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Original Research Article

A study to evaluate the immediate effect of proprioceptive neuromuscular facilitation versus active dynamic stretching during warm-up on 20-meter sprint in amateur soccer players

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ABSTRACT

Background: Soccer is a highly popular sport and is played worldwide. It is an explosive sport and has a high incidence of injuries. In soccer, sprinting dominates the majority of the game, and it imposes a demand on players to have strong, flexible, and dynamic lower limbs. Amateur soccer players don't usually practice warm-ups before their matches; hence, an appropriate warm-up protocol is required that can be incorporated into the training routine of players to avoid injuries and improve performance. The current study aims to evaluate and compare the immediate effect of PNF stretching versus active dynamic stretching during warm-up on 20-meter sprint performance in amateur soccer players.
Methods: According to the inclusion criteria, 80 amateur soccer players participated in this cross-sectional study design. They were randomly distributed into 2 groups: A) PNF stretching (N = 40) and B) active dynamic stretching (N = 40). Participants in both groups performed the 20-meter sprint test initially, followed by their respective warm-up intervention, after which the 20-meter sprint test was repeated and new readings were recorded.
Results: Both Group A and Group B showed improved performance; however, Group B was significantly better. (p value<0.05).
Conclusions: This study therefore concludes that both PNF and active dynamic stretching can be used as a warm-up protocol. However, according to the inter-group comparison, active dynamic stretching shows a noteworthy improvement in 20-m sprint performance in amateur soccer players.

Keywords: Dynamic stretching, Proprioceptive neuromuscular facilitation, Soccer, Sprint, Stretching, Warm-up

INTRODUCTION

Soccer, famously known as football, happens to be a sport of high complexity due to its unpredictable dynamics.[1] Performance in soccer depends on a variety of individual skills. Along with tactical and technical skills, physical capabilities must also be well-developed to become a successful player.[2,3] Physical attributes such as power and speed abilities are considered crucial in decisive situations in soccer.[2,3] Athletic fitness is also needed for good performance. Athletic fitness can be improved with the help of aerobic training, anaerobic training, flexibility training, and agility training.[4-6] Soccer is a game that requires good aerobic capacity, also known as cardio-respiratory endurance.[7-11] Athletes also use illicit methods, such as dope substances, to improve performance.[12,13] Recently, the focus of soccer-related research has shifted from aerobic to anaerobic demands.[14] Time-motion analyses reveal that short sprints occur frequently during soccer games; over 90% of all sprints

in matches are shorter than 20 meters.[15] Straight sprinting is the most frequently performed action before goals; it is typically defined by acceleration, maximal running velocity, and deceleration. These sprints are special because of their brief duration, which emphasizes the importance of the acceleration phase. Here, the player's ability to accelerate quickly is critical to their performance, and this capacity is further dependent on neural-motor integration.[14,15]

The present study focuses on sport-oriented and task-specific components, i.e., sprinting. Two warm-up protocols were compared to comprehend their effects on performance. A good warm-up is a necessary practice before any physical exercise or sport.[16,17] It prepares the players for the demands of the exercise, i.e., to obtain an optimal physical and psychological state; improve muscle dynamics so that they are less inclined to injury, i.e., through kinetic and coordinated preparation; and enhance subsequent competition or training performance.[16,17] The most significant warm-up method used by players is stretching. Static stretching has been found to have counterproductive impacts on performance in prior studies.[16,18-21]

Proprioceptive neuromuscular facilitation (PNF) stretching targets muscle spindles and Golgi tendon organs, which suppresses muscle spindles and enhances Golgi tendon organ activity, allowing the muscle to stretch further.[16] Thereby increasing muscle range of motion by inducing relaxation through autogenic and reciprocal inhibition.[22] One way to define active dynamic stretching is as controlled motion through each joint's active range of motion.[23] The amateur and professional soccer populations can be very different from one another. In a game, a professional player covers around 10.5 km, while an amateur player covers approximately 7.80 km, resulting in an average disparity of 34%. Peak speed is another area where differences may be seen; professional and amateur players' highest speeds differ by around 20%.[24]

Herrero et al stated that amateur football players have a lower injury rate than their elite counterparts, most likely due to their lower participation rate in training and matches and underdeveloped physical and technical attributes. However, the injuries of an amateur player take a longer time to recover since amateur players are treated with less advanced techniques, few facilities, and at a lower frequency, which is the opposite in the case of professionals.[25]

Therefore, to assess the benefits of a properly structured warm-up protocol and offer a planned practical approach to use on the field, it is crucial to examine how various warm-up protocols, such as PNF stretching and active dynamic stretching influence the performance of an amateur football player in a sport-specific action. This study aimed to evaluate and compare the immediate effect of PNF stretching versus active dynamic stretching during warm-up on 20-meter sprint performance in amateur soccer players.

METHODS

A cross-sectional study was conducted on a football field at Pravara Institute of Medical Sciences (DU), Loni, Maharashtra, from April 2023 to January 2024, with the ethical permission of the institutional ethics committee of the Pravara Institute of Medical Science (DU). Based on the inclusion and exclusion criteria, 80 participants were recruited. OpenEpi software was used to calculate the sample size.

Inclusion criteria

Individuals who are willing to give informed consent; between the age group of 18 to 25 years; gender (both male and female); subjects having at least one year of experience playing soccer; subjects belonging to local amateur soccer teams were included.

Exclusion criteria

Players with recently sustained injuries; any cardiovascular, pulmonary, or neurological disorders; showed signs of exercise intolerance; or refused to participate in the study were excluded.

Before the trial began, participants were informed about the study, asked for their informed consent, and demographic data was collected. Allocation concealment was done by SNOSE and the participants were split into two groups randomly (Lottery method using chits). Group A was assigned to PNF stretching (N=40), and Group B was assigned to active dynamic stretching (N=40). Following a 10-minute warm-up consisting of conventional jogging, participants from each group were asked to complete a 20-metre sprint test. The time taken to complete the test was noted on the data collection sheet.

After the test, each group was administered their respective warm-up intervention. Group A underwent PNF stretching for the calf, quadriceps, and hamstrings (Table 1); whereas Group B performed Active Dynamic Stretching, i.e., toe walk for the calf; walking quad stretch for quadriceps; straight leg march; and hamstring handwalk-inchworm for hamstrings (Table 2).

Following this, the participants were re-assessed using the 20-metre sprint test, and new data was recorded in the data collection sheet.

Statistical analysis

Statistical analyses were done using the SPSS software to calculate the mean and standard deviation of the two experimental groups. The mean value of the age of the participants in each group was analysed. The paired T-

test was used to analyse within-group comparison. For between-group comparison and analysis, an unpaired T-test was done to check the effectiveness of PNF stretching and active dynamic stretching on 20-meter sprint performance in amateur soccer players.

Table 1: Group A protocol for PNF stretching.

PNF stretching	Procedure	Repetitions and sets
Calf muscles	Subject's position – supine lying Therapist position – beside the leg being tested Procedure – the therapist must grasp the ankle of the subject and passively perform dorsiflexion until the end range of motion, then ask the individual to isometrically contract their calf muscle by plantar flexing the foot. Hold the contraction for 15 seconds while the therapist provides sufficient resistance followed by a 30-second stretch.	5 REPS * 3 SETS
Quadriceps Muscle	Subject's position – prone lying position, knee is flexed. Therapist position – beside the leg being tested. Procedure- proximally therapist one hand grasps the thigh and the other hand around the ankle distally. Instruct the subject to perform isometric contractions by flexing the hip and extending the knee, holding the contraction for 15 seconds, as the therapist provides sufficient resistance, followed by a 30-second stretch.	3 REPS * 5 SETS
Hamstrings Muscle	Subject's position – supine lying Therapist position – beside the leg being stretched facing the subject. Procedure – The therapist passively flexes the hip of the subject and asks the subject to perform isometric contractions by pressing the leg against the therapist's shoulder i.e. by performing hip extension movement, with resistance. The maximal isometric contraction performed will be held for 15 seconds followed by a 30-second stretch before beginning with the next contraction.	5 REPS * 2 SETS

Table 2: Group B protocol for active dynamic stretching.

Target muscle	Active dynamic stretching	Description of stretch	Repetitions and sets
Calf (triceps surae)	Toe walk	While walking raise both heels and balance on the balls of your feet. Push into the ground with the ball of your leading foot, trying to extend up onto your toes. Repeat the exercise with alternating legs.	15 reps* 2 sets
Quadriceps	Walking quads stretch	While walking bend the knee, and kick heels up towards the buttocks.	10 reps* 3 sets
Hamstrings	Straight leg march	While walking, flex the arms in front till shoulder height, swing each leg in such a way that their leg touch their fingers, a stretched is felt in the posterior thigh when the leg is extended and ankle is in plantar flexion.	10 reps* 3 sets
	Hamstring handwalk-inchworm	While walking, bend forward and walk on your hands and feet using them as fore and hind limbs, make sure the knees are extended. A stretch is felt in the posterior aspect of leg.	10 reps* 2 sets

RESULTS

The objectives of study were to determine effect of PNF stretching during warm-up on 20-meter sprint performance in amateur soccer players and to determine the effect of active dynamic stretching during warm-up on 20-meter sprint performance in amateur soccer players.

Table 3: Demographic data.

Parameters	Group A-PNF stretching	Group B- dynamic stretching
Age		
Mean±SD	21.38±1.66	20.73±1.89
Gender		
Male	32	29
Female	8	11

The demographic data is described in Table 3. A total of 80 subjects participated in the study, out of which 76.25 % were male and 23.75% were female. The mean age of the total participants was 21.08±1.80.

This is to signify that normality of the data is maintained and the gender of the participants has not affected the study (Table 4).

Table 4: Comparison of mean values of 20-meter sprint test in male and female gender.

	Male		Female	
	Group A	**Group B**	**Group A**	**Group B**
Pre-test	4.27±0.42	4.14±0.46	5.12±0.38	5.05±0.36
Post-test	4.22±0.48	3.84±0.43	5.17±0.36	4.69±0.44

There is a significant improvement in the performance of Group B $p<0.05$ as compared to Group A with no significant improvement $p>0.05$ (Table 5).

Table 5: Comparison of pre and post-20-meter sprint test values of Group A and B.

20-meter sprint test	Pre-test	Post-test	P value
Group A	4.44±0.53	4.42±0.60	0.44
Group B	4.40±0.60	4.08±0.58	0.00

The results obtained from the statistical analyses using the SPSS software support the alternate hypothesis, which stated that there would be a significant difference between PNF stretching and active dynamic stretching, and one of them would show a higher efficacy in performance in the 20-meter sprint test. The statistical analyses proved that active dynamic stretching showed significant improvement in 20-meter sprint performance (Table 6).

Table 6: Comparison between Group A and Group B for the 20-meter sprint test. Group B is statistically significant p<0.05 (0.01).

20-meter sprint test	Group A	Group B
T-test (between groups)	**0.72**	**0.01**
	Not significant	significant

DISCUSSION

The main aim of the study was to evaluate and compare the immediate effects of PNF stretching versus active dynamic stretching during warm-up on 20-meter sprint performance in amateur soccer players. This study was done because amateur players do not perform an accurate warm-up before a game which could help them improve their performance and avoid injuries.

Studies in the past have suggested that static stretching may not improve performance. Due to this, there is a need to understand which warm-up protocol could enhance performance and prove to be more effective. To debate, researchers are conducting studies intending to investigate which warm-up protocol enhances performance for their respective sport using specific outcome measures.

Trombi et al in their study compared dynamic stretching with static stretching to check the effects on 20-meter sprint performance, the results showed that a combination of static and dynamic stretching gives better results.[26] Püsök et al concluded that a dynamic stretching warm-up has only a significant effect on sprint performance and agility if performed over longer distances or durations.[27] Tuna et al suggested that the dynamic stretching group had positive effects on 20-meter sprint performance in female volleyball players, whereas the static stretching group did not affect performance.[28] Alikhajeh et al in their study, used the 20-meter sprint test to compare the effects of various stretching protocols. Their study concluded that the group performing active dynamic stretching had significantly faster sprint time.[23] Alemdaroğlu et al conducted a study on taekwondo practitioners to evaluate the acute effects of stretching on sprint performance, the individuals recovered for one minute after stretching and then again at five, ten, fifteen, and twenty minutes later. They completed two maximum 20-meter sprints (with 10-meter split timings also recorded). These sprints were also done by them before the stretching exercises. The results determined that while sprint performance is less impacted by ballistic stretching than it is by the other stretching modalities, sprint performance may be adversely affected by the acute impacts of static, PNF, and ballistic stretching. As a result, it is not recommended to engage in static stretching or PNF just before a sprint competition.[29] Ruparelia et al stated that PNF stretching showed better results and was more effective than dynamic stretching in improving performance using the 12-minute Cooper run test and flexibility using sit and reach test.[16]

It is apparent that there has been quite a variance in opinions regarding an adequate warm-up protocol. Also, most of the studies have been done on individuals who were professionals, semi-professionals, or individuals with a good amount of training. The studies that have considered youth players did not use specific outcome measures that would target a sport-specific activity and act as stimulation before the game.

In PNF stretching, the contract-relax method was used. Phil Page and Paul R. Surburg have described the contract-relax technique as the contraction of muscle through its spiral diagonal PNF pattern.[30] Ylinen et al wrote the book “Stretching Therapy for Sports and Manual Therapies,” which explains the contract-relax technique. In the beginning, move the muscle-tendon unit into a stretched position and tense the muscle against the

therapist or an object for resistance. Then relax the antagonist muscles and allow the stretch to increase by contracting the agonist muscles. Preserve the new stretch position, and with a new barrier, the cycle is repeated. The complete stretch cycle consists of isometric contraction of antagonists, relaxation of antagonists, and the dynamic contraction of agonists: contract-relax agonist-contract. It has been proposed that contracting muscles before stretching activates the Golgi tendon organs, which promote relaxation by inhibiting motor neurons through activation of the Renshaw cell, thereby lowering the sensitivity of the muscles to contraction. According to a different idea, contracting muscles before stretching activates muscle spindle receptors, which lessens the sensitivity of the receptors and reduces muscular tension and stretch resistance.[31]

Ruparelia et al describe dynamic stretching as one type of self-stretching exercise that is low-intensity active stretching, which involves repetitive, brief, end-range active muscular contractions of the muscle opposing the shortened muscle. The processes proposed to account for the benefits of dynamic stretching are merely hypothesized; these include elevated heart rate, core temperature, muscle warmth, a higher transmission rate, and enhanced metabolism, which in turn increase range of motion and tissue compliance. Strength and power development may also result from specific movement pattern practice that may improve proprioception and an increase in neuromuscular activity that may be connected to post-activation potentiation (PAP).[16]

Alikhajeh et al suggested that elevated core temperatures enhance nerve receptor sensitivity and nerve impulse speed, causing muscles to contract more quickly and forcefully. When sprinting, proprioception is essential, especially for pre-activation, which facilitates the quick transition from eccentric to concentric contraction, which is needed to produce running speed. Rehearsing movement in a more targeted pattern with coordination could be the second explanation for the improvements seen in performance in active dynamic stretching.[23]

This study has some limitations. The study has only one outcome measure, exclusively focusing on a single component of the sport. It didn't consider the other reasons due to which the speed might be impacted, such as body type, gender, diet, having a different schedule, having different durations of daily physical activity, etc. The study didn't consider that the different cardiovascular and respiratory endurance levels of the participants could impact their performance.

CONCLUSION

This study concludes that active dynamic stretching shows significant performance improvement, making it a better alternative for amateur soccer players to use this warm-up protocol in their daily routine to enhance their performance and excel in their game. However, both PNF and active dynamic stretching can be used as a warm-up protocol.

Recommendations

Future studies can include more outcome measures for various components to evaluate the players based on a holistic perspective. Further studies can be done by combining both of these protocols in a single group and comparing them with an experimental group to find much better alternatives that could yield good results for amateur players. Studies can also be done on the long-term effects of active dynamic stretching during warm-up.

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REFERENCES

1. Dambroz F, Clemente FM, Teoldo I. The effect of physical fatigue on the performance of soccer players: A systematic review. PloS one. 2022;17(7):e0270099.
2. Haugen TA, Tønnessen E, Hisdal J, Seiler S. The role and development of sprinting speed in soccer. Int J Spor Physiol Perform. 2014;9(3):432-41.
3. Ulupınar S, Özbay S, Gençoğlu C, Franchini E, Kishalı NF, Ince I. Effects of sprint distance and repetition number on energy system contributions in soccer players. J Exer Sci Fitness. 2021;19(3):182-8.
4. Kumar N, Archana PS. To determine the association of cardiorespiratory fitness with anthropometric characteristics in collegiate athletes. Srb J Sports Sci. 2015;9(1):27-30.
5. Shejwal K, Kumar N. Comparison of simple reaction time between volleyball and football playing collegiate athletes. Int J Res Rev. 2020;7(2):421-4.
6. Kumar N, Laroiya N. Association of VO2 Max, Agility and BMI among collegiate athletes. Ann Sports Med Res. 2017;4(5):1121.
7. Kumar N, Srivastava D, Tiwari NN, Dwivedi S. Effective time for consumption of preexercise energy drink to enhance cardiorespiratory fitness. Saudi J Sports Medi. 2017;17(2):79-81.
8. Kumar N, Sharma S. Effect of Tobacco Chewing on VO2 max. Med Sportiva. 2011;7(27):3.
9. Kumar N, Agrahari R. Effect of pre-exercise sports drink on cardio-respiratory fitness. Medicina

Sportiva: J Roman Sports Medi Soci. 2012;8(2):1846.
10. Kumar N, Badwe AN. A study to determine basic values of Aerobic, Anaerobic and running time performances of 800 meter rural collegiate athletes. YMER. 2022;21:10:274-9.
11. Kumar N, Badwe AN. Association of rural collegiate 800 m athletes' running time with their cardiorespiratory endurance, power, and F30 time. Saudi J Sports Med. 2023;23(1):17-21.
12. Kumar N, Singh A, Sinha N, Tripathi VM. Comparison of physical fitness between tobacco chewer and non-tobacco chewer. Saudi J Sports Medi. 2015;15(2):137-41.
13. Neeraj K, Maman P, Sandhu JS. Why players engage in drug abuse substances? A survey study. Doping J. 2011;8(1).
14. Thompson MA. Physiological and biomechanical mechanisms of distance specific human running performance. Integrat Comparat Biol. 2017;57(2):293-300.
15. Haugen TA, Tønnessen E, Hisdal J, Seiler S. The role and development of sprinting speed in soccer. Int J Spor Physiol Perform. 2014;9(3):432-41.
16. Ruparelia H, Patel S, Shukla YA. Study to compare the immediate effect of PNF stretching and dynamic stretching during warm-up on 12 Minute cooper run test performance and modified sit and reach test among young individual: A comparative study. Int J Sci Res. 2021;10(9):p900-906.
17. Neves PP, Alves AR, Marinho DA, Neiva HP. Warming-up for resistance training and muscular performance: a narrative review. Contemporary Advances in Sports Science. 2021.
18. Peck E, Chomko G, Gaz DV, Farrell AM. The effects of stretching on performance. Curr Sports Medi Repor. 2014;13(3):179-85.
19. O'Sullivan K, Murray E, Sainsbury D. The effect of warm-up, static stretching and dynamic stretching on hamstring flexibility in previously injured subjects. BMC Musculoskel Dis. 2009;10(37):1-9.
20. Carvalho FL, Carvalho MC, Simão R, Gomes TM, Costa PB, Neto LB, et al. Acute effects of a warm-up including active, passive, and dynamic stretching on vertical jump performance. J Str Condit Res. 2012;26(9):2447-52.
21. Deguzman L, Flanagan SP, Stecyk S, Montgomery MM. The immediate effects of self-administered dynamic warm-up, proprioceptive neuromuscular facilitation, and foam rolling on hamstring tightness. Athletic Train Sports Health Care. 2018;10(3):108-16.
22. Kisner C, Colby LA. Therapeutic exercises: Foundation and Techniques. 6th ed. Jaypee brothers; 2012.
23. Alikhajeh Y, Rahimi NM, Fazeli K, Fazeli H. The effect of different warm up stretch protocols on 20m-sprint performance in trained soccer players. Procedia-Soci Behavi Sci. 2012;46:2210-4.
24. Soccer Improved. Difference between pro and amateur player. Available at: https://www.soccerimproved.com/pro-andamateurs. Assessed on 20 January 2024.
25. Herrero H, Salinero JJ, Del Coso J. Injuries among Spanish male amateur soccer players: a retrospective population study. Ame J Spor Medi. 2014;42(1):78-85.
26. TROMBI, Osama Ali M. Comparing Effect of Static, Dynamic, and Combined Stretching Exercises for Semi-Professional College Football Players on Sprint Performance. Biomedicínská laboratoř, 2023.
27. Püsök P, Kollarics A, Simon-Ugron Á, Gyuró M, Szőts B, Ács P, et al. PMS99-acute effects of dynamic stretching after warm up on sprinting ability and agility among adolescent basketball players. Value Health. 2018;21:S304-5.
28. Gökhan TU, YALÇINKAYA AE. Investigating the acute effects of different warm-up protocols on sprint performance in female volleyball players. Online J Recreat Sports. 2023;12(4):797-804.
29. Alemdaroğlu U, Köklü Y, Koz M. The acute effect of different stretching methods on sprint performance in taekwondo practitioners. J Spo Medi Phys Fitn. 2016;57(9):1104-10.
30. Page P. Current concepts in muscle stretching for exercise and rehabilitation. Int J Sports Phys Ther. 2012;7(1):109.
31. Jari Y. Stretching Therapy: for sport and manual therapies. 1st English ed. Churchill Livingstone/Elsevier; 2008.

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