



The Effect Of Proprioceptive Neuromuscular Facilitation With The Hold-Relax Method On Flexibility Hamstring Muscles Of Basketball Club Mansa Athletes

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Abstract

This study examines the issue of suboptimal hamstring muscle flexibility in Mansa Basketball Club athletes, which may limit range of motion, reduce performance, and increase the risk of injury. The objective is to determine the effect of Proprioceptive Neuromuscular Facilitation (PNF) using the Hold-Relax method on hamstring muscle flexibility in these athletes, as well as to measure the extent of improvement. This quantitative study employed a pre-experimental design with a one-group pretest-posttest design, involving 12 Club Mansa athletes as both the population and sample. Data collection was conducted through the V-sit test administered before (pretest) and after (posttest) the 7-day consecutive PNF Hold-Relax intervention. Data analysis included descriptive statistics, Shapiro-Wilk normality test (since the sample size was ≤ 50), and paired sample T-test hypothesis testing with a significance level of $p < 0.05$. The results showed a significant increase in flexibility. The pretest average was 5,33, which increased to 11,75 in the posttest. The hypothesis test yielded one-sided and two-sided significance values < 0.001 , with a t-value of -6.124 and 11 degrees of freedom. This indicates that H_0 is rejected and H_a is accepted, confirming that PNF using the Hold-Relax method significantly improves hamstring muscle flexibility in Club Mansa basketball athletes. In conclusion, the PNF Hold-Relax intervention was proven effective in improving hamstring muscle flexibility in Club Mansa basketball athletes

Keywords: *Basketball, PNF, Muscle Flexibility, Hamstring Muscles*

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INTRODUCTION

In a general sense, sports encompass any physical activity undertaken by an individual with the aim of maintaining and enhancing their health. Health sports specifically refer to activities designed to improve well-being and provide benefits for the body (Rajab et al., 2024). More broadly, sports involve regulated and planned body movements intended to maintain and improve one's quality of life and achieve physical fitness (Puspodari, 2021). In modern life, sports activities are integral to human existence, crucial for both maintaining health and achieving performance goals.

In the world of sports, sports development plays a crucial role in enhancing athletic achievement, as the progress of sports globally is significantly influenced by such initiatives

(Muhammad, 2024). Sports development is defined as a structured and continuous process aimed at improving the physical, technical, tactical, mental, and social capabilities of individuals or groups. Therefore, sports development is paramount in the athletic world and should be implemented across all sports, including basketball. Basketball is a major team sport played by two teams, each consisting of five players. The objective is to score points by shooting the ball into the opponent's hoop. A basketball court is rectangular, measuring 28 meters long and 15 meters wide, with the hoop positioned at a height of 2.75 meters (Huda et al., 2022).

In basketball, a combination of several physical components is essential, including strength, speed, agility, endurance, and flexibility. Specifically, leg muscle flexibility is crucial in basketball, as it contributes significantly to agility, particularly the flexibility of the hamstring muscles. Flexibility, or suppleness, is a vital physical biomotor component for enhancing game performance and preventing injuries in basketball (Okta et al., 2023). The importance of flexibility in sports, especially basketball, stems from its definition as the range of motion of a joint. In other words, a joint's ability to move fully and freely is critical in this sport. Basketball athletes frequently experience hamstring muscle injuries due to the intense demands of the game, such as sprinting, jumping, and sudden changes in direction. A contributing factor to hamstring injuries is often a lack of hamstring muscle flexibility. Many basketball players struggle with suboptimal hamstring flexibility; this muscle stiffness can diminish training performance and affect the efficiency of movements during a game.

The hamstring itself is a group of muscles comprising the biceps femoris, semitendinosus, and semimembranosus. These muscles, located at the back of the thigh, play a crucial role in providing postural stability, facilitating lower extremity and trunk movement, and supporting various thigh-related actions (Bramana et al., 2024). In basketball, hamstrings are essential for movements such as sprinting, jumping, and sudden changes in direction. Adequate hamstring flexibility can enhance athletic performance and reduce injuries, whereas poor flexibility can lead to slower movements. While many training methods aim to increase hamstring flexibility, including static stretching, instrument-assisted soft tissue mobilization (IASTM), and Proprioceptive Neuromuscular Facilitation (PNF) not all of them prove equally effective for athletes. One effective method for enhancing hamstring muscle flexibility is Proprioceptive Neuromuscular Facilitation (PNF). Studies indicate that PNF exercises can significantly improve flexibility compared to conventional static stretching methods (Husnul and Mukrim, 2024).

Proprioceptive Neuromuscular Facilitation (PNF) is a stretching method frequently employed in physical therapy and rehabilitation. Various studies indicate that this technique can significantly enhance muscle flexibility in a relatively short period (Puentedura et al., 2011). PNF is designed to boost muscle elasticity and expand both active and passive ranges of motion. As a specialized approach in therapeutic exercise and rehabilitation, PNF aims to stimulate proprioceptors and improve responses within neuromuscular mechanisms. PNF stretching techniques offer an advantage over other conventional stretching methods because they can relax the stretched muscle, making them considered the most effective for developing body flexibility (Hariadi et al., 2023). PNF involves a combination of alternating muscle contractions and stretches through techniques such as Hold-Relax (HR), Contract-Relax (CR), and Slow Reversal-Hold-Relax (SRHR).

The Hold-Relax technique is a PNF method utilized to enhance joint range of motion. It is based on the isometric contraction of a shortened muscle against maximal resistance. No joint movement should occur, and the isometric contraction should not be limited. The Hold-Relax procedure is applied at any point within the subject's range of motion where limitations exist due to pain, muscle spasms, or other causes. The mechanism behind Hold-Relax for increasing hamstring flexibility is theoretically a stretching exercise performed by maintaining a stretched position for an extended period, with movements executed slowly and deliberately (Jumharyati, 2020). At the point of limitation, the muscle is given slight tension, enabling it to perform a maximal isometric contraction. Specifically, structured stretching is an effective method for improving flexibility. Stretching techniques are implemented before physical activity, including sports, primarily to minimize injury risk and support optimal sports performance. To prevent injuries and achieve peak performance, good joint range of motion and adequate muscle strength are crucial, and these conditions can be attained through consistent and programmed flexibility training (Rahman and Islam, 2020).

The researcher chose to study athletes from the Mansa Basketball Club because initial observations revealed they exhibited poor hamstring flexibility during static stretching after training. Providing PNF stretching exercises to these athletes was deemed crucial, as it can enhance flexibility in trained athletes and thereby reduce the risk of injuries during training (Dewanti, 2020). Initial observations indicated that the athletes in the club exhibited suboptimal hamstring flexibility, particularly during static stretching performed after training sessions. This lack of

flexibility, in practice, can elevate the risk of injury and diminish athletic performance. The researchers also noted that stretching exercises employing the Proprioceptive Neuromuscular Facilitation (PNF) method can aid in improving muscle elasticity and mitigating injury risk during physical activity (Dewanti, 2020).

Furthermore, additional information was gathered from interviews with the team captain and coach. The basketball captain reported that many players complained of hamstring stiffness after training or matches, which adversely affected their movement capabilities and muscle function. The coach concurrently acknowledged that the existing training program lacked proper structure and was implemented on an ad hoc basis. It was also discovered that neither the coach nor the athletes were familiar with the PNF method and had never undergone such treatment after physical exertion. Based on these findings, the researchers identified several issues, including: high-intensity physical activity can induce eccentric contractions, leading to muscle tension and a reduction in flexibility such as the lack of post-exercise recovery programs and the absence of prior research specifically examining the effect of PNF on hamstring flexibility in basketball athletes, particularly following physical activity. These factors motivated the researchers to conduct further investigation.

In this regard, the researchers believe that the application of PNF can serve as a solution to improve suboptimal flexibility caused by muscle tension after intense exercise, as PNF offers various beneficial effects for muscles. Therefore, in this study, the author assumes that using the PNF Hold-Relax technique can enhance hamstring flexibility in Mansa Basketball Club athletes.

Based on these considerations, the research questions addressed are: Is there a significant effect of the PNF method on hamstring flexibility, and does flexibility increase following the application of this technique? The aim of this research is to investigate the effect of the PNF method and to measure the degree of improvement in hamstring flexibility after the intervention.

This research offers several benefits. Theoretically, it is expected to enrich the scientific literature in sports science regarding the application of the PNF method post-physical activity. Practically, it can serve as an evaluative resource for athletes, coaches, and sports practitioners in addressing muscle stiffness. This study's scope is specifically limited to examining the impact of the PNF Hold-Relax technique on enhancing hamstring flexibility in athletes from the Mansa Basketball Club.

METHOD

The research design employed in this study was a quantitative quasi-experiment, utilizing a pre-experimental method and a one-group pretest-posttest design. This involved a single intervention group without a control group, and outcome measurements were taken once after the treatment was administered. The population for this study consisted of all 12 athletes from the Mansa Basketball Club, and all 12 athletes were included in this research. The study was conducted at the Madrasah Aliyah Negeri Surabaya sports field and lasted for 7 days.

For this study, data was collected by providing a 7-day intervention. Here are the training program procedures.

Table 1. Proprioceptive Neuromuscular Facilitation (PNF) Stretching Program

No	Day	Program Procedures
1	Day One	<p>Initial stretch</p> <ol style="list-style-type: none">1. Assume a supine position with one leg extended vertically.2. Move the target muscle to its maximal passive range of motion (without pain).3. Hold this position for 5 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none">1. The subject completely releases muscle tension.2. Rest the muscle for 2 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none">1. Perform a passive stretch into a new range of motion, slightly beyond the initial position.2. Hold the movement for 10 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>

2	Day Two	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 10 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 15 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>
3	Day Three	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 15 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 15 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>

4	Day Four	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 18 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 23 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>
5	Day Five	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 23 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 25 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>

6	Day six	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 25 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 28 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>
7	Day Seven	<p>Initial stretch</p> <ol style="list-style-type: none"> 1. Assume a supine position with one leg extended vertically. 2. Move the target muscle to its maximal passive range of motion (without pain). 3. Hold this position for 25 seconds to prepare the muscle. <p>Relaxation Phase</p> <ol style="list-style-type: none"> 1. The subject completely releases muscle tension. 2. Rest the muscle for 3 seconds. <p>Passive Stretch</p> <ol style="list-style-type: none"> 1. Perform a passive stretch into a new range of motion, slightly beyond the initial position. 2. Hold the movement for 30 seconds. <p>Repetition</p> <p>This movement is performed for 3 sets to achieve maximum flexibility results.</p>

The V-sit test was administered to gather data on hamstring flexibility, which involved several stages: delivering the treatment to the subjects for seven consecutive days, followed by both a pre-test and a post-test.

The research design began with a Pretest (O1) to measure the group's initial condition. Following this, the group received a specific treatment (X). At the end of the period, a Posttest (O2) was administered to measure the final condition. The effectiveness of the treatment (X) was then determined by comparing the results between before (O1) and after (O2) the intervention.

In this study, the quantitative data obtained from the pre-test and post-test results were processed through several stages. First, using validity and reliability tests, descriptive analysis was performed to generally describe both the research data and the study subjects. Next, a normality test was conducted on the pretest and posttest data using the Shapiro-Wilk analytic method as a prerequisite. The subsequent analysis involved hypothesis testing using a paired-sample T-test to determine the significance between the pre-test and post-test data and, consequently, to ascertain the presence or absence of an effect.

RESULTS AND DISCUSSION

Result

This study was conducted at the Madrasah Aliyah Negeri Surabaya sports field, utilizing tests and measurements as data collection techniques. The analysis involved administering pre-tests and post-tests to 12 basketball athletes. The research comprised three stages: pre-test, treatment, and post-test. Data were collected from the athletes' test results before and after the treatment. The purpose of these tests was to assess the achievements made throughout the research process.

A. Validity Test

Table. 2 Validity Statistics Test Result

Statement	r-calculated	r-table	P (sig.)	Description
Pretest	.777	0,632	.003	VALIDITY
Posttest	.777	0,632	.003	VALIDITY

The validity test results for the Pretest statement showed an r-calculated value of .777 with a significance value of .003. Similarly, for the Posttest statement, the r-calculated value was .777 with a significance value of .003. Based on these validity test results, both statements are considered valid because their r-calculated values are greater than the r-table value of 0.632 at the 5% significance level, and their significance values are below 0.05. Validity testing was conducted to determine the validity, or the degree of suitability, of the research instrument used by the researcher to obtain data from the subjects. Here, the calculated r-value was greater than the r-table value at a significance level of 0.05, indicating that the items were valid.

B. Reliability Statistics Test

Table. 3 Reliability Statistics Test Result

Reliability Statistics	
Cronbach's Alpha	N of Items
.833	2

Based on the reliability test conducted using IBM SPSS version 24.0 software, the statistical reliability for the logical thinking ability assessment, which comprised two statement items, was found to be 0.833. This value is greater than the Cronbach's Alpha reliability threshold of 0.60, indicating that both statements are reliable or consistent.

C. Statistical Descriptive Analysis

Table. 4 Descriptive Statistical Test Results

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	12	1	10	5.33	3.200
Posttest	12	5	24	11.75	6.002
Pretest-Posttest	12	4	14	6.42	2.802

The descriptive analysis provides a summary of the descriptive statistics for each variable measured in the study, based on a sample of 12 data points. For the pretest V-sit and reach variable, the minimum value was 1 and the maximum value was 10, with a mean score of 5.33. The standard deviation was 3.200, indicating a relatively large data variation. For the posttest V-sit and reach variable, the minimum value was 5 and the maximum value was 24, with a mean score of 11.75. The standard deviation was 6.002, demonstrating a significant variation in the data.

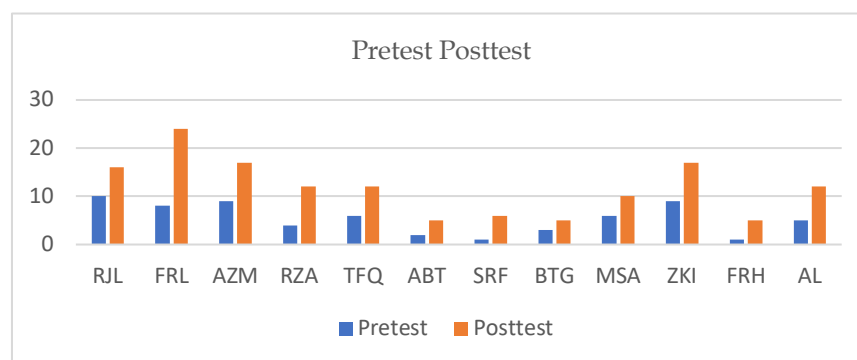


Figure 1. Diagram pretest posttest

The diagram's results clearly illustrate a significant increase in hamstring flexibility among the 12 participants after undergoing the PNF training program. This indicates that PNF exercises effectively influence the improvement of hamstring flexibility.

D. Normality Test

Table 5. Normality Test Results

Tests of Normality		
	df	Sig.
Pretest	12	.385
Posttest	12	.208

The Shapiro-Wilk test was used for normality testing because the research sample consisted of only 12 subjects, which is fewer than 50. This sample size did not meet the prerequisites for using the Kolmogorov-Smirnov normality test, thus necessitating the use of the Shapiro-Wilk test. For the V-sit and reach pretest variable, the significance (sig) value was 0.385, and for the V-sit and reach posttest variable, the sig value was 0.208. Since all sig values were greater than 0.05, these variables met the assumption of normality based on the Shapiro-Wilk test.

E. Hypothesis Test

Table 6. Hypothesis Test Results

Paired Samples Test									
Paired Differences									
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig.
					Lower	Upper			
Pair 1	PRETEST - POSTTES	-6.417	3.630	1.048	-8.723	-4.111	6.124	11	<.001

Based on the results of the Paired Samples Test between post-test and pre-test scores, the mean difference was -6.417, with a standard deviation of 3.630 and a standard error of the mean of 1.048. The obtained t-value was -6.124 with 11 degrees of freedom. The 95% confidence

interval for the difference between the means ranged from -8.723 to -4.111. The two-tailed p-value was less than 0.001, which is conventionally much smaller than the standard significance level of 0.05

Significance level of 0.05, these findings reveal a significant difference between post-test and pre-test scores. In other words, there is sufficient evidence to reject the null hypothesis that the two scores are equal. In conclusion, based on the paired-sample t-test at a 0.05 significance level, this intervention is statistically efficient in producing a significant positive impact on participants' scores.

Discussion

This research aimed to determine if the Proprioceptive Neuromuscular Facilitation (PNF) method, specifically the Hold-Relax technique, can improve hamstring flexibility in athletes from the Mansa Basketball Club. The study involved a seven-day intervention, with results measured through pre- and post-tests. Findings showed a significant increase in flexibility, with average flexibility scores rising from 5.33 cm to 11.75 cm. A paired sample t-test statistically reinforced these results, indicating that PNF treatment was statistically effective.

These findings are consistent with previous research indicating PNF's effectiveness in increasing flexibility. For example, studies by Hariadi et al. (2023) and Pevri (2017) demonstrated significant improvements in muscle flexibility following PNF intervention. The consistency of these results strengthens the validity of using PNF, both for basketball athletes and in other sports and populations. This implies that PNF has broad applications and is not limited to the context of this study alone. Prior to this study, researchers observed that athletes from the Mansa Club frequently reported hamstring stiffness following training sessions or matches. This issue was exacerbated by the absence of systematic recovery programs, inadequate warm-ups and cool-downs, and a limited understanding of PNF methods among both coaches and athletes. Consequently, athletic performance declined, and the risk of injury increased. Therefore, implementing PNF treatment was considered an important alternative solution.

Physiologically, the effectiveness of the PNF method, particularly the Hold-Relax technique, is explained by the activation of the Golgi Tendon Organ (GTO). The GTO is a receptor that detects muscle tension. When a muscle is isometrically contracted and then relaxed, the GTO sends signals to the nervous system to inhibit further muscle contraction. This mechanism allows

the muscle to stretch further and safely, thereby increasing flexibility. This process is carried out gradually over several days, with the duration of contraction and stretching progressively increased.

In the context of basketball, hamstring flexibility is vital as it directly relates to crucial movements such as sprinting, jumping, and sudden changes in direction. Flexible hamstring muscles enable athletes to perform movements more quickly, smoothly, and with minimal risk of injury. Conversely, a decrease in flexibility leads to slow and inefficient movements, which can significantly reduce performance during competition. Therefore, flexibility training, like PNF, becomes extremely important in supporting athletes' biomotor capabilities.

Beyond its effectiveness for basketball athletes, the PNF method is also relevant for various other sports and age groups. PNF can be utilized by coaches and sports practitioners as part of a structured flexibility training program. By integrating PNF into training regimens, athletes can not only increase their range of motion but also reduce the risk of injuries often caused by stiff or inflexible muscles. Therefore, this research confirms that the Hold-Relax method is a valuable tool for overall athlete performance development.

CONCLUSION

The research findings and data analysis indicate that Proprioceptive Neuromuscular Facilitation (PNF) treatment significantly impacts hamstring flexibility in basketball players from the Mansa club. This study found that the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted, signifying a demonstrable effect. The data clearly show a significant improvement in flexibility, with the average score before the intervention (pretest) being 5.33, which then increased to 11.75 after the intervention (posttest).

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