

THE EFFECT OF STATIC, PROPRIOCEPTIVE NEUROMUSCULAR FASCILITATION AND DYNAMIC STRETCHING ON THE ACTIVATION OF HAMSTRING MUSCLE AMONG PREADOLESCENCE

Mohamed @ Mohd Sadek Mustaffa¹, Mohamad Nizam Nazarudin², Mohd Azemir Mustafa³,
Borhan Yusof¹, Mohd Radzani Abdul Razak⁴ & Tajul Arifin Muhamad⁴

¹Universiti Teknologi MARA, ²Universiti Malaysia Sabah, ³Ministry of Health Malaysia,

⁴Universiti Kebangsaan Malaysia

ABSTRACT

Introduction: Flexibility of the hamstring muscle can enhance performance in sports through prevention of injury, muscular and postural imbalance, maintenance of full range of joint movement and optimal musculoskeletal function (Schuback, Hooper & Salisbury, 2004). Sullivan, Murray & Sainsbury (2009) stated that decreased hamstring flexibility was suggested to be one of the predisposing factors for hamstring strains and hamstring stretches were routinely used as part of an exercise routine. **Purpose:** The purpose of this study was to determine the more effective stretching method between static, PNF, and dynamic stretching on the activation of hamstring muscles among preadolescence and its relationship with power. **Method:** This research employed pre and post experimental design which comparing between and within subjects. Eighty subjects were assigned to four groups consist of static, PNF, dynamic and control group. Each participant exhibited tight hamstrings. Tight hamstrings were defined as a 30 degree knee extension deficit with the hip at 90 degree as described by Bandy et al (1997) & Gajdosik et al (1983). All of the participants was sedentary and not athletes. They were selected based on the low result from SEGAK (National Physical Fitness Standard). Each of the group followed six weeks intervention program except the control group. Outcome measures were measured using pre and post test. Statistical analyses used were mixed between-within subjects ANOVA and Pearson product moment correlation. **Result & Discussion:** Hamstring muscle activation following interventions with PNF was superior compared to other forms of stretching ($p < 0.05$). Sit and reach test, $F(3, 76) = 25.57$; $p < 0.05$, knee flexion test (dominant leg), $F(3, 76) = 17.414$; $p < 0.05$, knee flexion test (non dominant leg), $F(3, 76) = 22.264$; $p < 0.05$. Relationship between sit and reach test with vertical jump, $r = -0.435$, $p < 0.05$. **Conclusion:** PNF stretching was the effective treatment compared to static or dynamic stretching, however moderate and inverse relationship between flexibility and power.

Keywords: Proprioceptive neuromuscular facilitation, dynamic stretching, hamstrings activation.

Introduction

Flexibility of the hamstring muscle can enhance performance in sports through prevention of injury, muscular and postural imbalance, maintenance of full range of joint movement and optimal musculoskeletal function (Schuback, Hooper & Salisbury, 2004). Sullivan, Murray & Sainsbury (2009) stated that decreased hamstring flexibility was suggested to be one of the predisposing factors for hamstring strains and hamstring stretches were routinely used as part of an exercise routine. According to Nelson et al (2004), stretching was the way or method to gain flexibility in our body. This was similar with a statement suggested by Zakas, Grammatikopoulou,

Zakas, Zahariadis & Vamvakoudis (2006), in which they had found out that stretching, helped the biochemical accuracy of competitive movements by improving the muscle function with increasingly raised the body temperature, decreased the muscle stiffness and increased the range of motion (ROM) at the joint, especially at the lower extremity (hip flexion, hip abduction, knee flexion and knee dorsiflexion, and also trunk flexion).

According to Rowlands et al (2003), there were two types of PNF, which were: a. contracted-relax-contraction (CRC) that the procedures lead to increase tension on the Golgi Tendon Organ (GTO) through the isometric contraction, b. contract-relax-agonist-contraction (CRAC) methods that the procedures utilized additional reflexes in the form of reciprocal inhibition. The third type of stretching was dynamic stretching which Yamaguchi & Ishii (2005) said that dynamic stretching of muscle groups of the lower limbs enhanced leg extension power. The intensity of dynamic stretching should vary according to the level of athlete or the person involved especially to the preadolescence and should not cause undue fatigue. From all of this advantage and positive effects of stretching not only able to be applied to the athlete and sports setting, but for the general population as well especially to the preadolescence in which it would be very good in adapting flexibility for their body. In some cases, they're better than adolescence as study by Koley & Singh (2008) shows that children between the ages of 5-9 years old had greater upward rotation of shoulder than adults. Relationship between flexibility and power was very important to identify because according to Duncan et al. (2006) there may be some advantage to performing a low to moderate stretching prior to activities that require high power outputs. This proof can be further confirmed with this study.

Background of study

There has been growing confusion among physical fitness practitioners especially teachers and coaches on which particular type of stretching method should be chosen. There was a debate about which one stretching protocols was more effective as we can see that the past researchers were given conflicting opinions among each other. Young, Elias & Power (2006), said that static stretching remain a popular method of increasing the ROM at a joint (flexibility) but differed with Spornoga et al (2001), which they said a number of previous studies had demonstrated that Proprioceptive Neuromuscular Facilitation (PNF) stretching techniques produced greater increase in ROM than passive, static or ballistic stretching methods. But differ with Yamaguchi et al (2005) said that dynamic stretching enhances muscular performance. So, this study was focus in determine on which particular type of stretching method was more effective among static, PNF or dynamic stretching towards the activation hamstring muscle among preadolescence.

Problem Statement

Although there had been significant research on static, PNF and dynamic stretching, the participants that were involved in previous research were reported as post adolescence athletes and physically active individuals. Studies on static, PNF and dynamic stretching on untrained individuals and preadolescence were lacking. It was understood that, post adolescence and preadolescence had different body capabilities and therefore we cannot generalize those post adolescence with the results to preadolescence respectively. Therefore, there was clearly a need for further research on the effects of different stretching protocols on untrained preadolescence.

Purpose of the Study

The purpose of this study was to determine the more effective stretching method between static, PNF, and dynamic stretching on the activation of hamstring muscles among preadolescence and its relationship with power.

Objective of the Study

The objectives of the study were,

- a. To determine difference between pre and post test of sit and reach, knee flexion and vertical jump test following static, PNF and dynamic stretching.
- b. To determine difference in sit and reach, knee flexion and vertical jump test between group of static, PNF and dynamic stretching.
- c. To determine relationship between flexibility and power.

Methods

Study design & sample

This research employed pre and post experimental design which comparing between and within subjects. The subjects for this study come from Sekolah Kebangsaan Taman Desaminium, Taman Lestari Perdana, 43300, Seri Kembangan, Selangor Malaysia. Sample participants followed the literature and effect size meaningfulness.

Description of sample

Before data collection, power analysis to determine a prior number of participants needed to provide sufficient power so that probability of rejecting type II error (accepting the null hypothesis when it was false) will not happen. Power gives probability of making a correct decision by detecting real differences. Since null hypothesis always be false in meaningful behavioral studies, having statistical power increases the odds of making correct decision.

Internal validity

History, maturation, instrumentation, experimental mortality and additional threats such as Pygmalion effect, Hawthorne effect,

Instrumentation

Sit and reach test, Knee flexion test and Vertical jump test

Data collection procedure

All eighty participants were divided into four groups with using randomized selection. The division of groups follow their stretching method with first group or Group A (n=20) performed static stretching. The second group or group B (n=20) performed PNF stretching and the third group or group C (n=20) performed dynamic stretching. The fourth group or group D (n=20) performed no training program.

Intervention phase

This experimental research lasted for six weeks (refer appendix G for manual stretching exercise). The training programs involved three meetings per week for six weeks to see the effect of the stretching on their flexibility ability. The stretching protocols were done in one period of time in physical education subject (30 minutes).

Post intervention phase

After the 6 weeks training program, there was a post-test to measure the improvement of their flexibility and relationship of flexibility and power. The flexibility level measured using sit-and-reach (SR) test and knee flexion test again. Relationship of flexibility and power were measured using vertical jump test.

Results

Difference in sit and reach test within groups

TABLE 1: Descriptive statistics of pre and post for sit and reach test

Group	Mean pre-test	Mean post-test	SD pre-test	SD post-test
1) Control	15.1500	15.0000	3.32890	3.38728
2) Static	17.5500	19.5000	2.06410	2.23607
3) Dynamic	20.0500	21.6750	3.49398	3.97451
4) PNF	20.1000	21.9250	5.21788	5.08422

In the table above, for the pre sit and reach test, the scores were in ascending order with the control group has the lowest mean score of 15.15 (± 3.33), followed by static group, 17.55 (± 2.06) and dynamic group, 20.05 (± 3.5). PNF group has the highest mean which was 20.1 (± 5.22). In post sit and reach test, the order was remained the same. The control group scored a mean of 15.0 (± 3.39), followed by static group with 19.5 (± 2.24), dynamic group with 21.68 (± 3.97) and the highest mean score was PNF group with 21.93 (± 5.08). The total mean for pre test were 18.21 (± 4.17), while for post test were 19.53 (± 4.67). Each of the group consisted of 20 subjects. Therefore, the total subjects in this study were 80 (n=80).

Difference in knee flexion test (dominant leg) within groups

TABLE 2: Descriptive statistics of pre and post for knee flexion test (dominant leg)

Group	Mean pre-test	Mean post-test	SD pre-test	SD post-test
1) Control	136.20	135.85	7.59917	7.74104
2) Static	136.45	135.80	9.07556	8.76956
3) Dynamic	142.30	145.95	3.96166	3.64872
4) PNF	142.15	147.70	3.32890	2.02874

In table above, the highest mean score in pre test was dynamic group, 142.30 (± 3.96), followed by PNF group, 142.15 (± 3.33). Both static group and control group scored almost the same mean score; static group was 136.45 (± 9.07) and control group was 136.2 (± 7.6). In post test, PNF has the highest mean, 147.7 (± 2.03) followed by dynamic group with 145.95 (± 3.65) and control group, 135.85 (± 7.74). The lowest mean score was static group with 135.8 (± 8.77). The total mean for pre test was 139.28 (± 7.0), while for post test the total mean was 141.33 (± 8.25). Each group consisted of 20 subjects, therefore the total subjects involved in this study were 80 (n=80).

Difference in knee flexion test (non-dominant leg) within groups

TABLE 3: Descriptive statistics of pre and post for knee flexion test (non-dominant) leg

Group	Mean pre-test	Mean post-test	SD pre-test	SD post-test
1) Control	135.70	135.80	7.63717	7.58530
2) Static	134.90	135.35	8.65052	8.27981
3) Dynamic	142.55	144.05	4.11000	4.23612
4) PNF	143.30	145.30	3.78501	4.01445

In the table above, the highest mean score in pre test was PNF group, 143.30 (± 3.79), followed by dynamic group, 142.55 (± 3.79) and control group, 135.70 (± 7.64). Static group has the lowest mean which was 134.90 (± 8.65). In post test, the order was remained the same. The PNF group scored a mean of 145.30 (± 4.01), followed by dynamic group with 144.05 (± 4.24), control group with 135.80 (± 7.59) and the lowest mean score was static group with 135.45 (± 8.28). The total mean for pre test were 139.11 (± 7.38), while for post test the mean were 140.12 (± 7.73). Each of the group consisted of 20 subjects, therefore the total subjects involved in the study were 80 (n=80)

Difference in sit and reach test between subjects

TABLE 4: Tests of between subjects effects for sit and reach test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta ²
Intercept	56964.756	1	56964.756	2.046	.000	.964
Group	923.256	3	307.752	11.052	.000	.304
Error	2116.237	76	27.845			

The table above showed the tests of between-subjects effects for independent variables, stretching groups (control, static, PNF and dynamic). The Sig. value is .000. As p was less than 0.05, it can be conclude that the main effect for group was significant. There was a significant different in the flexibility between static, PNF and dynamic stretching groups (those who received static, PNF and dynamic stretching intervention). The effect size of the between subject effect can be saw in the Partial Eta Squared, and value for group was .304. This was moderate effect size and achieved desired effect size.

Difference in knee flexion test (dominant leg) between subjects

TABLE 5: Tests of between-subjects effects for knee flexion test (dominant leg)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3149454.400	1	3149454.400	4.202	.000	.998
Group	2869.100	3	956.367	12.759	.000	.335
Error	5696.500	76	74.954			

The table above showed the tests of between-subjects effects for independent variable, groups of control, static, dynamic and PNF. The result can be reported as $F(3, 76) = 12.759$, $p < 0.05$. As p was less than 0.05, it can be conclude that there was a significant main effect for control, static, dynamic and PNF group on the pre and post for knee flexion test.

Difference in knee flexion test (non-dominant leg) between subjects

TABLE 6: Tests of between-subjects effects for knee flexion test (non dominant leg)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3118943.256	1	3118943.256	3.861E4	.000	.998
Group	2825.069	3	941.690	11.658	.000	.315
Error	6139.175	76	80.779			

The table above shows the tests of between-subjects effects for groups (control, static, dynamic and PNF). The result can be reported as: $F(3, 76) = 11.658$, $p < 0.05$. As p was less than 0.05, it can be conclude, there was a significant main effect for groups. There was a significant difference on overall between control, static, dynamic and PNF group on the pre and post knee flexion tests for non dominant leg scores.

As a conclusion from between-subjects effect, there was a significant difference between groups with Wilk's Lambda = 0.532, $F(3, 76) = 22.264$; $p < 0.05$, partial eta² = 0.468. There was

also a significant effect for between-subject effects in pre and post knee flexion tests for non-dominant leg with Wilks' Lambda = 0.396, $F(1, 76) = 116.0$; $p < 0.05$, partial $\eta^2 = 0.604$. These results suggested that there were effectiveness in the treatment approaches as both pre and post tests showed significant differences for dynamic and PNF group. PNF group showed the most effective treatment for increasing the range of motion in knee flexion for non dominant leg. Therefore, second null hypothesis was rejected because there was a significant different between post test in knee flexion test (non dominant leg).

Relationship between flexibility and power

TABLE 7: Pearson product-moment correlation between flexibility and power

	Pre sit & reach	Post sit & reach	Pre vertical jump	Post vertical jump
Pre sit & reach	-	0.969	-0.339	-0.056
Post sit & reach	0.969	-	-0.336	-0.435
Pre vertical jump	-0.339	-0.336	-	0.535
Post vertical jump	-0.056	-0.043	0.535	-

There was a moderate, negative correlation between the two variables, pre vertical jump test and pre sit and reach test; $r = -0.339$, $n = 80$, $p < 0.05$ and post vertical jump test and post sit and reach test; $r = -0.435$, $n = 80$, $p < 0.05$. Both pre and post tests of the two variables were strong, positively correlated with each other with pre and post vertical jump tests; $r = 0.535$, $p < 0.05$ and pre and post sit and reach tests; $r = 0.969$, $p < 0.05$. Therefore, null hypothesis was rejected.

Discussion

For hypothesis one, it was rejected because there was a significant difference between pre and post test following static, PNF and dynamic stretching. Hypothesis two, it was also rejected because there was a significant difference in post test results of three tests, sit and reach, knee flexion and vertical jump test following static, PNF and dynamic stretching intervention.

Meanwhile, for hypothesis three, from the result of Pearson Product Moment Correlation between flexibility and power, the null hypothesis was rejected too. There was a significant difference among both of it as we can see the moderate, negative correlation between the two variables. Both pre and post tests of the two variables were strong, positively correlated with each other. It can be concluded that flexibility was giving significant different in determine relationship between flexibility and power.

From the results, it showed effectiveness in the treatment approaches as both pre and post tests showed significant differences. From sit and reach test, we can see three groups of static, PNF and dynamic group increased in scores during post test compare to the pre test. As expected control group did not showed any improvement in fact it slightly declined in the post test of sit and reach. For the second test with involve knee flexion test for dominant leg, it can be seen that two groups (PNF and dynamic) increased in the post test compare to the pre test. But not for the both static and control group. This may be due to lower effectiveness of the static stretching in activating hamstring muscles compare to other stretching protocols. And once again, PNF group showed greater increased as compare to dynamic group.

The third objective to determine relationship between flexibility and power, there was a moderate, negative correlation between the two variables, the results indicated that a high muscle power during pre vertical jump test associated with lower muscle flexibility during pre sit and reach test. A high muscle power during pre vertical jump also associated with lower muscle flexibility in post sits and reach test. Both pre and post tests of the two variables were strong, positively correlated with each other. It showed that, higher flexibility would produce lower muscular power ability.

Conclusion

This finding suggest that PNF should be practiced among preadolescence because it effectively activating hamstring muscles. The teacher and coaches can practice PNF stretching rather than practicing static or dynamic stretching. We can found the inverse relationship between flexibility and power which participants with lower flexibility score better performance in vertical jump compare to the participants with higher flexibility score.

Recommendation for Future Study

This study recommendation for future study:

- 1) Researchers must try to focus more to the level of flexibility ability for their subjects to reduce the risk of injuries and also prevent the subjects from get injuries.
- 2) Researchers can combine their method of training to give participants both benefits, like combine flexibility and power training together, this is more effective and fast result can be seen.
- 3) Furthermore, more research should be done on more students in more primary schools in Malaysia. Perhaps it will help the physical education teachers with the variety of stretching exercise that can be applied in their physical education class rather than just embarking students with just playing around during the physical education class without any directions and objectives.

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