

The Effect of Proprioceptive Neuromuscular Facilitation (PNF) and Static Stretching (SS) on Flexibility in Youth Football Players

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Abstract:

Background and Objective: Flexibility is an important physical attribute in football. The present study compared an eight-week Proprioceptive Neuromuscular Facilitation (PNF) stretching program with an eight-week static stretching program in improving flexibility among youth football players.

Methods: An experimental two-group design was used. Sixteen youth football players from Chabab Kais were divided into an experimental group (n = 8), which performed (PNF) stretching, and a comparison group (n = 8), which performed static stretching (SS). Both programs were applied for eight weeks, for 15 minutes per training session during the final part of the main training phase. Flexibility was assessed using the Sit-and-Reach Test. Paired-samples and independent-samples t-tests were used for statistical analysis.

Results: The experimental group's flexibility mean increased from 19.37 ± 3.73 at pre-test to 26.50 ± 4.17 at post-test ($t = 24.14$, $p < 0.001$; reported Cohen's $d = 1.80$). The comparison group's mean increased from 19.00 ± 2.39 to 20.75 ± 2.60 ($t = 10.69$, $p < 0.001$; reported Cohen's $d = 0.70$). Post-test comparison showed a statistically significant difference in favor of the experimental group (26.50 ± 4.17 vs. 20.75 ± 2.60 ; $t = 3.30$, $df = 14$, $p = 0.005$; reported $\eta^2 = 0.43$).

Conclusion: Both (PNF) and (SS) improved the flexibility-test results, while the (PNF) program produced a greater improvement under the conditions of the present study. The findings should not be generalized beyond the studied sample and protocol without further research.

Keywords: Proprioceptive Neuromuscular Facilitation (PNF); static stretching (SS); flexibility; football.

1. Introduction:

Modern football is characterized by high physical demands as a result of the continuous development in the speed of play, the variety of playing situations, and the frequent changes that occur during competition. This requires players to possess a high level of physical abilities, including flexibility, which enables them to perform movements efficiently and economically and may contribute to improving performance and reducing the likelihood of injury (Saleh&Al-Jamal, 2022).

Flexibility is one of the fundamental physical abilities associated with the range of motion available at the joints and with the ability of muscles and surrounding tissues to lengthen. Its development requires

continuity and regularity in the application of exercises appropriate to the nature of the sporting activity and the requirements of the player. Therefore, stretching exercises have become an essential component of modern training programs, whether used independently or as part of physical preparation.

Stretching methods used in sport vary, among the most prominent being static stretching and Proprioceptive Neuromuscular Facilitation (PNF). Static stretching is essentially based on lengthening the target muscle to a certain range and maintaining the stretched position for a specified period. PNF methods, in contrast, use a sequence of muscular contraction, relaxation, and stretching according to the specific technique employed (Al-Hawari, 2021).

(PNF) methods have received considerable attention in sports and rehabilitation because many studies have indicated their potential to improve range of motion and flexibility. Their effects may be related to several neural, mechanical, and physiological mechanisms, including changes in the nervous system's response to stretching and changes in stretch tolerance, in addition to the effects resulting from a muscular contraction performed before stretching. Therefore, the effectiveness of (PNF) in increasing range of motion should not be attributed to a single neural mechanism, but rather to the interaction of several neural, muscular, and mechanical factors (McAtee&Charland, 1999).

The scientific literature also indicates that static stretching can improve range of motion and flexibility when applied regularly, whereas other studies have reported the effectiveness of (PNF) methods in developing range of motion to varying degrees depending on the method of application, contraction intensity, stretching duration, number of repetitions, and characteristics of the sample (Arntz et al, 2023).

Based on the researchers' observations and experience in the field of sports training, there appears to be a need for greater attention to the scientific and systematic application of flexibility-development programs among football players, particularly through the use of (PNF) and comparison with static stretching within the training program. Furthermore, an important proportion of research addressing (PNF) has focused on rehabilitation and injury prevention, while there remains a need to investigate its effects when systematically incorporated into training programs for football players and compared with static stretching.

Accordingly, the present study aims to identify the effect of a stretching program using (PNF) and another program using static stretching on flexibility among youth football players, and to determine whether the effects of the two methods differ in the flexibility test used in the study.

Therefore, the research problem can be formulated in the following main question:

What is the effect of stretching using Proprioceptive Neuromuscular Facilitation (PNF) and static stretching on improving flexibility among youth football players?

2. Research Questions:

1. Are there statistically significant differences between the pre-test and post-test flexibility results among the experimental group participants who underwent the (PNF) stretching program?
2. Are there statistically significant differences between the pre-test and post-test flexibility results among the comparison group participants who underwent the static stretching program?

3. Are there statistically significant differences between the post-test flexibility results of the experimental group and the comparison group?

3. Objectives of the Study:

1. To identify the effect of a stretching program using Proprioceptive Neuromuscular Facilitation (PNF) on flexibility among youth football players.
2. To identify the effect of a static stretching program on flexibility among youth football players.
3. To compare the effects of (PNF) stretching and static stretching on improving flexibility among youth football players.

4. Research Hypotheses:

1. There are statistically significant differences between the pre-test and post-test flexibility results among the experimental group participants, in favor of the post-test.
2. There are statistically significant differences between the pre-test and post-test flexibility results among the comparison group participants, in favor of the post-test.
3. There are statistically significant differences between the post-test flexibility results of the experimental group and the comparison group, in favor of the experimental group.

5. Previous Studies:

5.1. Study by Bakri et al. (2021)

The study was entitled “Effectiveness of Stretching Exercises Using Proprioceptive Neuromuscular Facilitation for the Prevention of Ankle Joint Injuries among Youth Football Players.” It aimed to identify the effectiveness of stretching exercises using (PNF) in preventing ankle joint injuries among youth football players.

The researchers used the experimental method, and the study was conducted on a sample of 25 youth players from Al Mokawloon Al Arab Club. The results indicated the effectiveness of static and dynamic muscular-strength exercises using passive and active resistance within (PNF) in developing the efficiency of the muscles acting on the ankle joint, which may contribute to improving function and reducing the likelihood of injury.

This study agrees with the present study in using (PNF) among football players, but differs in its focus: the present study investigates the effect of (PNF) on flexibility and compares it with static stretching among youth football players.

5.2. Study by Al-Saeed (2018):

The study was entitled “The Effect of Using Static and Dynamic Muscle Stretching Exercises on Some Physical Attributes among Youth Football Players.” It aimed to identify the effects of static and dynamic stretching exercises on selected physical attributes among youth football players.

The sample consisted of 24 players from a youth sector, aged between 10 and 19 years. The findings indicated that both static and dynamic stretching exercises contributed to developing the physical attributes under investigation. The study also indicated that neither method had an absolute superiority under all circumstances, with the suitability of each method depending on the training objective and phase.

The present study benefits from these findings in emphasizing the importance of stretching in football training programs, while it differs by using (PNF) as one intervention and directly comparing it with static stretching.

5.3. Study by Al-Zeftawy (2023):

The study addressed “The Effect of a Proprioceptive Training Program on Developing Flexibility among Female Swimming-Specialization Students.” It aimed to identify the effect of a training program based on selected (PNF) methods, including reciprocal contraction (SR) and repeated contraction (RC), on flexibility among female swimming-specialization students.

The researcher used an experimental two-group design and applied the study to a sample of 10 female students from the swimming specialization at the Faculty of Physical Education, Helwan University. The results showed a positive effect of the proposed program using reciprocal contraction and repeated contraction on flexibility.

This study agrees with the present study in examining PNF-based methods for flexibility development, but differs in the sample and sport: the previous study involved female swimming students, whereas the present study involves youth football players and compares (PNF) with static stretching.

5.4. Commentary on Previous Studies:

The reviewed studies indicate that stretching in its different forms is an important means of developing flexibility and range of motion. Studies addressing (PNF) have also reported positive outcomes in the development of selected physical and functional variables. However, previous studies differ in sample characteristics, sporting activities, and stretching methods.

The present study therefore seeks to contribute by comparing two stretching programs—one based on (PNF) and the other on static stretching—among youth football players, with the aim of determining the relative effectiveness of each program in improving flexibility and identifying differences between them.

6. Terms of the Study:

6.1. Stretching:

Stretching refers to a set of procedures or exercises intended to increase the length of muscles and associated soft tissues, either temporarily or through adaptation, thereby allowing an increase in the available range of motion around a joint and improving the ability to perform movement through a greater range. Operationally, stretching in the present study refers to the exercises used to improve flexibility through two different programs: a (PNF) program and (SS) program.

6.2. Static Stretching (SS):

(SS) is a stretching method in which a muscle or joint is gradually placed in a position that lengthens the muscle and associated tissues, and the position is then maintained for a specified period without bouncing or rapid repetitive movement. Operationally, (SS) refers to the program applied to the comparison group, based on reaching a stretching position and maintaining it for a specified duration according to the training program.

6.3. Proprioceptive Neuromuscular Facilitation (PNF):

(PNF) comprises a group of movement-based methods that use movement patterns, resistance, and different forms of muscular contraction to improve neuromuscular responses and increase range of motion and functional capacity. Operationally, (PNF) in the present study refers to the stretching program applied to the experimental group, incorporating muscular contractions, stretching, and relaxation according to the selected technique, with the aim of improving flexibility-test performance.

6.4. Flexibility:

Flexibility is the ability of a joint or group of joints to move through a particular range of motion. It is influenced by several factors, including the characteristics of muscles and soft tissues, joint structures, neural factors, and tolerance to stretching. Operationally, flexibility in the present study refers to the score obtained in the Sit-and-Reach Test, used to assess changes related to posterior-body flexibility by comparing pre-test and post-test results.

6.5. Football:

Football is a team sport in which two teams compete; in official competition, each team consists of eleven players on the field. The objective is to score more goals than the opposing team in accordance with the laws of the game. Operationally, football in the present study refers to the sport practiced by the participants, namely youth players of Chabab Kais during the study period.

7. Methodology and Statistics:

7.1. Methodology:

The researchers used the experimental method with an equivalent two-group design consisting of an experimental group and a comparison group.

7.2. Study Limits:

7.2.1. Geographical/Spatial Setting: The study was conducted at the 8 May 1945 Municipal Stadium in Kais, Khenchela Province, Algeria.

7.2.2. Time Frame: The study was conducted from 4 November 2022 to 6 January 2023.

7.3. Study Population:

The study population consisted of youth-category teams participating in the Regional Division of the Batna Regional Football League during the 2022/2023 season.

7.4. Study Sample:

The sample consisted of 16 youth players from Chabab Kais, divided into 8 players in the experimental group and 8 players in the comparison group.

7.5. Study Instrument:

Flexibility was assessed using the Sit-and-Reach test. Participants sat on the floor with their feet on a flexibility box, ensuring their legs were not bent. They placed their hands on a ruler above the box and moved the ruler with both hands together as far as possible without bending their legs. Lower limb flexibility was measured by the distance reached above the box in centimeters.

7.6. Statistical Methods:

The data were analyzed using SPSS version 22. The following statistical procedures were used:

- Paired-samples t-test.

- Independent-samples t-test.

7.7. Study Procedures:

Two training programs were applied to the study sample for eight weeks. The experimental group underwent a (PNF) stretching program, whereas the comparison group underwent a (SS) program. Both programs were performed during the final part of the main training phase, before the concluding phase, for 15 minutes per training session. The same stretching exercises were used for the lower limbs in the (PNF) and (SS).

8. Analysis and Discussion of Results:

8.1. Results and Discussion of Hypothesis One:

The first hypothesis stated: “There are statistically significant differences between the pre-test and post-test flexibility results among the experimental group participants, in favor of the post-test.”

A paired-samples t-test was used to compare the experimental group's flexibility results before and after the training program.

Table 01: Results of the first hypothesis:

Group	Pre-test	Post-test	t	P	Cohen's d
PNF	19.37 ± 3.73	26.50 ± 4.17	24.14	<0.001	1.80

Through the table 01 shows the experimental group's pre-test mean was 19.37 with a standard deviation of 3.73, whereas the post-test mean was 26.50 with a standard deviation of 4.17. The mean therefore increased by 7.13 units.

The calculated t value was 24.14 and the probability value was $p < .001$, which is below the significance level of $\alpha = 0.05$, indicating a statistically significant difference between the pre-test and post-test measurements.

The reported Cohen's d was 1.80, indicating a large effect size. Accordingly, the first hypothesis is accepted.

The improvement may be attributed to the effectiveness of the (PNF) stretching program and participants' adherence to it. (PNF) uses sequences of muscular contraction, relaxation, and stretching according to the selected technique, which may contribute to increasing range of motion and improving tolerance to stretching. The improvement should not be attributed to a single neural mechanism; rather, it may reflect the interaction of neural, muscular, and mechanical factors.

Madkour and Shaghati (2011) the repeated exposure to stretching may also increase tolerance to the sensation of stretch, allowing the player to reach a greater range of motion during the test. These findings are consistent with previous research reporting positive effects of (PNF)-based methods on range of motion and selected physical or functional variables.

McAtee and Charland (1999) show that (PNF) leads to significant gains in flexibility in a very short time due to the creative use of many integrated neural mechanisms to enhance the muscles' ability to stretch. Jordan et al. (2012), (PNF) in its various ways develops and improves range of motion, as well

as increases strength compared to other stretching methods, since stretching without strength may expose the individual to joint injury. Using these exercises is effective in preventing sports injuries by jointly developing strength and flexibility and promoting good muscle relaxation.

8.2. Results and Discussion of Hypothesis Two:

The second hypothesis stated: “There are statistically significant differences between the pre-test and post-test flexibility results among the comparison group participants, in favor of the post-test.”

A paired-samples t-test was used to compare the comparison group's results before and after the static stretching program.

Table 02: Results of the second hypothesis:

Group	Pre-test	Post-test	T	P	Cohen's d
SS	19 ± 2.39	20.75 ± 2.60	10.69	<0.001	0.70

Through the table 02 shows the pre-test mean was 19.00 with a standard deviation of 2.39, whereas the post-test mean was 20.75 with a standard deviation of 2.60. The mean increased by 1.75 units.

The calculated t value was 10.69 and $p < .001$, which is below $\alpha = 0.05$, indicating a statistically significant difference between the pre-test and post-test results.

The reported Cohen's d was 0.70, indicating a moderate-to-large effect according to commonly used interpretations. Accordingly, the second hypothesis is accepted.

The improvement may be attributed to the effectiveness of the (SS) program. When applied regularly and with appropriate duration and intensity, (SS) can increase range of motion and improve tolerance to stretching. Repeated exposure may contribute to adaptations in the muscle–tendon system and to changes in the perception of stretch.

These findings are consistent with the study by Kataura et al. (2017). These findings indicate that (SS) with greater intensity is more effective in increasing range of motion (ROM) and reducing passive muscle tendon stiffness. The results of this study are also consistent with the study by Hirata & Akagi (2023). They compared the acute effects of (SS) on non-muscular tissue stiffness between the elderly and the young and investigated whether reducing tissue stiffness improves joint flexibility. The results showed that static stretching increased range of motion (ROM) and decreased passive joint stiffness. Bacurau et al. (2009) found that static stretching provides a greater improvement in flexibility compared to ballistic stretching exercises. Bryant et al. (2023) conducted a systematic review of the evidence on the effects of using different static stretching intensities on range of motion (ROM) and strength. All studies showed that (SS) increased only (ROM). Arntz et al. (2023) indicated that chronic (SS) exercises lead to significant improvements in flexibility, with greater effects from passive stretching. Regarding flexibility, they also noted greater benefits after a higher number of repetitions per exercise, longer stretching time per session, and a longer total stretching time.

8.3. Results and Discussion of Hypothesis Three:

The third hypothesis stated: “There are statistically significant differences between the post-test flexibility results of the experimental group and the comparison group, in favor of the experimental group.”

An independent-samples t-test was used to compare the two groups' post-test flexibility results.

Table 03: Results of the third hypothesis:

Group	Post- t	T	P	η^2
PNF	26.50 $\pm$ 4.17	3.30	<0.005	0.43
SS	20.75 $\pm$ 2.60			

Through the table 03 shows the experimental group's post-test mean was 26.50 with a standard deviation of 4.17, whereas the comparison group's post-test mean was 20.75 with a standard deviation of 2.60. The difference between the two post-test means was 5.75 units in favor of the experimental group.

The calculated t value was 3.30 with 14 degrees of freedom, and $p < .005$, which is below $\alpha = 0.05$. This indicates a statistically significant difference between the two groups in the post-test.

The reported eta-squared value was $\eta^2 = 0.43$, indicating a large effect according to common benchmarks. Accordingly, the third hypothesis is accepted.

Both programs improved flexibility, but the magnitude of improvement was greater in the experimental group. The experimental group increased from 19.37 to 26.50, whereas the comparison group increased from 19.00 to 20.75.

The greater improvement observed with (PNF) may be related to the structure of the method, which combines muscular contraction, relaxation, and stretching according to the selected technique. A contraction performed before stretching may influence neural and muscular responses to stretch and increase tolerance to the stretching sensation, thereby allowing a greater range of motion.

The results do not indicate that (SS) is ineffective; rather, they indicate that the (PNF) program used in the present study produced a greater improvement in the flexibility-test result than the (SS) program under the conditions of this study. The superiority of (PNF) should therefore not be generalized to all populations or all stretching methods.

These findings are consistent with the study by Jason et al. (2014) and Landon et al. (2018), which found that (PNF) is more effective than (SS) due to the significant gains this method makes in increasing joint range of motion and improving flexibility.

Jothi and Jose (2015), contraction before muscle lengthening not only improves muscle flexibility but also increases muscle performance. Sanavi et al. (2013) demonstrated that training the proximal hamstring muscles (PNF) increases flexibility, strength, and endurance in non-athlete men. Akbulut and Agopian (2015) confirmed that eight weeks of (PNF) stretching improves and increases the range of motion (ROM) of lower limb joints in young soccer players. Hindle et al. (2012) found that performing at least two sets of (PNF) contraction-relaxation or antagonistic contraction-relaxation (CRAC) per week is essential for maintaining gains in both flexibility and muscle performance.

9. Conclusion

1. The (PNF) stretching program improved flexibility among the experimental group, with statistically significant differences between pre-test and post-test results in favor of the post-test.
2. The (SS) program also improved flexibility among the comparison group, with statistically significant differences between pre-test and post-test results in favor of the post-test.
3. The post-test comparison revealed statistically significant differences in flexibility between the two groups in favor of the experimental group.
4. The (PNF) stretching program used in the present study was more effective than the (SS) program used in the study in improving the flexibility-test result among youth football players.
5. (PNF) may therefore be considered an effective option within physical-preparation programs for football players when the appropriate technique is selected and contraction intensity, stretching duration, and repetition are suitably controlled.
6. The superiority of (PNF) cannot be generalized to all stretching methods or all sporting populations because of the small sample size, the characteristics of the flexibility test, the specific training programs, and the conditions under which the study was conducted.

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