Galore International Journal of Health Sciences and Research
Vol. 8; Issue: 4; Oct.-Dec. 2023
Website: www.gijhsr.com
Original Research Article *P-ISSN: 2456-9321*

Study of Static Vs Proprioceptive Neuromuscular Facilitation Stretching of Tight Hamstrings, and Its Effect on Lower Limb Flexibility and Speed of Sprinter - A Comparative Study

Nallagatla Venkateshwarlu[1], Enrico Maria Staderini[2], Naveen Kumar Balne[3]

[1]Chief Physiotherapist, Sports authority of Andhra Pradesh, IGMC Stadium, Vijayawada, India.
[2]Prof. Enrico Maria Staderini, Tor Vergata University of Rome, Italy
[3]Faculty, Department of Physiotherapy, Nizam's Institute of Medical Sciences, Hyderabad, India

Corresponding Author: Nallagatla Venkateshwarlu

DOI: https://doi.org/10.52403/gijhsr.20230415

ABSTRACT

Background: Hamstring injuries are one of the most common injuries seen in sprinters, leading to reduction in flexibility and speed in sprinters. The study aimed at comparing the two most appropriate methods of hamstring stretching, i.e., static stretching (SS) and proprioceptive neuromuscular facilitation stretching (PNFS), in sprinters for the management of tight hamstrings and measurement of their effectiveness on flexibility and speed.
Materials and Methods: After ethical clearance and informed consent, 80 male subjects who met inclusion criteria were recruited and randomised into the SS (n = 40) and PNFS (n = 40) groups. Baseline data on age, height, weight, BMI, hamstring flexibility (knee extension deficit (KED) on active knee extension test (AKET), and speed parameters (30-metre sprint test) documented at the beginning of the study and at the end of the 12-week study period.
Results and Conclusion: subjects showed variable results. Flexibility differences within groups pre- and post-intervention were statistically significant, but not between groups, indicating both methods are effective on flexibility. The differences in speed components of athletes were statistically significant within and between groups. The PNFS group has shown better improvements than the SS group on speed testing. This may be attributable to the neurological mechanism involved in the contract-relax method, where muscle is elongated and tone is stabilised during the contraction phase of PNF stretching.

Keywords: static stretching, PNF Stretching, knee extension deficit, active knee extension test, 30-meter sprint test, Pheezee, Range of motion tool, Hamstrings flexibility, Hamstrings tightness.

1. INTRODUCTION

Sprinting is a sport where a person run as fast as he can over a short distance in a short amount of time. It depends on the flexibility of subject's lower leg muscles, especially the ones in the hamstrings (1). High-speed runners need to be able to control their hamstring muscles both when they are contracting and when they are relaxing. Hamstring muscle strain injuries have a high re-injury rate of 12–31%. Athletes need to be flexible to do well, and stretching strategies for flexibility can be either Static or dynamic. There are two classes of stretching: static and proprioceptive neuromuscular (PNF) which are commonly employed (2).
In sports like sprinting, hamstring strains are common and account for up to 29% of all injuries. Due to recurrence of hamstrings tightness, trainers and professionals need to be actively involved in getting people back to sports. Flexibility and strength of the hamstrings are controllable risk factors for

hamstring injuries. Exercises and knowledge on the mechanics of the hamstring muscles during running can help improve strategies for injury prevention and recovery. Having flexible hamstrings, muscles can help players move their hips and knees to take longer steps. Hamstring tightness caused by direct injury to muscles, excessive tissue strain, Musculo tendinous junctional strain, shortening and not loosening up enough, and insufficient training (3).

Different methods, like static and dynamic Proprioceptive Neuromuscular Facilitation (PNF) stretching, are popular and often used in sports and therapies to improve both active and passive range of motion (ROM) of Knee and Hip. Static and PNF stretching is often used as a warm-up before sports or training and make muscles more flexible and improve joint range of motion (4) (5). This study aims to validate the effectiveness of static and Proprioceptive Neuromuscular Facilitation (PNF) stretching procedures in improving flexibility and speed in sprinters. Hamstrings are common injuries that can lead to muscle tightness, reducing performance and speed (6). The optimal elasticity and length tension of the lower limb are crucial for speed enhancement. Despite previous research, there is limited conclusive evidence on the effects of these stretching methods on sprinter performance. The study provides evidence to clinicians and helps improve outcomes for sprinters by addressing the uncertainties surrounding the effects of static and PNF stretching.

Purpose: This study compares the effectiveness of static stretching (SS) and Proprioceptive neuromuscular stretching (PNFS) over tight hamstrings on speed and flexibility in sprinters. The objectives include documenting changes in hamstring flexibility in terms of knee extension deficit (KED), speed on 30-meter sprint test after hamstrings SS and PNFS, as well as comparing changes in flexibility and speed following the exercise protocol. The study aims to provide valuable insights into the benefits of stretching for sprinters.

2. METHODS

The research was conducted at the sports authority of Andhra Pradesh (SAAP), athletic academy, Acharya Nagarjuna University, Mangalagiri, Guntur, Andhra Pradesh, India. The study design is quasi experimental, with a sample size of 80 subjects, two groups (SS and PNFS) of 40 in each group. The sampling method is computer generated random numbers. The study includes subjects aged 16-22 years, males, sprinting with tight hamstrings (15 or more than 15 degrees of KED on AKET). Exclusion criteria include No positive health risks, No other conditions of lower limbs causing hamstring tightness, coordination problems, hyper mobile joints, uncooperative and disoriented subjects, and other conditions affecting hamstring function. Subject's demographic data like Age, Height, Weight, BMI, Speed and Flexibility was measured before and after 12 weeks of duration. 30 meters sprint test was done on an athletic synthetic running track for the speed testing. Knee extension deficit (KED) range of motion was measured on the Active Knee extension test (AKET) as measure of hamstrings flexibility using Pheezee device modules and electronic stopwatch for time measurement.

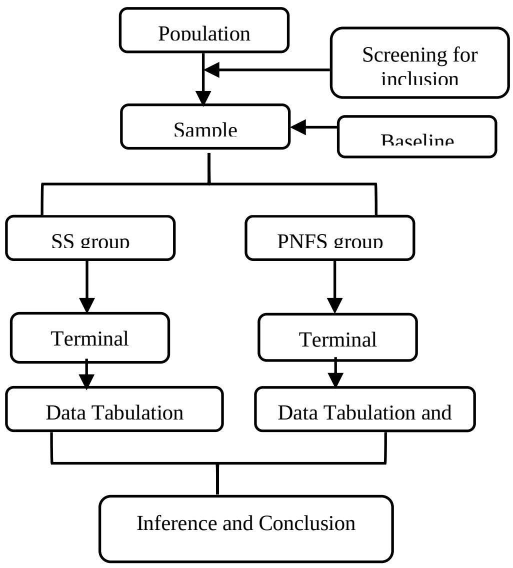

Figure 1:Study flow

2.1 The Active Knee extension test:
The Active Knee extension test (AKET) measures hamstring muscle flexibility by assessing knee extension deficit (KED) range of motion. The test involves a subject lying on a couch, extending their knee from 90 degrees hip flexion, and measuring the knee extension deficit using a Pheezee ROM device. Pheezee is a real-time digital device that measures range of motion (ROM) from joints in the human body. The device has an on-board ARM microcontroller and motion sensors for data acquisition and processing. It is made up of two modules (7). for knee ROM measurement modules are placed one above the knee and one below the knee, and has an ability of measuring Range of motion at accuracy of 96% compared to traditional goniometers. Participants were placed on a couch with their hip joint aligned at 90 degrees. Two Phezee device modules were affixed to their knee joints for experimentation. A zero-reference point was established before any movement. The angular displacement of the knee joint was visually represented on an android mobile application display. The knee extension deficit (KED) range of motion was documented as the hamstrings flexibility on active knee extension test (AKET) (8). The subjects performed AKET as trained by the therapist. The subjects' performance on the test was recorded for measurement of hamstrings flexibility (9) (10) (11).

2.2 The 30-meter sprint test
The 30-meter sprint test is a speed test designed to determine acceleration and speed metrics. It requires a marked track, stopwatch, cone markers, and a flat surface of at least 50 meters. Participants underwent health risk screening prior to test, obtained informed consent, and provided necessary information for test. The test area is accurately measured and outlined. Participants are instructed to perform a 30-meter sprint at their maximum velocity on a designated track, starting from a standstill posture with one foot in front of the other. The duration of the sprint is measured in units of seconds. The investigator offered suggestions on optimizing speed. The results are documented with precision to the nearest two decimal points, starting with the start-up of a stopwatch and concluding when the chest region crosses the designated ending point (12) (13).

Figure 2:Active Knee extension test

2.3 Static stretching:
Static stretching is a method where a muscle is held in a specific position for a predetermined period. This technique was performed in lying on the back. subjects knee was maintained in extended position while the lower limb is taken into hip flexion where two ends of the hamstrings muscle are strtched. In this study, "hamstring static stretching" involves elongating the hamstring muscle by applying external stress and maintaining this posture for 15 to 30 seconds. Static stretching aids muscle relaxation and enhances range of motion (ROM). To improve the outcome, a moist therapy was administered to the contracted hamstrings to induce relaxation and increased flexibility. The stretching exercise was performed daily, with three sets of ten repetitions, five days each week, for twelve weeks. The patient experienced no discomfort during the procedure (14) (15).

2.4 Proprioceptive neuromuscular facilitation stretch (PNFS):
Proprioceptive neuromuscular facilitation (PNF) is a widely used stretching technique in physical therapy and exercise science. The Contract-Relax Technique involves

passive stretching followed by an isometric contraction, typically applied by the therapist's hand. To improve the efficiency of the hamstring stretch, moist therapy is applied prior to stretch. The patient is positioned on a couch, and the therapist is in a stable position with their back straight and core muscles engaged. Both hands are placed on the distal part of the femur to prevent knee flexion during the stretch. It involves a sequence of stretches and contraction of muscle designed to improve an individual's flexibility. To prevent excessive strain and potential injury, each movement is carefully controlled and incrementally advanced (16). The subject's limbs are elevated until they experience a manageable sense of stretching in hamstrings, then subject is asked to contract muscle against therapist resistance, and the subject is progressively lowers the contraction for the remaining ten seconds. The PNF stretching method is repeated for each subject, starting with mild stretches and gradually progressing to deeper stretches. The muscle then enters a state of relaxation, leading to further stretching and an additional contraction (17).

3. RESULTS

The study involved 80 male sprinters with tight hamstrings, randomly assigned to either the SS(n=40) or PNFS(n=40) group. Data was collected on age, height, weight, BMI, speed, and hamstring flexibility. The study investigated the statistical significance of hamstring flexibility and speed within the SS and PNF groups using paired for within group and unpaired t-tests for between groups. The data was documented, tabulated, and graphically presented.

3.1 Demographic data:

Static stretch group had 40 subjects with average age of 18.75±1.94 years, with the range between 16 to 22 years. Height of 162.9±5.22 ranging between 155 – 170 cm, weight of 62.62±5.2 Kgs with the range of 56 - 72 cm and BMI of 23.69±2.73 with range of 19.38 - 29.17.PNF stretch group had 40 subjects with average age of 18.9±1.91years, with the range between 16 to 22 years. Height of 161.6±5ranging between 155 – 170 cm, weight of 64.87±5.36 Kgs with the range of 55-72 cm and BMI of 22.86±2.27 with range of 20.7-29.57 (Table 1: Demographic data)

Table 1: Demographic data

	Static stretch group		PNF stretch group	
	Mean± SD	**Range**	**Mean± SD**	**Range**
Age	18.75±1.94	16 - 22	18.9±1.91	16-22
Height	162.9±5.22	155 - 170	161.6±5	155-170
weight	62.62±5.2	56 - 72	64.87±5.36	55-72
BMI	23.69±2.73	19.38 - 29.17	22.86±2.27	20.7-29.57

3.2 Flexibility:

Hamstring flexibility in static stretching group showed a knee extension deficit of 27.1±3.84 degrees (range: 21-33 degrees) at the start of the research Following the trial, the average knee extension deficiency range decreased to 11.67±5.34 degrees (range: 5-25 degrees), indicating significant findings (p=<0.05). Hamstring flexibility in the PNF stretching group showed a knee extension deficit of 27.32±4.41 degrees (range: 19-35 degrees) at the start of the trial. After the study, the average knee extension deficiency reduced to 10.325±3.331, a significant reduction (p-<0.05) (range: 5-15 degrees) (Table 2: hamstrings flexibility in degrees) (Figure 3)

Table 2: Hamstrings flexibility in degrees

	Static stretch group (P Value :P=<0.05)		PNF stretch group (P Value :P=<0.05)	
	Mean± SD	**Range**	**Mean± SD**	**Range**
Hams flex pre	27.1±3.84	21 - 33	27.32±4.41	19-35
hams flex post	11.67±5.34	5 - 25	10.325±3.331	5-15

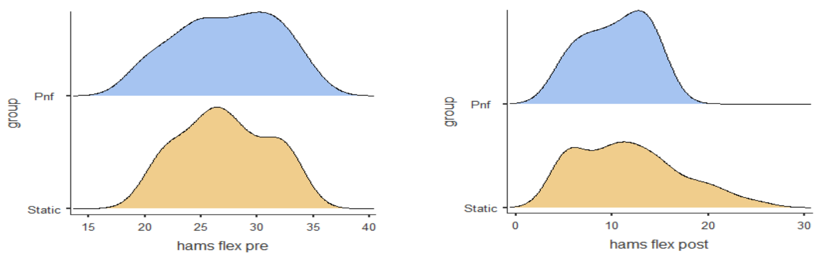

Figure 3: Hamstrings flexibility

3.3 30-metre sprint (Speed test):

The athlete's velocity was measured through a 30-metre sprint. At the start of the trial, athletes had an average speed of 5.72± 0.47 seconds, and at the end of study improved to 4.77± 0.45 seconds. The research showed statistical significance at $p < 0.05$. Proprioceptive neuromuscular facilitation (PNF) stretching group mean speed was 5.76 ± 0.455 seconds. The study found that athletes' average speed improved, to 3.99±0.26 seconds. Statistical significance was achieved since the p-value was less than 0.05 (Table 3: 30-meter sprint test time in seconds) (figure:4)

Table 3: 30- meter sprint test time in seconds

	Static stretch group (P Value :P=<0.05)		PNF stretch group (P Value :P=<0.05)	
	Mean± SD	**Range**	**Mean± SD**	**Range**
30mtr sprint pre	5.7±0.47	5.02 - 6.59	5.76±0.455	5.02-6.56
30mtr sprint post	4.77±0.45	4.02 - 5.52	3.99±0.26	3.55-4.41

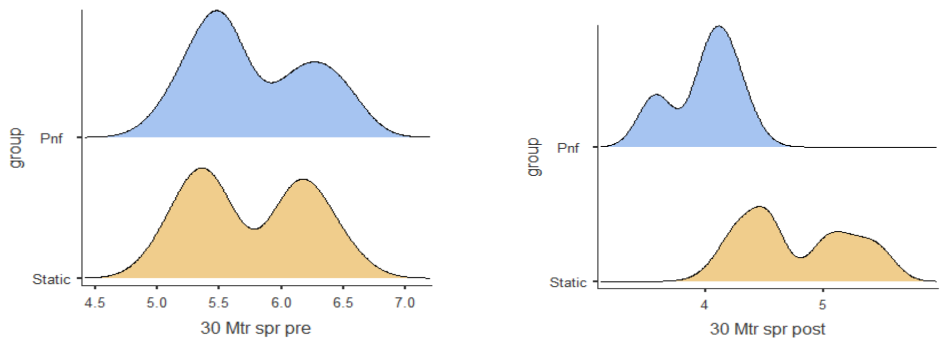

Figure 4:Thirty-meter sprint test

3.4 AKET test hamstring flexibility (KED): Group comparison:

The SS and PNF groups' pre- and post-Hamstrings flexibility (KED) scores were compared. Static stretching KED decreased from 27.1±3.84 to 11.67±5.34. The pre- and post-hamstring flexibility (KED) values of the PNF group showed a considerable increase, from 27.3±24.41 to 10.325±3.331. Although the Knee Extension Device showed substantial clinical increases in hamstring flexibility within each group. AKET test hamstring flexibility (KED). The statistical analysis showed no significant difference between the SS and PNF groups. Both groups improved clinicallyFigure 5: Hamstrings Flexibility (KED) on AKET test – between groups(Figure 5: Hamstrings Flexibility (KED) on AKET test – between groups).

3.5 30-metre sprint between groups:

The static stretching group showed a speed improvement from 5.7±0.47 to 4.77±0.45. Proprioceptive neuromuscular facilitation (PNF) training sessions led to a speed increase from 5.76±0.455 to 3.99±0.26 in the group. Both groups had similar mean speeds before the intervention. Analysis showed a statistically significant difference between SS and PNF (Figure 4:30-meters sprint results- Between Groups

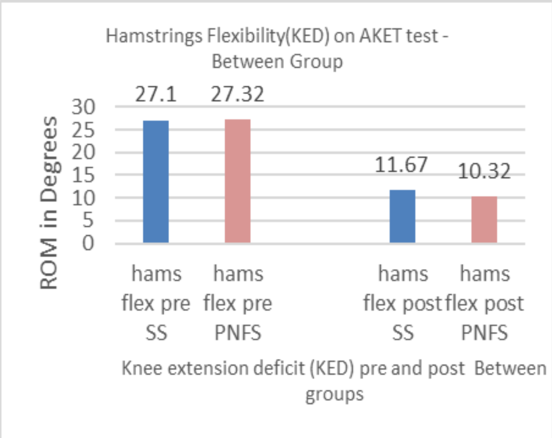

Figure 5: Hamstrings Flexibility (KED) on AKET test – between groups

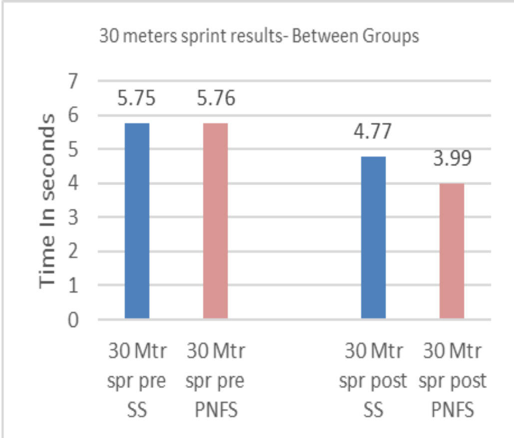

Figure 4:30-meters sprint results- Between Groups

4. DISCUSSION AND CONCLUSION

During the screening process, almost every participant had some degree of tightness in their hamstrings, suggesting that sprinters have the greatest likelihood of hamstring tightness (18). The study results showed an overall decrease in flexibility between both groups at the time of recruiting. This phenomenon could be attributed to the inherent diversity observed across the different components of the hamstrings muscles, such as the semitendinosus (ST), semimembranosus (SM), and biceps femoris (BF) (19). The participants were divided randomly into two groups after meeting inclusion criteria. Static stretching involves engaging in a slow, purposeful activity to elongate the muscle without discomfort. Proprioceptive neuromuscular facilitation (PNF) is a technique that involves contracting and lengthening targeted muscles simultaneously, enhancing muscle tone and facilitating early recovery (20). To ensure reliable results regarding the impact of hamstring flexibility on knee extension deficit (KED), the investigators utilized an instrument called Pheezee, which demonstrated its accuracy and reproducibility in measuring range of motion (21).

The static stretching group showed consistent clinical improvements in knee joint extension range of motion, particularly hamstrings flexibility similar to PNFS group. The proprioceptive neuromuscular facilitation (PNF) group showed superior performance in the 30-meter sprint than SS group as well as flexibility also. The contract relax PNF stretch technique triggers the inverse stretch reflex, aiding muscle recovery to its optimal position and preventing injury during the stretching process. Neurological activation plays a crucial role in the use of PNF stretching, as demonstrated in this study. The study also emphasizes the importance of evaluating running speed and joint movement in the lower extremities. Both static stretching and PNF stretching can improve flexibility and performance in running a 30-meter sprint faster. The study found that the PNF group displayed higher performance in the thirty-meter sprint.

5. CONCLUSION

The study focused on the benefits of proprioceptive neuromuscular facilitation (PNF) stretching and static stretching for improving hamstring flexibility and speed of sprinters. The PNF stretching technique, contract relax, was found to be the most effective method, triggering the inverse stretch reflex and aiding in muscle recovery and preventing injury during the stretching process. Both static and PNF stretching improved a person's flexibility and ability to run a 30-meter sprint faster but The PNF group had better results in speed tests compared to the static group. The neural mechanisms involved in muscle contractions in PNF stretch may explain the PNF group's better results. The study concluded that PNF stretching is an effective approach than Static stretch for enhancing not only flexibility and speed of sprinter while preserving muscle tone.

Informed consent was obtained from all participants

Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration by Authors

Ethical Approval: This research was reviewed and approved by Acharya Nagarjuna University, Ethics Committee, Guntur, Andhra Pradesh: Committee Review Letter no: EC-PhD/2020/Jan/Metricola/0282921, Dated 09.01.2020

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Giorgos P Paradisis, Panagiotis T Pappas et al. Effects of static and dynamic stretching on sprint and jump performance in boys and girls. Journal of strength and conditioning research. 2014 January; 28(1): p. 154-60.
2. F G Shellock, W E Prentice. Warming-up and stretching for improved physical performance and prevention of sports-related injuries. Sports medicine. 1985; p. 267-78.
3. Xianglin Wan, Shangxiao Li et al. Effects of flexibility and strength training on peak hamstring musculotendinous strains during sprinting. Journal of sport and health science. 2021 March; p. 222-229.
4. Kosuke Takeuchi, Masatoshi Nakamura, Shingo Matsuo et al. Effects of Speed and Amplitude of Dynamic Stretching on the Flexibility and Strength of the Hamstrings. Journal of sports science and medicine. 2022 December; p. 608-615.
5. Brandon Schmitt, Tyler Tim, PT, and Malachy McHugh et al. Hamstring injury rehabilitation and prevention of reinjury using lengthened state eccentric training: a new concept. International journal of sports physiotherapy. 2012; p. 333-341.
6. Carl M Askling, Magnus Tengvar, Tönu Saartok et al. Acute first-time hamstring strains during high-speed running: a longitudinal study including clinical and magnetic resonance imaging findings. American Journal of Sports Medicine. 2007 February; p. 197-206.
7. Sureshkumar Kamalakannan, Vijay Battina, Suresh Susurla V et al. Feasibility and acceptability of pheezee tm: a mobile phone-based wearable prognostic device for physical rehabilitation. International Journal of Pharmacy & Technology. 2021 June; 13(2).
8. Babina Rani, P P Mohanty. A Comparison between Two Active Stretching Techniques on. IOSR Journal of Dental and Medical Science. 2015 April; p. 12-16.
9. Russell T. Nelson, William D. Bandy. Eccentric Training and Static Stretching Improve Hamstring Flexibility of High School Males. Journal of athletic training. 2004; p. 254-258.
10. Akshata Chaphekar, Sneha Somarajan, Meeti Naik et al. Prevalence of Hamstrings Tightness Using Active Knee Extension Test among Diamond Assorters. Indian Journal of Public Health Research & Development. 2021 March; 12(2): p. 7-11.
11. R Gajdosik, G Lusin. Hamstring muscle tightness. Reliability of an active-knee-extension test. Physical therapy. 1983 July; 63(7).
12. Federico Nigro, Sandro Bartolomei, Franco Merni. Validity of different systems for time measurement in 30m-sprint test. In Youth Sport 2016; 2016; Lubiana. p. 104-108.
13. Warren Young, Andrew Russell, Peter Burge et al. The use of sprint tests for assessment of speed qualities of elite Australian rules footballers. International journal of sports physiology and performance. 2008 June; 3(2): p. 199-206.
14. Kosuke Takeuchi, Kazunori Akizuki et al. Association between static stretching load and changes in the flexibility of the hamstrings. Scientific Reports. 2021 November.
15. Slavko Rogan, Dirk Wüst, Thomas Schwitter et al. Static Stretching of the Hamstring Muscle for Injury Prevention in

Football Codes: a Systematic Review. Asian journal of sports medicine. 2013 March; 4(1): p. 1-9.
16. Lim, Wootaek. Optimal intensity of PNF stretching: maintaining the efficacy of stretching while ensuring its safety. Journal of Physical therapy science. 2018 August; 30(8).
17. Christopher S. Cayco, Alma V. Labro et al. Hold-relax and contract-relax stretching for hamstrings flexibility: A systematic review with meta-analysis. Physical Therapy in Sport. 2019 January; 35: p. 42-45.
18. Danny J McMillian, Josef H Moore, Brian S Hatler et al. Dynamic vs. static-stretching warm up: the effect on power and agility performance. 2006 August; p. 492-9.
19. Rant Freckleton, Tania Pizzari. Risk factors for hamstring muscle strain injury in sport: a systematic review and meta-analysis. 2013 April; p. 351-8.
20. Barta, Kristen. PNF stretching: Technique and guidelines. Health line. PNF Stretching: A How-To Guide. 2017 July 9.
21. Oung, Warren B. and Behm, David G et al. Should Static Stretching Be Used During a Warm-up for Strength and Power Activities? 2002 Dember; 24(6): p. 33-37.

How to cite this article: Nallagatla Venkateshwarlu, Enrico Maria Staderini, Naveen Kumar Balne. Study of static vs proprioceptive neuromuscular facilitation stretching of tight hamstrings, and its effect on lower limb flexibility and speed of sprinter - a comparative study. *Gal Int J Health Sci Res*. 2023; 8(4): 120-127.
DOI: https://doi.org/10.52403/gijhsr.20230415

******