

## THE EFFECT OF SPORTS MASSAGE THERAPY ON FITNESS RECOVERY OF FEMALE SOCCER ATHLETES: ANALYSIS OF CREATINE KINASE LEVELS AND PHYSICAL PERFORMANCE

### ВПЛИВ ЛІКУВАЛЬНОГО СПОРТИВНОГО МАСАЖУ НА ВІДНОВЛЕННЯ ФІЗИЧНОЇ ФОРМИ СПОРТСМЕНОК: АНАЛІЗ РІВНІВ КРЕАТИНКІНАЗИ (КК) І ФІЗИЧНОЇ ПРАЦЕЗДАТНОСТІ

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#### Abstracts

**Purpose of the work.** This study aims to evaluate the effectiveness of sports massage in promoting muscle recovery among female soccer players. The focus is on analyzing changes in creatine kinase (CK) levels, a biomarker of muscle damage, and vertical jump performance, an indicator of muscle power recovery.

**Methods and materials.** Thirty female soccer players were recruited and randomly assigned to two groups. The first group received sports massage as part of their recovery protocol, while the second group performed active stretching exercises following their matches. CK levels were measured at four specific intervals: baseline, immediately after the match, and 24 and 48 hours post-match. Vertical jump performance was also tested at these same intervals to assess recovery progress. A mixed-design ANOVA was employed to investigate changes in CK levels over time and between groups, focusing on significant interactions between these variables.

**Results.** CK levels significantly increased in both groups immediately after the match, reflecting exercise-induced muscle damage. However, the sports massage group demonstrated a faster reduction in CK levels at 24 and 48 hours post-match compared to the active stretching group. This suggests that sports massage facilitates the quicker elimination of muscle damage markers. Additionally, paired t-tests indicated significant improvements in vertical jump performance in the sports massage group by 48 hours post-match, signifying enhanced muscle power recovery and reduced delayed onset muscle soreness (DOMS). In contrast, the active stretching group exhibited slower recovery, with less pronounced improvements in jump performance.

**Conclusions.** The findings highlight the significant benefits of sports massage as an effective recovery strategy for athletes. By enhancing blood flow, relieving muscle tension, and accelerating the removal of metabolic waste products, sports massage promotes faster recovery and reduces muscle soreness. This allows athletes to restore their performance more efficiently. The study underscores the importance of incorporating sports massage into post-match recovery protocols. Further research is encouraged to explore the underlying physiological mechanisms and optimize recovery strategies for competitive athletes across various sports.

**Key words:** sports massage, creatine kinase, muscle recovery, vertical jump, female soccer player.

**Мета дослідження.** Це дослідження спрямоване на оцінку ефективності спортивного масажу у відновленні м'язів серед жінок-футболісток. Основна увага приділяється аналізу змін рівня креатинкінази (СК), біомаркера пошкодження м'язів та результатів у вертикальному стрибку, які є індикатором відновлення м'язової сили.

**Методи та матеріали.** У дослідженні взяли участь 30 жінок-футболісток, яких випадково розподілили на дві групи. Перша група проходила спортивний масаж як частину відновлювального протоколу, а друга виконувала активні вправи на розтяжку після матчів. Рівні СК вимірювали у чотирьох часових інтервалах: у вихідному стані, одразу після матчу, через 24 та 48 годин після матчу. Також у ці ж інтервали оцінювали результати вертикального стрибка для аналізу прогресу.

су відновлення. Зміни рівня СК у часі та між групами аналізували за допомогою дисперсійного аналізу (ANOVA) змішаного типу.

**Результати.** Рівні СК значно підвищувалися у обох групах одразу після матчу, що свідчить про пошкодження м'язів внаслідок фізичних навантажень. Проте група, яка отримувала спортивний масаж, демонструвала швидше зниження рівня СК через 24 та 48 годин порівняно з групою, яка виконувала розтяжку. Це свідчить про те, що спортивний масаж сприяє швидшому усуненню маркерів пошкодження м'язів. Крім того, парні t-тести виявили значне покращення у результатах вертикального стрибка у групі масажу через 48 годин після матчу, що вказує на краще відновлення м'язової сили та зменшення затриманого м'язового болю (DOMS). Натомість у групі розтяжки відновлення відбувалося повільніше.

**Висновки.** Результати підкреслюють значні переваги спортивного масажу як ефективного методу відновлення для спортсменів. Завдяки покращенню кровообігу, зменшенню напруження м'язів та прискоренню виведення метаболічних продуктів спортивний масаж сприяє швидшому відновленню та зменшенню болю у м'язах. Це дозволяє спортсменам швидше відновити свою оптимальну продуктивність. Подальші дослідження рекомендується спрямувати на вивчення фізіологічних механізмів цього процесу та оптимізацію стратегій відновлення для професійних спортсменів

**Ключові слова:** спортивний масаж, креатинкіназа, відновлення м'язів, вертикальний стрибок, футболістка.

**Introduction.** Soccer is physically demanding, so recovery is crucial to performance. Female soccer players have significant muscle fatigue and damage during training and matches. When muscle fibers are injured, creatine kinase (CK) is released into the bloodstream, a commonly used biomarker [8]. High CK levels indicate muscle damage, so monitoring them is crucial to muscle recovery [2]. Effective recovery strategies can help athletes recover faster and avoid overuse injuries [13]. Sports massage is believed to reduce muscle soreness and improve metabolic waste removal [27]. Sports massage is thought to increase blood flow, reduce muscle stiffness, and aid tissue repair by manually stimulating muscles [28]. After high-intensity activity, many athletes and physiotherapists consider it essential to their recovery protocol. Research on the direct effect of sports massage on CK levels and muscle recovery is inconclusive, requiring further study [4].

With the intensity and frequency of physical demands in soccer, especially for female athletes, finding an effective recovery strategy is very important. Female athletes may experience different recovery needs compared to male athletes, due to physiological and hormonal differences [6]. Rapid recovery is important to prevent fatigue, overtraining, and injury, all of which can hinder long-term performance. Thus, the exploration of more targeted recovery methods, including sports massage, is essential

to improve recovery time and ensure continued performance [15].

After physical activity, intramuscular inflammatory changes can cause Delayed Onset Muscle Soreness (DOMS), swelling, reduced joint range of motion, and more [23]. Sports massage can reduce creatine kinase-induced tissue damage. Sports massage uses hand manipulation to relax muscles and increase blood circulation [1]. All limbs can receive sports massage, especially tired ones after exercise [5]. Standard sports massage lasts 30 minutes and targets the desired body part [3].

After intense exercise, sports massage can reduce creatine kinase production by increasing skin and muscle temperature and vascularization (vasodilation) [25]. Based on the background, the researcher wants to study whether sports massage reduces CK levels in female soccer players after exercise.

## **Method**

### ***Study design and participants***

This quantitative study uses a two-group pre-post test method to assess the effects of sports massage interventions on female soccer players' recovery after physical training. The study involved academy members from November 2023 to January 2024 at the Surakarta Women's Soccer Academy in Central Java, Indonesia. Accidental sampling divided participants into a control group (active stretching) and an experimental group (sports massage) post-

training based on inclusion and exclusion criteria. The total sample in this study consisted of 30 female soccer athletes. The control and intervention groups each consisted of 15 female soccer athletes.

The Surakarta Women's Soccer Academy membership, physical and mental fitness, willingness to follow research procedures, prior physical training, and creatine kinase (CK) level assessment were the inclusion criteria. Non-academy membership, unwillingness to participate, illness or inability to train, menstruation, and injection fear were exclusion criteria. Dropout criteria were voluntary withdrawal or improper research completion.

#### **Group intervention**

In the intervention group, female soccer athletes received a sports massage focusing on the lower extremities. The massage involved a sequence of techniques, starting and ending with effleurage and stroking, and including petrissage, shaking, tapotement, skin walking, skin rolling, and vibration. Each massage session lasted approximately 30 minutes.

#### **Blood sampling**

Blood sample collection was conducted by nurses from PKU Muhammadiyah Hospital in Surakarta. Samples were taken from the brachial artery of athletes in both groups at four time points: before the match, immediately after the match, 24 hours post-match, and 48 hours post-match. The samples were stored in vacutainer tubes, kept in an ice box at  $-20^{\circ}\text{C}$ . Serum was separated from other blood components by centrifuging at 3000 rpm for 30 minutes. CK concentration measurements were then performed using an ELISA assay at the Clinical Pathology Laboratory of Dr. Sardjito Central General Hospital.

#### **Bioethics**

This research has received ethical approval from the Medical/Health Research Bioethics Commission, Faculty of Medicine, Sultan Agung Islamic University, Semarang with Number 436/X/2023/Bioethics Commission.

#### **Statistical analysis**

This study examined sports massage effects using bivariate analysis. To determine if sports

massage affected vertical jump performance and Creatine Kinase (CK) levels, an Analysis of Variance (ANOVA) was used to compare mean results across groups at pre-match, post-match, 24 hours post-match, and 48 hours post-match. A paired sample t-test was used to compare the effects of an ice bath to the control group by comparing CK level changes within the same group pre- and post-intervention or between the two groups. Statistics and interpretation were made easier with SPSS 22, allowing a thorough analysis of sports massage's effects on the variables studied.

### **Result**

#### **Vertical Jump**

Sports science and physical therapy use the Vertical Jump, particularly the Countermovement Jump (CMJ), to assess lower limb strength and explosive power [20]. Participants start the CMJ standing with feet shoulder-width apart and arms relaxed. Like a squat, the movement begins with rapid hip and knee flexion while drawing the arms back to maximize muscle-tendon energy storage [10].

The jump phase involves an immediate and powerful extension of the knees, hips, and ankles and an upward arm swing to increase momentum and vertical thrust [12]. To absorb impact and reduce injury risk, knees must be bent during landing [21]. For consistent jump mechanics, the torso must remain straight and vertical [16].

For accurate performance metrics, force plates or jump mats are used to measure jump height, peak force, and power output [22]. Repeating the CMJ with consistent form improves measurement reliability, allowing for accurate neuromuscular performance monitoring over time [26]. Figure 1 below shows the test results.

According to the figure, the findings are: the pre-match stretching cohort started at 43 cm. After the match, the measurement decreased to 37.2 cm, indicating a significant decrease ( $p < 0.05$ ). After a 24-hour recovery period with stretching, performance metrics improved by 41 cm, indicating a significant statistical change compared to post-match results ( $p < 0.05$ ). Reevaluation 48 hours post-match showed no statistically significant difference



**Fig. 1. Result of vertical jump following a one-off soccer match for stretching and sport massage groups**

(Values are means and standard deviations. \*Significant difference versus baseline for both groups ( $P < 0.05$ ))

from baseline at 44.1 cm. The data showed that pre-match stretching decreased performance, while a 24-hour recovery phase with stretching improved performance, stabilizing at baseline by 48 hours. This suggests that athletic preparation stretching protocols may need to be revised to improve performance.

This graph shows how sports massage compares to stretching for muscle recovery after exercise. Initial baseline measurements for the sports massage group were 45.3 cm. Post-exercise, the measurement dropped to 38.4 cm, indicating immediate muscle flexibility or tightness ( $p < 0.05$ ). The sports massage and stretching groups had no statistically significant difference post-exercise ( $p > 0.05$ ), suggesting that both may have similar short-term effects. Sports massage group follow-up measurements 24 hours later showed a mean of 41.8 cm. This value indicates a recovery trend compared to immediate post-match measurements and significantly differs from baseline ( $p < 0.05$ ). Comparing the post-24-hour results to those in the stretching group showed no significant difference ( $p > 0.05$ ), supporting the idea that both methods may aid recovery. A 48-hour assessment showed 43.6 cm for the sports massage group.

This reading is not significantly different from baseline or the stretching group after 48 hours ( $p > 0.05$ ). The data show that sports massage can reduce muscle tightness immediately, but its long-term recovery effects may be similar to stretching. Future research could examine these modalities' mechanisms and muscle recovery effects over time.

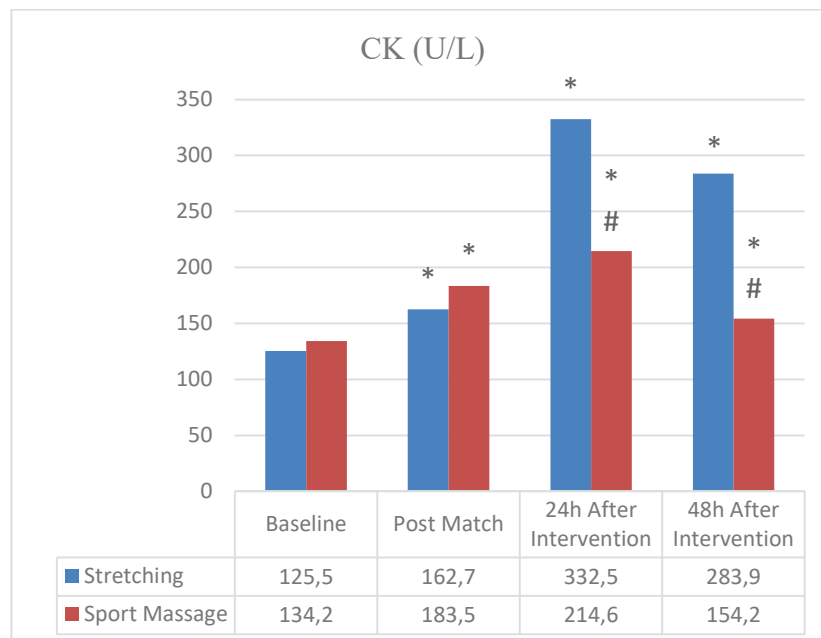
### Creatine kinase

Informed consent and patient education are the first steps in creatine kinase (CK) testing. Next, prepare sterile syringes, blood collection tubes, and gloves. After positioning the patient's arm, alcohol swabs disinfect the venipuncture site and a tourniquet is applied to facilitate venous blood flow.

The vein is then carefully accessed with a sterile needle at an angle to allow blood to flow into the collection tube. After collecting a sufficient sample, the tourniquet is released, the needle is removed, and sterile cotton is applied to the puncture site to stop bleeding. Use a small bandage to secure the area. Label and transport the sample to the lab for analysis immediately. An enzymatic assay accurately measures serum CK activity in the lab. Since elevated CK levels indicate cellular damage, they can indicate

muscle or organ injury. CK reference ranges vary by laboratory, but men's average values are 38–174 U/L and women's are 26–140 U/L [18]. Figure 2 below shows the test results.

Figure 2 shows how stretching affects athlete creatine kinase (CK) levels biochemically. The baseline CK level was 125.5 U/L before the match. The match resulted in a significant



**Fig. 2. Result of CK following a one-off soccer match for stretching and sport massage groups**

(Values are means and standard deviations. \*Significant difference versus baseline for both groups ( $P < 0.05$ ). #Significant difference versus stretching group ( $P < 0.05$ ))

increase in CK levels, reaching 162.7 U/L ( $p < 0.05$ ). 24-hour post-stretching monitoring showed a significant increase in CK levels to 332.5 U/L compared to baseline and post-match measurements ( $p < 0.05$ ). Reassessing CK 48 hours after the match showed 283.9 U/L. This measurement showed a significant difference compared to baseline, post-match, and 24-hour post-stretching CK levels ( $p < 0.05$ ).

A baseline creatine kinase (CK) level of 134.2 U/L was found in sports massage recipients before the match. CK levels reached 183.5 U/L after the competitive event, indicating a significant increase ( $p < 0.05$ ) from baseline values. After the match, sports massage increased CK to 214.6 U/L. The post-massage CK level differed significantly from baseline, post-match, and 24-hour post-stretching values ( $p < 0.05$ ). CK levels were taken 48 hours after the match and were 154.2 U/L. This measurement

differed significantly from pre-match, post-match, 24-hour post-stretching, and immediate post-massage levels ( $p < 0.05$ ). The consistent statistical significance of these results supports sports massage as a recovery modality in sports science.

**Discussion.** The creatine kinase (CK) levels were the primary focus of this research project, which compared the effectiveness of getting a sports massage to getting some passive rest on muscle recovery. At 24 hours after the exercise, the results showed that there were significant differences in the levels of CK between the group that received sports massage and the group that served as the control. These differences continued to be significant at 48 hours. The enhanced vertical jump scores at 24 and 48 hours after receiving a sports massage support the hypothesis that sports massage is connected with a more significant recovery of muscle strength.



It has been demonstrated in previous studies that sports massage can reduce muscle soreness and improve performance markers such as running and leaping within twenty-four hours [27]. The outcomes of the current study support these findings.

Different sports massage techniques can result in different physiological consequences, even though they are routinely used to alleviate acute muscle soreness [11]. In addition to reducing muscle tension, it improves blood circulation, making eliminating waste products from the metabolism easier. Sports massage has been shown to dramatically reduce delayed onset muscle soreness (DOMS), according to research conducted by [28]. However, it may not prevent functional losses. There is a correlation between eccentric training and microtrauma, which is necessary for muscle growth. It has been suggested by Supriyadi that reducing discomfort can improve the effectiveness of recovery and that sports massage can enhance the effectiveness of overall healing experiences [24]. It enhances blood circulation, nutrition delivery, and oxygen transport to injured muscles, facilitating waste elimination [19]. Additionally, it activates the lymphatic system, reducing muscle swelling [17].

Additionally, sports massage reduces the levels of stress hormones like cortisol, which can be detrimental to the recovery process. It is responsible for regulating pro-inflammatory cytokines, and increased levels of interleukin-6 (IL-6) may enhance anti-inflammatory responses, hence reducing the severity of muscle injury [9]. Our experiment's findings agree with those of Davis, Alabed, & Chico, who found that both sports massage and passive recovery improve recovery perceptions and decrease muscular soreness [5]. However, our investigation demonstrated that the improvements in vertical jump performance were more substantial. This gap could be explained by variations in technique as well as variations in athlete conditioning. Although sports massage effectively reduces discomfort, sports massage suggests that its impact on physical performance may vary from person to person [14].

The findings of our study indicate that the effectiveness of sports massage in improving vertical jump performance is directly proportional to the duration and intensity of the massage. The massage group showed accelerated IL-6 reductions, which were associated with lower levels of oxidative stress. Additionally, the group that received sports massage demonstrated improved recovery at both 24 and 48 hours post-match, as evidenced by vertical jump scores, confirming the method's efficacy following intense activity. These results align with previous findings that a 15-minute sports massage enhances recovery compared to passive techniques.

Assessing muscle strength through vertical jump scores is crucial due to its strong link to athletic performance. In our research, combining these evaluations enabled a precise investigation into muscle recovery post-exercise. The massage group also exhibited lower CK levels compared to the control group, supporting prior studies on the effectiveness of sports massage in enhancing blood circulation and reducing muscle damage. The benefits include pain relief, muscle relaxation, and injury prevention, all of which contribute to holistic recovery.

Previous studies examining the physiological effects of prolonged high-intensity exercise have shown that eccentric contractions can cause muscle injury and elevated CK levels [7]. Research further indicates that these contractions lead to micro-tears and discomfort. Consequently, sports massage effectively enhances recovery by targeting these metabolic issues, which is particularly beneficial for soccer players.

**Conclusion.** Athletes' vertical jump performance and creatine kinase (CK) levels improved after sports massage, proving its importance. The findings support previous research that sports massage reduces muscle pain and speeds recovery. Sports massage improves blood circulation, muscle tension, and stress hormone levels, making it important for sports recovery. The results show that massage time and intensity affect healing outcomes, though individual responses vary. Sports massage improves post-exercise

rehabilitation, especially for high-intensity athletes, improving performance and preventing injuries.

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**Conflict of interest.** The authors declare that there are no conflicts of interest.

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