Comparative Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching on Flexibility and Power Performance in Collegiate Football Players

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ABSTRACT

The present study examined the chronic effects of proprioceptive neuromuscular facilitation (PNF) stretching and static stretching on flexibility and power performance in collegiate football players. Stretching is a fundamental element of athletic training, yet limited evidence compares its impact on specific performance outcomes in this population. Twenty male football players (aged 19–25 years) were randomly assigned to a PNF group (n = 10) or a static stretching group (n = 10). Both groups completed a four-week intervention using structured stretching protocols. Flexibility was measured with the Sit-and-Reach Test, and power performance with the Countermovement Jump Test. Pre- and post-intervention data were analysed with paired-sample t-tests for within-group effects and independent t-tests for between-group comparisons. Statistical significance was set at $p < 0.05$, and effect sizes were calculated using Cohen's d. Static stretching significantly improved flexibility (pre: 26.02 ± 9.12; post: 27.40 ± 9.08; $p = 0.017$, $d = 0.15$). PNF stretching produced larger mean improvements, although not statistically significant (pre: 28.76 ± 3.27; post: 31.20 ± 4.63; $p = 0.196$, $d = 0.58$). In terms of power, the PNF group achieved superior post-test outcomes compared with the static group ($p = 0.010$, $d = 0.47$). In conclusion, both stretching modalities improved flexibility and power, but PNF stretching offered a modest advantage in explosive performance. These findings suggest that PNF stretching may be more applicable in training programmes where strength and agility are prioritised.

Keywords: Proprioceptive Neuromuscular Facilitation, Static Stretching, Flexibility, Power Performance, Football

INTRODUCTION

Stretching is a fundamental component of athletic training and rehabilitation. It is widely used to improve flexibility, enhance range of motion, and reduce the risk of injury (Rahman & Islam, 2020). Stretching involves the deliberate elongation of muscles and connective tissues to optimise physical function and performance. Among the various methods, static stretching and proprioceptive neuromuscular facilitation (PNF) stretching are the most frequently applied in both sports and therapeutic settings. Static stretching entails passively elongating a muscle to the point of mild discomfort and maintaining the position for 30–120 seconds (Toninelli, 2025). It is recognised for improving joint range of motion and reducing injury risk, although prolonged application may temporarily reduce power output (Bryant et al., 2023). By contrast, PNF stretching combines voluntary muscle contractions with passive stretching to produce greater neuromuscular adaptations (Ruas et al., 2018). The "hold–relax" method, for example, promotes autogenic and reciprocal inhibition, thereby enhancing muscle extensibility and coordination (Wanderley et al., 2019). Initially developed for rehabilitation, PNF has since been integrated into athletic training because of its benefits for both flexibility and power (Kaya, 2018).

Although many studies have explored stretching modalities, their comparative effects remain inconclusive. Both static and PNF stretching are known to improve flexibility, yet conflicting findings persist regarding their impact on muscular power. Moreover, research specific to football athletes is limited, as most studies have

focused on other sports or general athletic populations. Football requires both flexibility for efficient movement and power for explosive actions. Understanding the differential effects of stretching methods in this context is therefore of practical importance. This study aimed to examine the chronic effects of a four-week static and PNF stretching programme on flexibility and power performance in collegiate football players. It was hypothesised that both methods would produce improvements, with PNF stretching expected to yield greater enhancements due to its neuromuscular mechanisms.

METHODOLOGY

Study Design

This study employed a quasi-experimental design to examine the chronic effects of static and proprioceptive neuromuscular facilitation (PNF) stretching on flexibility and power performance. Two intervention groups were compared across a four-week training programme.

Participants

Twenty male collegiate football players aged 19–25 years were recruited. All participants were actively involved in competitive football and free from injuries or medical conditions that could interfere with performance. Participants were randomly assigned into static stretching (n = 10) and PNF stretching (n = 10) groups using a computer-generated random number sequence. Allocation was concealed in sealed envelopes opened at the first training session.

Experimental Protocols

The intervention was conducted over a four-week period, with all stretching sessions carried out under supervision to ensure adherence and correct technique. Each session began with a light warm-up designed to promote blood flow and prepare the muscles for subsequent activity. Participants assigned to the static stretching group performed stretches that were held for 15 to 30 seconds at a comfortable range of motion, targeting the major lower limb muscle groups. In contrast, those in the PNF stretching group completed the hold–relax technique, which involved a 10-second isometric contraction immediately followed by a 20-second assisted stretch. Both protocols were applied consistently across the intervention period to evaluate their respective effects on flexibility and power performance.

Measurements

Flexibility was assessed using the Sit and Reach Test, administered with a standard sit-and-reach box. Participants completed three trials, with the best score recorded. Power performance was measured using the Countermovement Jump Test, where jump height was calculated as the difference between standing reach and jump reach. Three attempts were allowed, with the average score taken as the final result.

Statistical Analysis

Normality was assessed using the Shapiro–Wilk test. Pre- and post-intervention scores within each group were analysed using paired-sample t-tests. Independent t-tests were used to compare between groups. Effect sizes were calculated using Cohen's d to provide additional context beyond p-values. Although no a priori power analysis was conducted, post-hoc considerations indicated that the small sample size may have reduced statistical power, and this limitation is acknowledged in the discussion. Statistical significance was set at $p < 0.05$. All analyses were performed in SPSS (Version 26).

RESULTS

Both groups improved in Sit-and-Reach scores after the four-week intervention. The static stretching group improved significantly from a pre-test mean of 26.02 ± 9.12 cm to a post-test mean of 27.40 ± 9.08 cm ($p = 0.017$, $d = 0.15$). The PNF stretching group recorded larger mean improvements, increasing from 28.76 ± 3.27 cm to 31.20 ± 4.63 cm, although this change did not reach statistical significance ($p = 0.196$, $d = 0.58$).

Independent t-test results indicated no significant difference between groups in flexibility outcomes (p = 0.574).

Table 1. Pre- and post-test flexibility scores for static and PNF stretching groups

Group	Pre-test Mean ± SD	Post-test Mean ± SD	*p*-value	Cohen's *d*
Static Stretching	26.02 ± 9.12	27.40 ± 9.08	0.017	0.15
PNF Stretching	28.76 ± 3.27	31.20 ± 4.63	0.196	0.58

Countermovement Jump Test scores also improved for both groups. The static stretching group increased from 43.51 ± 6.88 cm to 45.98 ± 6.40 cm (p = 0.074, d = 0.37). The PNF stretching group improved from 44.77 ± 8.13 cm to 48.56 ± 7.43 cm (p = 0.298, d = 0.47). An independent t-test revealed a significant between-group difference, with the PNF group achieving superior post-test performance compared with the static stretching group (p = 0.010, d = 0.47).

Table 2. Pre- and post-test power scores for static and PNF stretching groups

Group	Pre-test Mean ± SD	Post-test Mean ± SD	*p*-value	Cohen's *d*
Static Stretching	43.51 ± 6.88	45.98 ± 6.40	0.074	0.37
PNF Stretching	44.77 ± 8.13	48.56 ± 7.43	0.298	0.47

DISCUSSION

The primary purpose of this study was to compare the effects of static and proprioceptive neuromuscular facilitation (PNF) stretching on flexibility and power performance in collegiate football players. The findings confirmed that both modalities elicited improvements across the four-week intervention, although their relative influence varied between performance outcomes. In terms of flexibility, the static stretching group achieved a statistically significant improvement. This result aligns with the physiological basis of static stretching, where prolonged passive elongation of the muscle–tendon unit enhances viscoelastic properties and increases stretch tolerance (Bryant et al., 2023). Static stretching is a simple, low-intensity technique that can be consistently applied, which may explain why even a short intervention period yielded measurable gains. The PNF stretching group also improved in flexibility, and although the mean increase was larger than in the static group, the difference was not statistically significant. A likely explanation is the small sample size, which limited statistical power. Recent reviews support the notion that PNF may require higher frequency or longer interventions to produce consistent gains in flexibility (Wanderley et al., 2019).

For power performance, both groups demonstrated positive trends, but only the PNF group showed a statistically significant advantage in between-group comparisons. The underlying mechanism may relate to the active muscular contractions within PNF stretching. The isometric contraction followed by assisted relaxation enhances motor unit recruitment, increases stretch tolerance, and improves neuromuscular efficiency (George et al., 2025). These adaptations are critical for explosive actions such as jumping and sprinting, where rapid muscle activation is required. Meta-analytic findings also suggest that PNF has greater potential to enhance performance in explosive tasks compared with static stretching, particularly in sports demanding agility and speed (Kaya, 2018; Ruas et al., 2018).

The practical implications are important for football training. Static stretching remains valuable for improving range of motion and reducing injury risk, making it useful during warm-ups and recovery phases. PNF stretching, however, appears to provide additional benefits for power development. Coaches and practitioners may consider incorporating PNF stretching during preparatory or conditioning sessions to support improvements in jump ability, acceleration, and agility. Integrating both modalities strategically may therefore optimise overall performance. Despite these promising results, several limitations must be acknowledged. First, the study involved a small, homogenous sample of 20 male players, limiting the generalisability of findings. Second, the study did not include female athletes, so gender-specific responses remain unknown. Third, the intervention was conducted during a single phase of the competitive season, which may have influenced training load and recovery. Finally, no additional performance measures such as sprint time or

agility drills were included. Expanding the scope of outcome measures in future research would provide a more comprehensive evaluation of stretching effects.

CONCLUSIONS

This study showed that both static and proprioceptive neuromuscular facilitation (PNF) stretching improved physical performance in collegiate football players, though their effects differed. Static stretching produced significant gains in flexibility, confirming its value for enhancing range of motion and reducing injury risk. PNF stretching, while not statistically significant for flexibility, yielded greater mean improvements and demonstrated clear advantages for power performance in between-group comparisons. These findings suggest that static stretching is most useful when flexibility development and injury prevention are the priority. In contrast, PNF stretching offers additional benefits for explosive performance, making it more suitable for training goals related to power, agility, and speed. For football players, who rely on both mobility and strength, a balanced combination of static and PNF stretching may optimise performance outcomes. Future research should address the limitations of this study by recruiting larger and more diverse samples, including female athletes, and extending interventions across different phases of the competitive season. Incorporating a broader range of performance measures, such as sprint and agility tests, will also provide deeper insights into the practical role of stretching in athletic preparation.

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