

# Revitalizing performance: Exploring the influence of sports massage and PNF stretching on lactic acid recovery in females futsal athletes

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## ABSTRACT

Elevated levels of lactic acid in the blood and muscles following intense training or competition can have detrimental effects on physical performance and increase the likelihood of injury. Therefore, it is crucial to identify effective recovery techniques to mitigate fatigue promptly. The objective of this study was to assess the impact of sports massage and the Proprioceptive Neuromuscular Facilitation (PNF) method on the recovery of lactic acid in athletes. This study employed a true-experimental design using a pretest-posttest without a control group. A sample of 20 female futsal athletes was divided into two groups: the sports massage group (SM) consisting of 10 participants, and the PNF method group also comprising 10 participants. Lactic acid levels were assessed before exercise, immediately after completing the anaerobic exercise, and immediately after the recovery intervention based on the respective group allocation. The results showed an increase in lactic acid after anaerobic exercise in both groups. The SM group experienced a significant decrease compared to the PNF group which did not experience a significant decrease. A significant disparity was observed in the mean lactic acid levels between the two groups in the post-test data. In conclusion, the application of sports massage following anaerobic exercise proves to be effective in reducing lactic acid concentrations in futsal athletes compared to the PNF method. The findings of this study are anticipated to yield advantages for coaches, sports medical teams, and athletes by lowering lactic acid levels, enhancing sports performance, and mitigating injury risks. Practically, the findings underscore the potential benefits of incorporating a 15-minute sports massage into the recovery routine of female futsal players.

**Keywords:** Sport massage; proprioceptive neuromuscular facilitation; lactic acid; futsal

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## INTRODUCTION

Futsal, a team sport, has experienced significant growth over the last decade worldwide. Female futsal in particular has received increasing global attention (Uluöz, 2016; Mascarin, Vicentini, & Marques, 2019). In

addition, investment funds issued in the sport of futsal have increased in all international confederations at the direction of FIFA as the world futsal parent (Sanmiguel-Rodríguez, 2021). Due to the growing prominence of female futsal, the inaugural global female futsal tournament took place in 2010 (Lago-Fuentes et al., 2018). In addition, there are several professional leagues with a high level of competition in countries such as Spain, Portugal, Russia, the Netherlands, Brazil, and Italy (Uluöz, 2016). In contrast to female futsal in countries such as Spain, Portugal, Russia, the Netherlands, Brazil, and Italy which have been established and advanced, female futsal in Indonesia is still growing. So it takes serious efforts from all stakeholders to improve female futsal in Indonesia.

Futsal sports have intermittent characteristics with high intensity so excellent physical abilities are needed for the players (Apriantono et al., 2021; Spyrou et al., 2020). Previous studies have shown that elite female futsal players consistently perform at intensities exceeding 80% of their maximum oxygen uptake during matches, indicating a high level of intensity (Sanmiguel-Rodríguez, 2021). Moreover, training sessions in female futsal have been found to be more intense compared to female football training (Clemente & Nikolaidis, 2016). As a result, it is imperative for futsal coaches and athletes to continuously explore strategies to enhance the body's physiological systems through the development of challenging and effective training programs. By doing so, female futsal athletes can enhance their ability to cope with acute fatigue (Barbieri et al., 2016).

Multiple studies have highlighted the significance of fatigue in athletes, as it not only hampers performance but also increases the risk of injuries (Coleman, 2019; Radulović et al., 2019; Soligard et al., 2016; Trajkovic et al., 2018). Fatigue is often associated with the accumulation of lactic acid in muscle fibers, which typically arises from engaging in high-intensity (Almeida et al., 2021; Santos-Silva et al., 2017). Hence, it is crucial for coaches and their support staff to employ effective recovery strategies that expedite the reduction of lactic acid concentrations, enabling athletes to recuperate and enhance their performance. Furthermore, coaches and their staff frequently employ various post-exercise strategies to optimize the recovery process and minimize fatigue levels among athletes (Kellmann et al., 2018).

Several recovery methods that are useful and effective in the context of futsal include therapy using light emitters, water immersion (either in cold, hot, thermoneutral, or contrast water), as well as recovery involving low-intensity aerobic activity (Martínez-Guardado et al., 2020). Although these recovery methods have been extensively researched and well-documented in the context of futsal athletes. The available scientific literature on the utilization of sports massage and the current understanding of the effectiveness and extent of PNF techniques in mitigating muscle fatigue and improving performance in female futsal athletes is limited and requires further exploration and investigation. Massage is a comprehensive set of actions involving mechanical manipulation of soft tissues through rhythmic movements and pressure to improve health and fitness (Dakić et al., 2023).

In addition to conventional manual massage, various other massage techniques are employed in sports settings, such as vibro-massage, hydro-massage, acupressure massage, myofascial release techniques, and the utilization of foam rollers or rolling foam, which have gained popularity in the sports and fitness industry (Davis et al., 2020). Meanwhile, the PNF (Proprioceptive Neuromuscular Facilitation) method is an approach used to increase static and passive flexibility by stimulating deep receptors that can relax muscles (Sajedi, 2020). PNF is recognized as a fast and effective method of expanding or accelerating the neuromuscular mechanism (Hegishte & Kumar, 2023). This method involves a stimulus that triggers a muscle response and its associated receptors, resulting in a significant increase in flexibility (Hegishte & Kumar, 2023). In addition to increasing flexibility, the PNF method is believed to improve sports performance and prevent injuries to athletes in several sports.

Previous research stated that using sports massage after training and competition had an effect on reducing lactic acid levels in male football athletes (Welis et al., 2023). However, athletic performance does not have a positive (Moran et al., 2018). Whereas the intervention of the PNF method after strenuous exercise has a positive impact on reducing pain in active individuals (Hegishte & Kumar, 2023; Sajedi, 2020) and increasing range of motion (ROM) in elite football athletes (Sajedi, 2020). However, the intervention of the PNF method on athletic performance did not have a positive impact (Alemdaroğlu et al., 2017).

Considering the previous debates surrounding the benefits and drawbacks associated with sports massage and the Proprioceptive Neuromuscular Facilitation (PNF) method, the main aim of this research is to assess the appropriateness of sports massage and the PNF method as recovery interventions for futsal athletes, with the goal of improving performance and reducing lactic acid levels. Currently, there is a gap in the literature regarding the specific impact of sports massage and the PNF method on lowering blood lactate levels in female futsal athletes. The study hypothesizes that sports massage administered after a strenuous training session will lead to a measurable reduction in lactic acid levels among female futsal athletes. It is further hypothesized that the implementation of the Proprioceptive Neuromuscular Facilitation (PNF) method immediately after a competitive futsal match will result in a significant decrease in lactic acid concentrations in female athletes. Therefore, the main objectives of this study is to compare the effects of sports massage and the PNF method on lactic acid levels in female futsal athletes.

## **METHOD**

### **Research Design**

This study embraced a true-experimental pretest-post-test design, ensuring a rigorous framework for our investigation (Creswell, 2013). To eliminate potential biases and ensure the transparency of participant allocation, a randomized procedure was meticulously employed to distribute participants into two distinct groups: the Sports Massage group (referred to as SM) and the Proprioceptive Neuromuscular Facilitation group (abbreviated as PNF). The randomization process was executed using a computer-generated random number sequence. Each participant's name was assigned a corresponding number, and these numbers were then shuffled to create the randomized allocation list. This method guarantees an unbiased and equitable distribution of participants, bolstering the validity of our findings. Subsequently, the SM group underwent a 15-minute sports massage session following the anaerobic exercise session, tailored to address specific muscle groups. Simultaneously, the PNF group experienced a sports massage intervention of the same duration after the identical anaerobic exercise session. By explicitly elucidating the randomization procedure and participant allocation, the study remains committed to upholding methodological rigor and transparency, thus fortifying the trustworthiness of our research outcomes.

### **Research Subject**

The study engaged a cohort of twenty dedicated female futsal athletes hailing from Serang City, who enthusiastically volunteered their participation to contribute to the study's objectives. To ensure the integrity of the participant pool, thorough assessments were conducted to verify their non-smoking history. The recruitment process adhered to strict inclusion criteria, which encompassed a requisite minimum of 5 years' experience in futsal training, signifying a seasoned cohort of athletes. Furthermore, candidates were mandated to be actively engaged in training regimens, consisting of no less than 3 weekly sessions, each spanning a minimum duration of 2 hours.

In line with optimal experimental conditions, the inclusion criteria extended to dietary habits. Participants were required to abstain from the consumption of alcohol and caffeine within the 24-hour window preceding the experimental procedures. This stipulation was aimed at mitigating any potential confounding influences on the study's outcomes. Notably, the participants presented a unique aspect with regard to their prior exposure to interventions under scrutiny. None of the athletes possessed any prior experience with sports massage or the Proprioceptive Neuromuscular Facilitation (PNF) method, thereby ensuring the novelty of the interventions within the context of the study.

The participants' age range spanned from 18 to 19 years old, yielding an average age of 18.5 years. This diverse age range was representative of the dynamic demographic composition of female futsal athletes in Serang City. The athletes' comprehensive profile, encompassing their experience, training intensity, dietary habits, and unfamiliarity with the interventions, collectively enriched the study's participant cohort, laying a robust foundation for the ensuing investigation.

The research protocol garnered sanction from the health research ethics committee at the Universitas Airlangga School of Medicine (Approval No. 223/EC/KEPK/FKUA/2022), and all enrolled participants

furnished written, informed consent. Preceding their involvement, prospective research subjects received comprehensive directives delineating research protocols and subsequently endorsed written consent documentation.

### Research Procedure

In the research that has been done, there are several stages. Among others are:

#### 1. First Stage

In the initial phase, the research participants were assigned to two groups: the SM group (n = 10) and the PNF group (n = 10). Following the group allocation, all participants underwent an anthropometric measurement session, which included height measurement using a stadiometer. Additionally, body weight, body mass index (BMI), and body fat percentage were measured using Omron Karada scales. After a series of anthropometric measurements, the research subjects were prepared for the assessment of lactic acid levels. In this test, we used the Lactate Accutrend device, 100 µl of capillary blood samples from the fingertips were collected from all research subjects for analysis.

#### 2. Second Stage

At this stage, (1) both groups did anaerobic exercise for 30 minutes, (2) immediately after completing the anaerobic exercise, both groups took blood samples from the fingertips for the process of assessing lactic acid levels, (3) after taking lactic acid blood, the group SM was intervened using sports massage for 15 minutes targeting muscle groups that are often used in futsal sports such as the hamstring, gluteal, quadriceps, gastrocnemius, and adductors muscles. Meanwhile, the PNF group intervened using the PNF method for 15 minutes.

#### 3. Third Stage

In the final stage, lactic acid intake was again carried out for all research subjects after completing the intervention according to the group.

### Statistic Analysis

The data analysis process was conducted using IBM SPSS version 24 statistical software. The study results are presented as mean ± SD values. The Shapiro-Wilk test was utilized to assess the homogeneity of the data. Two-Way Repeated Measures Analysis of Variance was employed to examine differences between groups and determine the presence of significant variations. If a significant difference was found with a confidence level of  $P < 0.05$ , it indicated a statistically significant distinction between the groups. Paired sample t-tests were conducted to evaluate changes in lactic acid levels from pretest to post-test within the SM and PNF groups. Additionally, an independent sample t-test was utilized to compare post-test lactic acid levels between the two groups.

### RESULTS AND DISCUSSION

The primary objective of this research is to examine and compare the immediate impacts of sports massage and PNF (Proprioceptive Neuromuscular Facilitation) techniques on lactic acid levels in female futsal athletes following anaerobic exercise sessions. To the best of our knowledge, this study represents the first attempt to compare the effects of sports massage and PNF on lactic acid specifically in female futsal athletes. The key finding of this investigation indicates that sports massage intervention is more effective in reducing lactic acid levels in female futsal athletes when compared to the PNF method.

Table 1 presents the measured values of body fat percentage, body mass index (BMI), weight, and height for both the SM and PNF groups (mean ± SD). The analysis indicates that there were no statistically significant differences in the anthropometric characteristics between the two groups in this study.

**Table 1. Anthropometric Characteristics of Research Subjects**

Variable	Group		P-value
	SM	PNF	
Age (years)	18.5 ± 1.7	18.2 ± 1.8	0.382
Weight (kg)	53.8 ± 4.6	55.2 ± 5.3	0.413
Height (cm)	156.6 ± 3.7	158.4 ± 4.3	0.344
BMI (kg/cm <sup>2</sup> )	21.5 ± 1.6	22.0 ± 1.8	0.424
Body Fat (%)	14.22 ± 2.8	15.82 ± 3.1	0.364

The paired sample t-test results revealed a significant difference ( $p < 0.05$ ) in the pretest and posttest data for the SM group, indicating a decrease in lactic acid levels after receiving sports massage intervention (3.02 mmol/L). However, no significant difference was observed in the PNF group, where the lactic acid level remained at 6.36 mmol/L. Furthermore, Table 2 demonstrates a significant difference between the post-test data of the SM and PNF groups ( $p < 0.05$ ).

**Table 2. Comparison of Pretest and Posttest Lactate Acid within Group SM and PNF**

Group	Baseline	Pretest	Posttest	P Value	Significance
SM	2.70 ± 0.78	7.24 ± 1.02	3.02 ± 1.11	0.002	Highly Significant
PNF	2.67 ± 0.72	7.31 ± 1.21	6.36 ± 1.03	0.165	Not Significant

Table 3 showed that the mean level of lactic acid after anaerobic exercise in the SM group was lower than in the PNF group. Based on an independent t test, it was found that there was a significant difference of  $p = 0.003$ , indicating a decrease in lactic acid levels.

**Table 3. Comparison of Mean Posttest Lactate Acid Between Group SM and PNF**

Group	Posttest	Mean Difference	P Value	Significance
SM	3.02 ± 1.11	3.34	0.003	Highly Significant
PNF	6.36 ± 1.03			

An important finding from the research that have been conducted is the positive effect of sports massage intervention on blood lactate concentrations after performing anaerobic exercise. Specifically, the researchers observed that the sports massage intervention had a more pronounced and rapid effect in reducing blood lactate concentrations in female futsal athletes compared to the PNF method, following muscle fatigue induced by anaerobic exercise. These results align with previous studies that have highlighted the greater efficiency of professional athletes in clearing blood lactate concentrations through the implementation of post-exercise sports massage, as opposed to passive recovery methods (Welis et al., 2023).

Moreover, previous research has established that sports massage exhibits superior efficacy in reducing blood lactic acid levels among physically active individuals, in comparison to passive recovery methods (Wiltshire et al., 2010). The PNF method in our research has the effect of reducing lactic acid levels but is not as effective as sports massage intervention. Previous studies have stated that duration and technique are important in maximizing the PNF method (Hegishte & Kumar, 2023). Therefore, the researchers believe that the lack of optimality of the PNF method in the research the researchers have conducted is caused by the inadequate duration of the PNF method and the movement technique of the PNF method which is not optimal, thereby limiting the effectiveness of the PNF method in reducing lactic acid levels.

The mechanisms underlying the reduction in blood lactate concentrations as a result of sports massage are still not fully understood and are limited. However, previous studies have shown that massage with the application of certain pressure and movements can increase blood flow in the area being massaged. This has the potential to accelerate the elimination of lactic acid from muscle tissue and increase the supply of oxygenated blood to the area (Dakić et al., 2023). Other studies have also concluded that massage can stimulate the activity of the lymphatic system, which has the function of transporting metabolic waste such as lactic acid. By stimulating lymphatic flow, massage can assist in removing lactic acid trapped in muscle tissue (Davis et al., 2020; Welis et al., 2023). In addition, through the application of certain techniques, massage can trigger



muscle relaxation responses. When the muscles are relaxed, blood flow and circulation become more optimal, which can help remove accumulated lactic acid (Mallard et al., 2021).

On the other hand, previous studies have noted that massage that is too intense or done at the wrong time can impact the recovery process (Welis et al., 2023). In addition, excessive pressure or inappropriate massage duration can slow down muscle recovery and affect performance in subsequent training or competitions (Hegishte & Kumar, 2023). While recognizing the limitations of our study in examining the potential adverse effects of sports massage on female futsal athletes, the researchers emphasize the importance of coaches, athletes, and sports scientists taking a cautious approach when considering the implementation of sports massage. Factors such as the frequency, intensity, duration, and specific techniques of sports massage should be carefully evaluated to mitigate any potential risks associated with its application.

In summary, the findings indicate that the use of sports massage after anaerobic exercise can significantly reduce blood lactate concentrations compared to the PNF method in female futsal athletes. This finding aligns with prior research that highlights the positive effects of massage in facilitating post-exercise recovery and suggests its potential in mitigating muscle fatigue (Dakić et al., 2023). However, additional investigations are warranted to address certain unresolved aspects that were beyond the scope of this study.

The researcher acknowledges certain limitations in this study that should be taken into account for future research. Firstly, the study did not account for the subjects' lifestyles and emotional states, which could potentially impact the study outcomes. Secondly, the inclusion of additional measures such as perceived fatigue levels and visual analogue scales could offer a more comprehensive understanding and address unanswered questions. Therefore, future research should address these aspects to enhance the overall understanding of the topic.

## CONCLUSION

The present study introduces a novel approach to enhancing post-exertion recovery in female futsal athletes, focusing on the specific influence of a targeted 15-minutes sports massage regimen. By centering attention on muscle groups critical to futsal performance—including the hamstring, gluteal, quadriceps, gastrocnemius, and adductors—this investigation advances understanding of how sports massage can distinctly impact lactic acid clearance, a key marker of recovery. In terms of its contribution to the body of knowledge, this study sheds light on the efficacy of sports massage as a tailored recovery strategy for female futsal athletes. By showcasing that this approach can facilitate the efficient removal of lactic acid from the bloodstream, the researchers broaden the scope of evidence-based recovery interventions. This novel finding underscores the importance of recognizing the specific muscle groups involved in futsal's dynamic movements and tailoring recovery methods accordingly.

Practically, the findings underscore the potential benefits of incorporating a 15-minutes sports massage into the recovery routine of female futsal players. By advocating for coaches and training staff to prioritize this method over the PNF approach, the study provides actionable recommendations rooted in empirical evidence. This guidance empowers coaches to make informed decisions when designing recovery strategies, ultimately enhancing the athletes' post-futsal training recuperation and, by extension, their overall performance. In sum, this study's innovative focus on targeted sports massage as a recovery tool offers valuable insights into the optimization of lactic acid clearance in female futsal athletes. The contributions to the body of knowledge, method, and practical recommendations converge to support the integration of tailored sports massage into the training and recovery paradigm, promising tangible benefits for athletes and coaching staff.

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## CONFLICT OF INTEREST

The authors state no conflict of interest.

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