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Facilitating Immediate Impact on Explosive Power and Recovery Ability of Volleyball Athletes' Proprioceptive Neuromuscular Receptors During Jumping

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Abstract:

*Background:*Stretching during warm-ups is commonly practiced among athletes and is believed to have an impact on performance. However, the specific effects of proprioceptive neuromuscular facilitation (PNF) stretching on athletes' explosive force (EF) and jump distance (JR) are not well understood. This study seeks to address this gap by investigating the effects of PNF stretching on EF and JR in male volleyball players. *Objectives*: The primary objective of this study is to determine the effects of proprioceptive neuromuscular facilitation (PNF) stretching on athletes' explosive force (EF) and jump distance (JR). Specifically, the study aims to compare the performance of volleyball players in EF and JR before and after two different PNF stretching protocols. *Method*: Twelve male volleyball players participated in the study, with various anthropometric measurements recorded. Two PNF stretching protocols were implemented: Protocol 1 involved four sets of maximum voluntary isometric contractions followed by thirty seconds of passive stretching, while Protocol 2 involved four sets of maximum voluntary isometric contractions followed by sixty seconds of passive stretching. EF and JR were assessed using the height of the countermovement vertical leap measured with the Leap System Pro. Student t-tests were conducted to compare jump heights before and after stretching for both protocols. *Result:* After both stretching protocols, there were no significant differences observed in EF and JR performances among the volleyball players. The t-tests conducted for EF and JR indicated no significant changes following either Protocol 1 or Protocol 2. *Conclusion:* The results of this study suggest that the PNF stretching routines employed did not significantly affect the EF and JR performances of male volleyball players. These findings highlight the need for further research to better understand the effects of PNF stretching on athletic performance and to explore alternative stretching methods that may yield different outcomes.

Keywords: Proprioceptive Neuromuscular Facilitation (PNF) stretching, explosive force (EF), jump distance (JR), volleyball players, warm-up, performance, stretching protocols.

1. Introduction

Both professional and amateur athletes frequently integrate stretching into their warm-up routines (Evan Peck et al., 2014; Bradley et al., 2007). Due to its potential advantages for improving performance and preventing injuries, this practice has been historically advocated (Safran et al., 1989; Smith, 1994; Shellock et al., 1985; Schneider, P., et al, 2004). However, new research has shown that stretching before exercise might not keep you from getting hurt and might even temporarily lower neuromuscular performance, depending on the type, intensity, and volume of exercise (Rubini et al., 2007; Bradley et al., 2007; Toai, 1996).

The impact of diverse stretching methods on force production has been established, showing a decrease in performance (Rubini et al., 2007). Among various stretching techniques, static stretching has been extensively studied and demonstrates the most consistent performance outcomes. Conversely, there is still uncertainty regarding the effects of proprioceptive neuromuscular facilitation (PNF) on performance. Explosive force, particularly in the lower limbs, is a critical component of an athlete's physical condition and performance (Caplan et al., 2009). Muscular endurance is another key aspect of athletic performance that can be influenced by warm-up stretching exercises (Barroso et al., 2012; Franco et al., 2008).

In volleyball, continuous jumping is a fundamental requirement, demanding athletes to generate explosive power and sustain jump resistance throughout a match (Schneider, P., et al, 2004; Nguyen T,L. (1998); Thuc, 2017). The ability to perform multiple jumps, especially in competitive settings, underscores the importance of maintaining high levels of explosive power in this sport. Coaches must be cognizant of factors that could impede players' performance as they recognize the significance of maintaining power expressions for success in volleyball.

Research suggests that stretching may diminish an athlete's physical performance by reducing muscular strength (Church et al., 2001). Consequently, there has been considerable debate regarding the impact of stretching on performance (Evan Peck et al., 2014). Static stretching, the most studied form, is contraindicated when performed before strength and power exercises (Bradley et al., 2007; Evan Peck et al., 2014). In contrast, proprioceptive neuromuscular facilitation (PNF) is widely used in sports contexts (Sharman et al., 2006), yet there is limited data on its effect on force production (Bradley et al., 2007; Evan Peck et al., 2014).

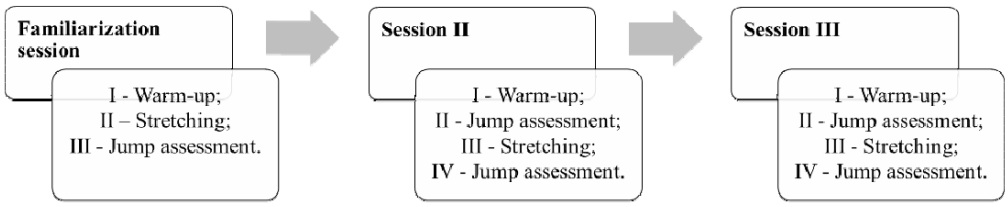
The findings regarding PNF's impact on performance are inconsistent (Barroso et al., 2012). Some studies (Church et al., 2001; Bradley et al., 2007) reported negative effects on explosive force assessed through vertical jumps, while others (Young et al., 2001; Christensen et al., 2008) found no decline in performance following PNF. Studies by Franco and colleagues (2008) and Barroso and colleagues (2012) looked at muscle endurance by counting repetitions in the bench press and the leg press. They found that resistance decreased after PNF, which suggests that it had a negative effect on muscle endurance. To date, no research has investigated how PNF affects jump resistance (JR).

The point of this study is to look at the short-term effects of PNF on volleyball players' explosive force (EF) and jump resistance (JR). There are currently debates about the short-term effects of stretching on performance, and there aren't any agreed upon results about PNF in the literature. Our initial hypothesis is that the stretching protocols employed in this study negatively impact muscular endurance and explosive force, with the degree of performance reduction dependent on the protocol used. This is based on substantial evidence demonstrating the adverse effects of passive stretching on performance and its role in elongating PNF.

2. Material and Methods

Twelve male participants from the university volleyball squad (average age 21 ± 4 years, height 178 ± 0 cm, weight 75.82 ± 11.02 kg, and body mass index 23 ± 2.87 kg/m2) were involved in the research. Each adhered to a routine comprising at least four sessions per week, lasting an average of 90 minutes. Individuals who had recently experienced lower limb injuries or missed any sessions were excluded from the study. Athletes were disqualified due to injuries to their lower limbs.

Each athlete visited the laboratory three times at consistent times of day, with a minimum of 48 hours between sessions. The primary objective of the initial session was to familiarize the participants with the equipment and procedures. The subsequent two sessions were allocated for the stretching experiment. Prior to each session, a five-minute warm-up encompassing progressively challenging running and volleyball-specific drills was conducted. The structure of the sessions is outlined in Figure 1.



Vertical Jump Counter-Movement Motion.

The counter-movement vertical jump (CMJ) was assessed for explosive force (EF) and jump resistance (JR). CMJ is a widely used method to evaluate lower limb explosive force due to its practicality and relevance to volleyball (Church

et al., 2001; Schneider, P., et al., 2004; Toai, 1996; Thuc, 2017). Starting from a standing position, individuals perform an eccentric phase of the movement with hips and knees flexed approximately 90 degrees, followed by an immediate concentric phase (jumping phase) with knees extended straight throughout the airborne phase. Both feet are placed parallel and shoulder-width apart. Subjects completed three vertical jumps with a 15-second rest interval to assess EF; the highest jump value was considered for statistical analysis. For JR assessment, participants completed 15 consecutive vertical jumps with a three-second rest interval. A CEFISE® contact mat was used to measure jump height, with results recorded in the Jump System Pro software.

Stretching Protocol.During unilateral hip flexion with knee extension, the posterior muscles of the lower limb (hamstrings and glutes) were stretched using the PNF stretching technique with the contract-relax method (Alter, 2004). With this method, individuals performed a maximal voluntary isometric contraction for five seconds after the target muscles were passively stretched to discomfort. Then, for thirty or sixty seconds, the therapist gently stretched the target muscles. Four sets were completed for each leg in a non-alternating sequence, with 10 seconds of rest between sets. Both passive stretching protocols—30 seconds for Protocol 1 (P1) and 60 seconds for Protocol 2 (P2)—have been previously used in studies (Bradley et al., 2007; Schneider, P., et al., 2004; Thuc, 2017; Behm et al., 2016; Thuc et al., 2018). The total stretching time for Protocols 1 and 2 was 280 and 520 seconds, respectively. Experienced physical therapists proficient in PNF methods conducted the exercises to ensure consistent muscle stretching.

Statistical Analysis

The mean values and standard deviations of the data for each variable are presented (Table 1). The normality of the data was confirmed using the Shapiro-Wilk test. Paired sample t-tests were employed to compare pre- and post-stretching values for EF and JR variables, with a significance threshold set at 5%. According to Rhea (2004), effect sizes (d) were calculated based on the following ranges: "small <0.35", "moderate, 0.35-0.80", "large, 0.80-1.5", and "very large > 1.5". Sample power for each motor test was assessed using power analysis.

3. Results

In both Protocols 1 and 2, pre- and post-stretching values for explosive force remained consistent, with no statistically significant differences observed ($t(7) = 1.471$, $p = 0.258$ and $t(7) = 1.411$, $p = 0.315$, respectively). Similarly, muscle resistance measured before and after stretching in both Protocols 1 and 2 did not show any significant changes ($t(7) = 1.539$, $p = 0.237$ and $t(7) = 0.498$, $p = 0.801$, respectively).

Despite the absence of statistically significant changes, explosive force decreased by 2.35% and 3.25% in Protocols 1 and 2, respectively. Furthermore, local muscle resistance exhibited deficits in both Protocols 1 and 2, with respective reductions of -2.25% and -0.85%.

Table 1: Changes in Explosive Force and Local Muscle Resistance Before and After Stretching Protocols

	Pre	Post	Fluctuation in percentage	Standard deviation	Magnitude of effect	Magnitude
			EF			
Protocol 30s	39.16±3.15	38.35±3.08	-2.35	1.09	0.48	Small
Protocol 60s	39.88± 3.45	38.58±3.55	-3.25	1.22	0.43	Small
			JR			
Protocol 30s	36.15±2.36	35.56±2.76	-2.25	1.07	0.56	Small
Protocol 60s	35.65± 3.51	35.36±3.18	-0.85	1.14	0.16	Trivial

4. Dicussion and Conclusions

This study aimed to investigate the immediate effects of two PNF protocols on athletes' resilience to vertical leaps and explosive force. Following PNF Protocols 1 and 2, there was a decrease of 2.35% and 3.25%, respectively, in explosive force. Similarly, following PNF Protocols 1 and 2, JR showed a decline of 2.25% and 0.85%, respectively.

However, these changes lacked statistical significance, suggesting that the stretching protocols used in this study were insufficient to impact the variables under examination.

Research assessing the influence of PNF on vertical jump performance has produced inconsistent outcomes regarding explosive force. For instance, Young and colleagues (2001) found no significant changes in vertical jump performance after PNF, employing the contract-relax method to stretch gluteus, quadriceps, and calf muscles. Similarly, Christensen and colleagues (2008) observed no adverse effects on vertical jump performance among university athletes engaging in various warm-up activities, including PNF. Conversely, Church and colleagues (2001) reported significant variations in vertical jump performance following PNF, employing the contract-relax agonist-contract (CRAC) approach with female athletes. Bradley and colleagues (2007) also noted a decline in vertical jump performance among male university students after PNF using the contract-relax technique with hamstring, plantar flexor, and quadriceps stretching. Discrepancies in study outcomes may arise from differences in research methodologies, including stretching duration, PNF techniques, muscle groups targeted, and participant demographics.

Variations in these factors can impact the effectiveness of stretching in activities involving the stretch-shortening cycle. Additionally, differences in participant profiles, such as non-athlete volunteers versus expert jumpers, may elicit distinct responses during tasks requiring rapid effort.

The number of stretched muscles may also contribute to performance variations following stretching. While this study targeted only hip extensors, other trials included stretching for additional muscle groups involved in vertical leaps, such as plantar flexors, hamstrings, quadriceps, gluteus, and hip adductors.

Despite the lack of negative effects on vertical jump performance observed in this study, caution is advised when implementing stretching exercises before explosive force activities. The total volume and number of muscles stretched may be more crucial factors to consider, as studies with low volume or few muscles stretched did not demonstrate adverse effects on performance.

This study's notable finding is the lack of impact of PNF protocols on vertical jump resilience. While some studies have shown negative effects of PNF on muscular resistance in resisted activities, further research is needed to explore PNF's effects on muscle endurance using vertical jumps. It is suggested that coaches and professionals organizing athletes' training routines stretch a limited number of muscles each session to minimize the risk of negative effects. Conversely, stretching numerous muscles for an extended duration before high-intensity jump activities may impair performance, as suggested by other research findings.

The findings of the research indicated that the explosive strength and jump resilience of volleyball athletes remained unaffected by the PNF routines, with neither showing a statistically significant adverse impact on leap performance. Thus, athletes can incorporate the stretching routines employed in this study into their warm-up routines without compromising their vertical jump capabilities.

Conflicts of Interest: The authors declare no competing interests.

References

1. Avloniti, A., Chatzinikolaou, A., Fatouros, I. G., Avloniti, C., Protopapa, M., Draganidis, D., ... & Kambas, A. (2016). "*The acute effects of static stretching on speed and agility performance depend on stretch duration and conditioning level*". *The Journal of Strength & Conditioning Research, 30(10), 2767-2773*.
2. Alter, M. J. (2004). Science of flexibility. Human Kinetics.
3. Barroso, R., Tricoli, V., dos Santos Gil, S., Ugrinowitsch, C., & Roschel, H. (2012). *"Maximal strength, number of repetitions, and total volume are differently affected by static-, ballistic-, and proprioceptive neuromuscular facilitation stretching". The Journal of Strength & Conditioning Research, 26(9), 2432- 2437.*
4. Behm, D. G., Blazevich, A. J., Kay, A. D., & McHugh, M. (2015). *"Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review". Applied physiology, nutrition, and metabolism, 41(1), 1-11.*
5. Bradley, P. S., Olsen, P. D., & Portas, M. D. (2007). *"The effect of static, ballistic, and proprioceptive neuromuscular facilitation stretching on vertical jump performance". Journal of Strength and Conditioning Research, 21(1), 223.*

6. Bui Trong Toai (1996), with the topic "*Research to determine the test system of physical fitness testers young women volleyball*". Master thesis, Ho Chi Minh City, VietNam.
7. Caplan, N., Rogers, R., Parr, M. K., & Hayes, P. R. (2009). *"The effect of proprioceptive neuromuscular facilitation and static stretch training on running mechanics". The Journal of Strength & Conditioning Research, 23(4), 1175-1180.*
8. Christensen, B. K., & Nordstrom, B. J. (2008). *"The effects of proprioceptive neuromuscular facilitation and dynamic stretching techniques on vertical jump performance". The Journal of Strength & Conditioning Research, 22(6), 1826-1831*.
9. Church, J. B., Wiggins, M. S., Moode, F. M., & Crist, R. (2001). *"Effect of warm-up and flexibility treatments on vertical jump performance". Journal of strength and conditioning research, 15(3), 332-336.*
10. Chanh Thuc Dao. (2018). *Measurement in sports.* LAP LAMBERT Academic Publishing, ISBN 978-613-9-90198-2.
11. Dao Chanh Thuc, (2017). *"Research and building system developmental strength exercises system by plyometric method for male students' major in volleyball of physical education department at An Giang University".* International Journal of Physical Education, Sports and Health, 4(6), P 156-158.
12. Dao Chanh Thuc, (2017). *"Studying and building volleyball curriculum in optional hour at An Giang University: An Giang province".* International Journal of Physical Education, Sports and Health, 4(6), P 137-142.
13. Dao Chanh Thuc, Nguyen Van Tang, & Le Thi Minh Dao. (2018). *"Studying and building the developmental strength exercises system by plyometric method for professional female volleyball players".* Journal of Physical Education Research, 5(1), P 01-06
14. Franco, B. L., Signorelli, G. R., Trajano, G. S., & de Oliveira, C. G. (2008). *"Acute effects of different stretching exercises on muscular endurance". The Journal of Strength & Conditioning Research, 22(6), 1832-1837*.
15. Kallerud, H., & Gleeson, N. (2013). *"Effects of stretching on performances involving stretch-shortening cycles". Sports medicine, 43(8), 733-750.*
16. Peck, E., Chomko, G., Gaz, D. V., & Farrell, A. M. (2014). *"The effects of stretching on performance". Current sports medicine reports, 13(3), 179-185*.
17. Rhea, M. R. (2004). *"Determining the magnitude of treatment effects in strength training research through the use of the effect size". Journal of strength and conditioning research, 18, 918-920*.
18. Rubini, E. C., Costa, A. L., & Gomes, P. S. (2007). *"The effects of stretching on strength performance". Sports medicine, 37(3), 213-224*.
19. Safran, M. R., Seaber, A. V., & Garrett, W. E. (1989). *"Warm-up and muscular injury prevention an update". Sports Medicine, 8(4), 239-249*.
20. Sharman, M. J., Cresswell, A. G., & Riek, S. (2006). "*Proprioceptive neuromuscular facilitation stretching". Sports Medicine, 36(11), 929-939.*
21. Shellock, F. G., & Prentice, W. E. (1985). "*Warming-up and stretching for improved physical performance and prevention of sports-related injuries". Sports Medicine, 2(4), 267-278.*
22. Smith, C. A. (1994). *"The warm-up procedure: to stretch or not to stretch. A brief review". Journal of Orthopaedic & Sports Physical Therapy, 19(1), 12-17*.
23. Le Quy Phuong. (2008). Warm up I. Sports medicine, 33(6), 139-154.
24. Lam Quang Thanh. & Nguyen Thanh Lam. (2011). *Measurement in sport*. Ho Chi Minh University Of Sport-HoChiMinh City-VietNam
25. Young, W., & Elliott, S. (2001). *"Acute effects of static stretching, proprioceptive neuromuscular facilitation stretching, and maximum voluntary contractions on explosive force production and jumping performance". Research quarterly for exercise and sport, 72(3), 273-279.*
26. Nguyen T,L. (1998), "*Research on development of physical strengths of 15-18 year old female volleyball players*", PhD thesis on education, (In VietNam).
27. Schneider, P., Benetti, G., & Meyer, F. (2004). Muscular strength of 9-18-year old volleyball athletes through computational dynamometry. *Revista Brasileira de Medicina do Esporte*, *10*, 85-91.