# The Effects of Proprioceptive Neuromuscular Facilitation Stretching on Agility Performance among Volleyball Varsity Players

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**Abstract**

Volleyball players perform stretching exercises to maintain their flexibility. Maintenance of normal muscle flexibility equates to an enhanced agility. Static stretching is the standard form of cool down technique in most athletic training programs. However, recent studies have found that post-exercise static stretching has no immediate and long-term effect on agility. At present, no evidence supports the effects of Proprioceptive Neuromuscular Facilitation (PNF) stretching on improving agility performance among volleyball players hence, this study was formulated. A total of twenty-eight participants ages 18 to 25 who have been training for a volleyball varsity team for at least 12 months were subjected to matched assignment into two groups: an intervention group which employed PNF stretching and a control group which used the usual static stretching during cool down period. Differences between groups were examined using independent T-test while dependent T-test was operated to assess the differences within group with time. All statistical levels of significance were set at $p<0.05$. After 3 weeks, the hitters of PNF stretching group produced a statistically significant difference from the result of their hexagon agility test ($p= 0.005$). This study concludes that PNF stretching is an effective technique in improving the agility performance of volleyball players.

***Keywords:*** Proprioceptive Neuromuscular Facilitation, stretching, cool down, agility, volleyball

**Introduction**

Volleyball is a team sport that requires its players to be agile (Reeser & Bahr, 2017). Gamble (2012) defined agility as the ability of a body to effectively accelerate while maintaining balance in response to a stimulus. Inside the court, volleyball players are expected to perform reactive movements such as spiking and blocking combined with quick jumps and short sprints while processing decisions rapidly based on the direction of the ball. Hence, agility dictates competitive success in the field of volleyball (Sabin & Alexandru, 2015).

A variety of factors affect agility. A recent study steered by Dhapola and Verma (2017) found that a higher body mass index (BMI) ultimately reduces the agility of a person. The training and biological age of an athlete are also factors that affect agility. Gamble (2012) highlighted that proficiency on fundamental motor skills is related to athlete's habitual sports activity and this connection between motor skills development and growth and maturation continue until late adolescence. On the other hand, Joyce (2014) underscored that "flexibility tends to plateau or even decrease at around the time of the adolescent growth spurt and into adulthood, which may suggest that maintaining previously acquired levels of flexibility should be the training focus for this stage of development". Furthermore, cigarette smoking has adverse effects on athlete's normal physiology that, in turn, declines sports performance (Chaabane, et al., 2016; Pesta, et al., 2013).

Studies conducted by Nagarwal, et al., (2010); Dawes and Roozen (2012) showed that maintenance of normal muscle flexibility equates to an enhanced agility. Hamstrings and gastrocnemius (Vaghela & Parmar, 2013) as well as rectus femoris (Dawes & Roozen, 2012; Gamble, 2012) play a significant role in the agility function of athletes. Dawes and Roozen (2012) corroborated that muscle imbalance in flexibility ultimately impede agility and overall performance. Pescatello, et al., (2014) state that flexibility is improved immediately after performing flexibility exercise and shows chronic improvement after about 3–4 weeks of regular stretching at a frequency of at least 2–3 times a week. Pescatello et al. (2014) also emphasized that flexibility exercise is most effective when the muscles are warmed as it consistently presented a detrimental effect on athletic performance when done preceding an exercise or a sports event. Thus, stretching as a warm-up routine affects agility negatively (Page, 2012; Peck, et al., 2014).

Static stretching technique is the most popular among several methods of stretching that are utilized in the sports setting today (Notarnicola et al., 2017). Static stretching involves soft tissue elongation just past the point of tissue resistance held in the lengthened position with a sustained stretch force over a period of time (Kisner, et al., 2018). However, based from the latest study accomplished by Van Hooren and Peake (2018), static stretching shows no immediate gains at improving athletic performance and does not likely produce an effective long-term enhancement on sports-related motor skills. This claim is further supported by a study made by Sermaxhaj, et al., (2017) which explicitly exposed that “static stretching during cool-down has an unimportant statistical impact on agility”.

Contraction of a muscle performed immediately before it is stretched shows effectiveness at improving and maintaining flexibility (Page, 2012). Proprioceptive Neuromuscular Facilitation (PNF) commonly employed in both athletic and clinical environments (Jothi & Jose, 2015) uses a pre-stretching contraction not just to improve muscle elasticity but also to increase muscular performance. According to Hindle, et al., (2012); Pescatello et al. (2014), performing at least two sets of PNF contract-relax (CR) or contract-relax agonist contract (CRAC) per week is necessary to preserve the gains for both flexibility and muscular performance. In addition, Kisner et al., (2018); Page (2012) substantiated that PNF stretching yields greater gains in range of motion compared to static stretching but there is no consensus on whether one PNF technique is significantly superior over another.

Review of current literature reveals no evidence regarding the effects of PNF stretching on agility of volleyball athletes. Therefore, the aim of this study was to compare PNF stretching and traditional static stretching in relation with agility performance of volleyball varsity players. The result of this study is beneficial among volleyball athletes in improving their agility performance while maintaining the muscle flexibility requirement of their sport.

## METHODS

### Research Design

A classical pre-test post-test randomized controlled trial was used to determine the effects of post-training PNF stretching and the traditional static stretching on the agility performance of volleyball varsity players. The participants were subjected to a matched assignment into a PNF stretching intervention group and a static stretching control group. Twenty-eight participants completed the study and all participants from both groups were assessed at baseline and after 3 weeks. A blinding method was used to create anonymity among the researchers, assessors, implementors and participants to prevent contamination of the results.

### Participants

The participants were recruited for inclusion in this study on October 2018. Seven schools with volleyball teams within Batangas were selected, however, only two schools participated. Participants were considered qualified for the study if they are young adults (18-25 years old) who have been training for a volleyball varsity team for at least 12 months. Those who have a history of musculoskeletal injury involving the lower limbs within the past six months, an abnormal body mass index (BMI), an abnormal muscle length test (MLT) range and smoking habit were excluded from this study.

All participants signed an informed consent prior to the conduct of the study. A total of 28 competitive male and female volleyball players from the two schools passed the criteria. All participants, as well as their coaches and trainers were informed about the benefits, demands and potential risks of the study. No monetary incentives were provided.

### Outcome Measures

I. **3-Cone Drill**: This test assesses change of direction, acceleration, body position and movement technique of the setters (Dawes and Roozen, 2012). Three marker cones are placed to form an "L" pattern with 5 yards apart. A stopwatch is required to record the laps completed. The participant was in down-hand position from the 1$^{st}$ cone and sprints forward to touch the 2$^{nd}$ cone followed by a 180° turn to return to the previous cone. Another 180° is performed before reaching the 2$^{nd}$ cone, executed a 90° turn to the right, and sprinted toward the third cone. At this point, the participant turns around to the left, and sprints back by passing to the 2nd cone to reach to the 1st cone. The time to complete the test is recorded in seconds. The shorter the time, the more agile the setter is. Reliability of this test is high with an intraclass correlation of 0.962 (Mann, et al., 2016).

II. **Hexagon Agility Test**: This test measures body control in a sustained balance position of the hitters (Dawes and Roozen, 2012). A hexagon, 60 cm long of each side, is drawn on the ground and a stopwatch is needed for this test. The participant is positioned in the center of hexagon with the face positioned to the front and feet together. The participant jumps over the hexagon line then return to the center of hexagon and then complete all the sides of hexagon in a direction of clockwise. The unit of time in seconds spent by the participant in completing three rounds of jumps in a hexagon is recorded. The shorter the time, the more agile the hitter is. Reliability of this test is high with an intraclass correlation of 0.924 and an MDC of 1.015 seconds (Beekhuizen, et al., 2009).

**Procedure**

All participants performed a 3-week regular flexibility training program. A licensed physical therapist was assigned for the PNF stretching intervention group and another for the traditional static stretching control group to demonstrate and supervise the respective stretching protocol during the cool-down period every training day for the 3-week study duration. Prior to the start of the study, all participants were assessed at baseline for the outcome measures by the blinded assessors.

The static stretching control group participants did their usual static stretching exercise which was passive static stretching. The stretch was maintained for approximately 5 seconds on each muscle groups of both upper and lower limbs, done once during the cool down period.

The PNF stretching intervention group participants were taught to perform an active PNF contract relax – agonist contract (CRAC) cycle using an inelastic strap. This technique required the participants to move the extremity to the end-range until a mild stretch sensation is felt followed by a 5-second isometric contraction. The technique continues with a 5-second relaxation then concentric contraction of the antagonist muscle for 15 seconds (Kisner et al., 2018). This cycle was performed for five repetitions with enough rest intervals as needed by the participant. The muscles that were stretched are the bilateral rectus femoris, hamstrings and gastrocnemius.

All participants were re-assessed after 3 weeks of performing their assigned stretching exercises during the cool down period to determine improvements in agility performance.

**Statistical Analysis**

Descriptive and inferential statistics were used in this study. The data were analyzed using SPSS Statistics 25. The Levene's t-test of Homogeneity was used to establish equality in characteristics of the participants at baseline. Differences between groups were examined using independent T-test while dependent T-test was operated to assess differences in each group with time (pre and post-test). All statistical level of significance was set at $p<0.05$

**Ethical Consideration**

The protocol was reviewed and approved by the Lyceum of the Philippines University – Batangas Research Ethics Review Committee. All participants signed a letter of consent prior to participation in the study and were informed about the research objectives and its social significance. All participants were guaranteed that their data will be kept confidential and will be used solely for research purposes.

## RESULTS AND DISCUSSION

**Table 1**

Baseline values of the participants

| | Static Stretching (n=14) | PNF Stretching (n=14) | p-value |
|---|---|---|---|
| **Playing Position** | | | 1.000 |
| Setters | 2 | 2 | |
| Hitters | 12 | 12 | |
| **Sex** | | | 0.699 |
| Male | 10 | 9 | |
| Female | 4 | 5 | |
| **Age** | 18.36±0.50 | 18.86±1.41 | 0.221 |
| **BMI** | 21.08±1.25 | 20.85±1.84 | 0.705 |
| **Hamstrings** | | | |
| Right | 80.36±11.68 | 85.00±7.60 | 0.224 |
| Left | 74.64±14.21 | 82.86±11.39 | 0.103 |
| **Gastrocnemius** | | | |
| Right | 19.64±1.34 | 20.00±0.00 | 0.327 |
| Left | 19.64±1.34 | 20.00±0.00 | 0.327 |
| **Rectus Femoris** | | | |
| Right | 133.57±4.13 | 132.86±4.26 | 0.656 |
| Left | 134.64±1.34 | 132.14±5.45 | 0.107 |
| **3-Cone Drill** | 7.33±0.00 | 7.34±0.94 | 0.995 |
| **Hexagon Agility Test** | 18.53±1.17 | 18.70±1.23 | 0.738 |

*Mean ± Standard Deviation*

Table 1 shows that all participants are homogeneous in terms of playing position, sex, age, BMI, MLT values of bilateral hamstrings, rectus femoris and gastrocnemius, and pre-test results of agility tests for setters (3-cone drill) and hitters (hexagon agility test) at baseline. Homogeneity was established to ensure that the intervention solely caused the results of the study.

After 3 weeks of intervention, the primary outcome measurement, in particular the hexagon agility test results differed in the hitters of the 2 groups with a mean of 18.14 in the PNF intervention group compared with 18.33 in the static stretching control group (Table 2). Furthermore, a statistically significant difference was found on the hitters of PNF stretching intervention group based from the mean result of the pre and post hexagon agility test (p= 0.005). The aforementioned findings indicate that PNF stretching administered as a post-training exercise for volleyball varsity players is an effective flexibility exercise in improving agility. The significant difference between the intervention and the control group was consistent with the study made by Hindle et al., (2012) which demonstrated that when PNF stretching is executed consistently after exercise, it improves athletic performance along with range of motion. Moreover, the systematic review of Behm, et al., (2016) revealed that PNF stretching is not just proven effective in increasing flexibility but also results in small-to-moderate changes in performance such as agility related to athletic environments.

According to Kisner et al., (2018), the physiology underpinning the positive effects of PNF stretching is the interaction of complex mechanisms of sensorimotor processing and continuation of viscoelastic adaptation of the muscle-tendon unit and changes in a patient's tolerance in the execution of stretching maneuver. In addition, Jothi and Jose (2015) corroborated this positive effect of PNF stretching when they asserted that stretch receptors adjust to the improved range of muscle length immediately after an isometric contraction of the target muscle.

On the other hand, the hitters of the static stretching control group demonstrated no significant difference between their pre- and post-hexagon agility test (p= 0.109). This result confirmed the findings of the research conducted among tennis players by Vaghela and Parmar (2013) which concluded that static stretching has no effect on agility performance. Furthermore, the literature reviewed by Peck et al. (2014) revealed that static stretching reduced sprint speed for speed and agility-dominant sports. In fact, Chatzopoulos, et al., (2014) proved that static stretching may have deleterious effect on agility.

Table 2 shows that there are no significant differences in agility between the setters of the 2 groups in the 3-Cone Drill test. This finding can be attributed to the limited number of setters in each group.

**Table 2**

Comparison of the effects of PNF stretching and static stretching

| Setters: 3-Cone Drill | Pre-Test | Post-Test | P-value |
|---|---|---|---|
| **Static Stretching** (n=2) | 7.33±0.00 | 7.33±0.00 | * |
| **PNF Stretching** (n=2) | 7.34±0.94 | 6.67±0.94 | * |
| **P-value** | 0.995 | 0.423 | |

| Hitters: Hexagon Agility Test | Pre-Test | Post-Test | P-value |
|---|---|---|---|
| **Static Stretching** (n=12) | 18.53±1.17 | 18.33±1.09 | 0.109 |
| **PNF Stretching** (n=12) | 18.70±1.23 | 18.14±1.26 | 0.005 |
| **P-value** | 0.738 | 0.689 | |

*Mean ± Standard Deviation*

In interpreting the results, several limitations must be considered. The small sample size of setters as compared to the hitters may have affected the results of their agility test. In addition, the specific role of the players in the team influences their performance. Different playing positions in volleyball require different physical qualities to execute the demands of play. Paz et al. (2016) found that hitters were remarkably faster and scored higher on agility tests than setters, possibly indicating that due to their role on the sport, hitters become more agile than setters.

## CONCLUSION

PNF stretching administered as a post-training flexibility exercise of volleyball varsity players is an effective method in improving agility when compared with the traditional static stretching technique.

## RECOMMENDATIONS

The results of this study proposed that PNF stretching can be utilized or added in the cool-down period of the training program of volleyball varsity players. The promising results of this study need replication in a large-scale randomized controlled trial. The trial should be sufficiently powered and should include a specific playing position. Moreover, replication is also recommended in other agility-related sports populations. Other experimental designs may be utilized to assess comparability of results. Similarly, the validated outcome measures should be used and evaluated not just over the short-term period but also in the intermediate and long-term durations.

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