 48 hours 87.20%, 72 hours 91.73%.

3. There is a difference in effectiveness between active and passive stretching after massage at 72 hours post-treatment in reducing pain, increasing ROM, and improving function after a knee injury. The calculated results indicate that there were significant differences (p<0.05) between the Active Stretching After Massage and Passive Stretching After Massage groups in terms of pain, flexion ROM, extension ROM, and functional outcomes at 24, 48, and 72 hours.

References

Acevedo, R. J., Rivera-Vega, A., Miranda, G., & Micheo, W. (2014). Anterior cruciate ligament injury: identification of risk factors and prevention strategies. Current Sports Medicine Reports, 13(3), 186–191.

Alghadir, A. H., Anwer, S., Iqbal, A., & Iqbal, Z. A. (2018). Test-retest reliability, validity, and minimum detectable change of visual analog, numerical rating, and verbal rating scales for measurement of osteoarthritic knee pain. Journal of Pain Research, 11, 851–856. https://doi.org/10.2147/JPR.S158847

Atkins, D. V., & Eichler, D. A. (2013). The effects of self-massage on osteoarthritis of the knee: A randomized, controlled trial. International Journal of Therapeutic Massage and Bodywork: Research, Education, and Practice, 6(1), 4–14. https://doi.org/10.3822/ijtmb.v6i1.119

Bahr, R., Alfredson, H., Järvinen, M., Järvinen, T., Khan, K., Kjær, M., Matheson, G., & Mæhlum, S. (2012). Types and causes of injuries. The IOC Manual of Sports Injuries: An Illustrated Guide to the Management of Injuries in Physical Activity, 1–24.

Boonperm, N., Wamontree, P., Putthumrugsa, N., Phasinam, K., Watcharinrat, D., & Taksin, R. (2022). The Effects of Applied Thai Traditional Massage Combined with Knee Exercise on Knee OA Patients: A Case Study of Ban Kracheng Community Health Promoting Hospital, Pathum Thani Province, Thailand. Journal of Pharmaceutical Negative Results, 13(1), 891–897. https://doi.org/10.47750/pnr.2022.13.S01.108

Chan, D. K. C., Lee, A. S. Y., Hagger, M. S., Mok, K.-M., & Yung, P. S.-H. (2017). Social psychological aspects of ACL injury prevention and rehabilitation: An integrated model for behavioral adherence. Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology, 10, 17–20.

Diwakar, M. (2018). Manangement of ACL tear in paediatric age group: a review of literature. Journal of Arthroscopy and Joint Surgery, 5(1), 9–14.

Fitriyah Ningsih, Y., Wismanadi, H., & Siantoro, G. (2016). PENGARUH SPORT MASSAGE DAN TERAPI BEKAM TERHADAP PENURUNAN KADAR ASAM LAKTAT DAN DENYUT NADI. Journal of Physical Education, 3(2). http://journal.unnes.ac.id/nju/index.php/jpehs

Gao, F., Liu, G., Chung, B. L.-H., Chan, H. H.-T., & Liao, W.-H. (2019). Macro fiber composite-based energy harvester for human knee. Applied Physics Letters, 115(3), 33901.

Ginitng, A. M., Wijanarko, W., & Erwansyah, R. (2022). Pengaruh Stretching Dan Strengthening Terhadap Penurunan Skala Nyeri Sendi Lutut Ostheoarthritis Genu Di Kwala Bekala Lingkungan XIV Medan. Jurnal Kesehatan Dan Fisioterapi, 2, 11–17.

Graha, A. S., & Harsanti, S. (2015). Efektifitas Terapi Masase Dan Terapi Latihanpembebanan Dalam Meningkatkan Range of Movementpasca Cedera Ankle Ringan. Medikora, XIII(1). https://doi.org/10.21831/medikora.v0i1.4590

Grassi, A., Quaglia, A., Canata, G. L., & Zaffagnini, S. (2016). An update on the grading of muscle injuries: A narrative review from clinical to comprehensive systems. Joints, 4(1), 39–46. https://doi.org/10.11138/jts/2016.4.1.039

Gunawan, T., & Imanudin, I. (2019). Hubungan antara Fleksibilitas Pergelangan Tangan dan Power Otot Lengan dengan Ketepatan dan Kecepatan Smash pada Cabang Olahraga Bulutangkis. Jurnal Terapan Ilmu Keolahragaan, 4(1), 1–7. https://doi.org/10.17509/jtikor.v4i1.10129

Helmi, Z. N. (2012). Buku ajar gangguan muskuloskeletal. Jakarta: Salemba Medika, 296.

Ibrahim, A. A., & Akindele, M. O. (2018). Combined Effects of Postural Education, Therapeutic Massage, Segmental Stretching, and Motor Control Exercise in a 19-Year-Old Male with Chronic Back Pain and Kypholordotic Posture: A Case Report. Middle East Journal of Rehabilitation and Health, 5(3). https://doi.org/10.5812/mejrh.74186

Jabbour, H. N., & Sales, K. J. (2014). Prostaglandin receptor signalling and function in human endometrial pathology. Trends in Endocrinology & Metabolism, 15(8), 398–404.

Jeong, H. M., Shim, J.-H., & Suh, H. R. (2017). The passive stretching, massage, and muscle energy technique effects on range of motion, strength, and pressure pain threshold in musculoskeletal neck pain of young adults. Physical Therapy Rehabilitation Science, 6(4), 196–201. https://doi.org/10.14474/ptrs.2017.6.4.196

Joseph, L. H., Hancharoenkul, B., Sitilertpisan, P., Pirunsan, U., & Paungmali, A. (2018). Effects of Massage as a Combination Therapy with Lumbopelvic Stability Exercises as Compared to Standard Massage Therapy in Low Back Pain: a Randomized Cross-Over Study. International Journal of Therapeutic Massage and Bodywork, 11(4), 16–22.

Kaur, K., & Sinha, A. G. K. (2020). Effectiveness of massage on flexibility of hamstring muscle and agility of female players: An experimental randomized controlled trial. Journal of Bodywork and Movement Therapies, 24(4), 519–526. https://doi.org/10.1016/j.jbmt.2020.06.029

Kennedy, A. B., Jerrilyn, A. C., Patricia, A. S., Ravensara, S. T., & Ruth, P. S. (2016). Clarifying Definitions for the Massage Therapy Profession: the Results of the Best Practices Symposium†. International Journal of Therapeutic Massage & Bodywork, 9(3), 15–26. http://ijtmb.org/index.php/ijtmb/article/view/312/370

Kusworo, Y. A., Kristiyanto, A., & Doewes, M. (2018). Acute Effect Of Active And Passive Static Stretching On Range Of Motion On Hip Joint Flexibility On Female Karate Athletes Of Muhammadiyah University Of Surakarta. Journal of Health, 5(2), 50–55.

Monayo, E. R., & Akuba, F. (2019). Pengaruh Stretching Exercise Terhadap Penurunan Skala Nyeri Sendi Lutut Pada Pasien Osteoartrtis. Jambura Nursing Journal, 1(1), 1–10. https://doi.org/10.37311/jnj.v1i1.2074

Mustafalo, A. (2022). The effect of one session massage in the lower limb muscle on flexibility, power and agility tests performance in soccer players. Pars Journal of Medical Sciences, 10(2), 17–24.

Napitupulu, R. M. (2021). Gambaran Perilaku Sehat Mahasiswa Fisioterapi Universitas Kristen Indonesia Healthy Behavior Profile of Physiotherapy Students at Universitas Kristen Indonesia. Paper Knowledge . Toward a Media History of Documents, 5(2), 105–113.

Nishikawa, Y., Aizawa, J., KaNemura, N., Takahashi, T., Hosomi, N., MaruYama, H., Kimura, H., MaTsumoTo, M., & TakaYaNagi, K. (2015). Immediate effect of passive and active stretching on hamstrings flexibility: a single-blinded randomized control trial ハムストリングの柔軟性に対する静的ストレッチと動的ストレッチの即時効果 単盲検無作為化比較試験. Journal of Physical Therapy Science, 27(10), 3167–3170.

Putri, D. A. R., Imandiri, A., & Rakhmawati, R. (2020). Therapy Low Back Pain With Swedish Massage, Acupressure and Turmeric. Journal of Vocational Health Studies, 4(1), 29. https://doi.org/10.20473/jvhs.v4.i1.2020.29-34

Rahmiati, C., & Yelni, S. (2017). Efektivitas Stretching Terhadap Penurunan Nyeri Sendi Lutut Pada Lansia. Seminar Nasional Multi Disiplin Ilmu UNAYA, 1(1), 379–386. http://ocs.abulyatama.ac.id/

Rahmiati, F., Wijianto, SST. F. M. O., & Wahyuni, SST. F. M. K. (2013). Pengaruh Active Stretching dan Hold Relax Stretching Terhadap Fleksibilitas Otot Hamstring Pada Pemain Futsal.

Rehman, A., Sadiq, N., & Khan, A. (2021). Comparison of Massage Therapy and Passive Stretching for Reducing Doms of Tibialis Anterior. European Journal of Health Sciences, 6(2), 18–29. https://doi.org/10.47672/ejhs.709

Sadeqi, M., Klouche, S., Bohu, Y., Herman, S., Lefevre, N., & Gerometta, A. (2018). Progression of the psychological ACL-RSI score and return to sport after anterior cruciate ligament reconstruction: a prospective 2-year follow-up study from the French Prospective Anterior Cruciate Ligament Reconstruction Cohort Study (FAST). Orthopaedic Journal of Sports Medicine, 6(12), 2325967118812819.

Sanders, T. L., Maradit Kremers, H., Bryan, A. J., Larson, D. R., Dahm, D. L., Levy, B. A., Stuart, M. J., & Krych, A. J. (2016). Incidence of anterior cruciate ligament tears and reconstruction: a 21-year population-based study. The American Journal of Sports Medicine, 44(6), 1502–1507.

Sanusi, R., Surahman, F., & Yeni, H. O. (2020). Pengembangan Buku Ajar Penanganan dan Terapi Cedera Olahraga. Journal Sport Area, 5(1), 40–50. https://doi.org/10.25299/sportarea.2020.vol5(1).4761

Setyaningrum, D. A. W. (2019). Cedera olahraga serta penyakit terkait olahraga. Jurnal Biomedika Dan Kesehatan, 2(1), 39–44. https://doi.org/10.18051/jbiomedkes.2019.v2.39-44

Sinha, A. G. (2010). Principle and Practice of Therapeutic Massage. Atreya Ayurveda.

Tama, A. L. A., Wahyudi, A. N., & Utomo, A. W. B. (2021). The Effect of Local Masase Lower Extremities As Passive Recovery On Muscle Strength of Football Players' Limbs. Jurnal Ilmiah Sport Coaching and Education, 5(2), 98–104.

Utomo, A. W. B., Wibowo, T., & Wahyudi, A. N. (2022). Peningkatan Range of Movement (ROM) Atlet Sepakbola Pasca Cedera Ankle dengan Terapi Massage dan Latihan Pembebanan. Physical Activity Journal, 3(2), 219. https://doi.org/10.20884/1.paju.2022.3.2.5718

Wahyuni, S., Raden, A., & Nurhidayati, E. (2016). Perbandingan Trancutaneous Electrical Nerve Stimulation Dan Kinesio Taping Terhadap Penurunan Skala Nyeri Punggung Bawah Pada Ibu Hamil Trimester III Di Puskesmas Juwiring Kabupaten Klaten. MOTORIK Jurnal Ilmu Kesehatan, 11(23).

Williams, L., & Wilkins. (2013). ACSM's Guidelines for Exercise Testing and Prescription. Lippincott williams & wilkins.

Zein, M. I. (2015). Cedera Anterior Cruciate Ligament (Acl) Pada Atlet Berusia Muda. Medikora, 11(2), 111–121. https://doi.org/10.21831/medikora.v11i2.2811.

Authors' and translators' details:

Arif Kurniawan	arifkurniawan@uny.ac.id	Autor/a
Ahmad Nasrulloh	ahmadnasrulloh@uny.ac.id	Autor/a
Sulistiyono	sulistiyono@uny.ac.id	Autor/a
Ali Satia Graha	ali_satiagraha@uny.ac.id	Autor/a
Hadwi Prihatanta	hadwi_prihantanta@uny.ac.id	Autor/a