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Original Research Article

STATIC STRETCHING VS HOLD RELAX (PNF) ON SUSTAINABILITY OF HAMSTRING FLEXIBILITY IN SEDENTARY LIVING COLLEGE STUDENTS

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ABSTRACT

Objective: This study was design to determine the either the static stretching or Proprioceptive Neuromuscular Facilitation (PNF) stretching technique have the greater effect on improving hamstring muscle flexibility and maintaining the gain flexibility after a one time stretching on sedentary living college student's population.

Materials and Methods: After the university research ethical committee have given the approval for the study those who fulfilled the selection criteria were invited to participate in this experimental study. This study design was Quasi experimental study where the 2 groups (Group A: Static stretching, n=15 and Group B; PNF stretching, n=15) of sedentary living subjects underwent one-time stretching. This study was conducted at Asia Metropolitan University, Cheras, Selangor, Malaysia. Hamstring tightness was determined as knee extension deficit (KED) using the active knee extension test (AKET) for pre-test and post-test using universal goniometer. Inclusion criteria were active knee extension test (AKET) of 20 degrees and above, right side hamstring tightness, both sex and age group between 18-25 years. They did not have any history of neurological abnormality, and previous injuries or disorders of the lower back or lower extremities.

Results: Paired 't' test of stretching group shows that there was a significant improvement in the hamstring flexibility after 1 time static stretching for right leg among sedentary lifestyle college students. Here, the t-value of 3 post-test measurement; t-value of 1st minute = -8.814 ($p<0.05$), t-value of 15th minute = -2.884 ($p<0.05$) and t-value of 30th minute = -2.609 ($p<0.05$). Paired 't' test of stretching group shows that there was significant improvement in the hamstring flexibility after 1 time PNF stretching for right leg among sedentary lifestyle college students. The t-value of 3 post-test measurement; t-value of 1st minute = -10.252 ($p<0.05$), t-value of 15th minute = -7.939 ($p<0.05$) and t-value of 30th minute = -4.837 ($p<0.05$). Independent 't' test was used to compare between groups the result shows there was no significant difference in hamstring muscle flexibility when compared between Static Stretching and PNF Stretching of 3 post-test measurements. The significant of 't' value of 1st minute = 0.144 ($p>0.05$), 15th minute = 0.649 ($p>0.05$), and 30th minute = 0.319 ($p>0.05$)

Conclusion: This study concluded that static and PNF stretching significantly effective in improving hamstring muscle range of motion when compared from pre-test with 1st minute post-test. However, the gained hamstring flexibility does not sustain longer on 15th minute and 30th minute measurement it gradually reduces when compared with post-test 1st minute. There was no significant effect between both the stretches by one-time stretching session.

KEY WORDS: Static stretching, Hold and relax, Hamstring flexibility, Active knee extension test, Knee range of motion.

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INTRODUCTION

The hamstring muscle functions are to actively flex the knee and extend the hip as in the motion. Hamstrings as a group of muscles, which has an impact on two joint systems, performs multiple functions, thus it is susceptible to various injuries. The 'normal' range of hip flexion (measured when lying flat on your back and raising the leg straight off the floor - knee straight) permitted by the hamstrings is in the region of 80-90 degrees. A range of hip flexion movement which less than 80 degrees are considered 'tight'.

Muscle "tightness" can be results from either an increase in tension from active or passive mechanisms. Actively, muscles can become shorter due to spasm or contraction; passively, muscles can become shortened through postural adaptation or scarring. However, hamstring muscle is the most common muscle that goes into shortens or tightness motion either the individual is living active lifestyle or sedentary lifestyle.

It has been proven that hamstring tightness is the main contributing factor which will lead to the risk of pathological conditions of the knee and spine [1,2]. One of the reason is that, tight hamstrings can cause the hips and pelvis to rotate back which leads to flattening the lower back muscle. Hence, back problems occur. Hamstring tightness is often an indicator of muscle weakness elsewhere. Weak and unstable of lower-abdominals and spinal erectors, which are the muscles of the lower back, can force the Hamstring to tighten to find stability during movement [1].

Tight hamstrings can also be responsible for postural problems and other back problems such as sacroiliac joint pain, as they will tend to pull the pelvis out of normal position [3]. Hamstring muscle activation is increased while executing activities of daily living such as walking, stair ascent, and stair decent between individuals with and without knee osteoarthritis. Altered muscle activation at the knee may interfere with normal load distribution in the knee and facilitate disease progression [4,5].

Flexibility is defined as "the range of motion available in the joint or a group of joints that is influenced by muscles, tendons, ligaments, and bones" [6]. Flexibility of hamstring has long been a concern of physical therapists and rehabilitation specialists, as well as physical educators and sport coaches. Claims have been made that increased flexibility resulting from stretching activities may decrease the incidence of musculoskeletal injuries, minimize and alleviate soreness, and improving athletic performance [6-9]. Many clinicians have recommended stretching is for the management of improve flexibility, but few have attempted to prove its effectiveness. Suggested benefits include improved athletic performance and functional gains [10]. In addition; stretching has maintained a time-honored role in health and fitness.

Definition of sedentary living activity is as "doing or requiring much sitting" and "not physically active", according to the Merriam-Webster Dictionary. An upcoming number of people involved in desk jobs, being in a stationary position in one location for at least eight hours a day. People assuming prolonged sitting position is susceptible to tight hip flexors, calves and hamstrings. Overall, sedentary living behaviors increased due to the computer and internet usage in the past decade. Thus, sedentary individuals are susceptible to inflexible or reconditioned hamstrings, while athletes and very physically active individuals are have healthy, well-conditioned hamstrings. Having tight hamstrings are common, yet not everyone prone to hamstring injury.

There are three different muscles stretching techniques as literatures are: Pre-Contraction stretch, Static stretch, and Dynamic stretches. While effects of different stretching are proven, yet the best particular stretching technique remains controversy [11]. The traditional and the most common type of stretching is static stretching, in which the hamstring muscle is held in a position up to a sensation of stretching is felt and this technique is repeated. This stretching can be performed actively and passively.

There are 2 types of dynamic stretching: active and ballistic stretching. Active stretching generally involves moving a limb through its full range of motion to the end ranges and repeating

several times. Ballistic stretching includes rapid, alternating movements or 'bouncing' at the end-range of motion; however, because of increased risk for injury, ballistic stretching is no longer recommended [12].

A variety of stretching activities have been presented in the literature in order to regain hamstring muscle flexibility. The most popular technique used is static stretching. Some other techniques, such as proprioceptive neuromuscular facilitation used to increase muscle flexibility.

Research done on duration of flexibility gains after a single session of stretching on 30 male military cadets using static and PNF method has shown the effect on hamstring flexibility [13]. Apparently, there is limited evidence regarding the effectiveness of static and PNF stretching on hamstring muscle on duration of flexibility gains after a single session of stretching for sedentary type of lifestyle population.

Objective of the study: This study was design to determine the either the static stretching or PNF stretching technique have the greater effect on improving hamstring muscle flexibility and maintaining the gain flexibility after a one time stretching on sedentary living college student's population.

MATERIALS AND METHODS

After the university research ethical committee have given the approval for the study those who fulfilled the selection criteria were invited to participate in this experimental study. This study design was Quasi experimental study where the 2 groups (Group A: Static stretching, n=15 and Group B; PNF stretching, n=15) of sedentary living subjects underwent one-time stretching. This study was conducted at Asia Metropolitan University, Cheras, Selangor, Malaysia. Hamstring tightness was determined as knee extension deficit (KED) using the active knee extension test (AKET) for pre-test and post-test using universal goniometer. Inclusion criteria were active knee extension test (AKET) of 20 degrees and above, right side hamstring tightness, both sex and age group between 18-25 years. They did not have any history of neurological abnormality, and previous injuries or disorders of the lower back or lower extremities.

Measurement tools: Universal goniometer was used to measure the hamstring flexibility of active knee extension range and General Practice Physical Activity Questionnaire was used to classify the level of living style.

Study procedure data collection: Study procedure was adequately explained to the subjects before obtaining their informed consent. Baseline Measurement: The baseline knee extension deficiency (KED) was measured using a universal goniometer. The subject performed the active knee extension test procedure as described by Spernoga et al (2001). The greater trochanter, the fibula head and the lateral malleolus of the subject were marked with a felt-tipped pen, and served as anatomical landmarks for the goniometric assessment [14].

With subjects lying on their left sides, the greater trochanter of the right femur, lateral femoral epicondyle, and lateral malleolus of right fibula were identified and marked with a black felt-tip marker to help ensure proper alignment for goniometric measurements. Subjects were positioned supine on an examination table with the hip flexed to 90 degree as measured by a goniometer.

Pre-stretch warm-up: Subjects in both groups (static stretch and PNF stretch) performed 5 AKEs with a 60-second rest period between repetitions [15].

Pre-test Measurement: The 6th AKE were recorded as pre-test measurement by performed the supine active knee extension test.

When the subject could not extend his lower leg any farther and that position was held approximately 2 to 3 seconds, while the investiga-tor positioned the goniometer's fulcrum on the lateral epicondyle, where the stable arm parallel to the femur and the movable arm parallel to the fibula, and pre-stretch hamstring ROM was measured [15].

Stretching Procedure:

Group A - Static stretch: Subject assumed in supine lying, right hip in 90 degrees of flexion, investigator passively extended the leg, until the subject first reported a mild stretch sensation, while left hip was securely strapped to the plinth. Held the right leg at the end of knee extension

for 30 second, and then slowly lowered the leg. Rest period of 15 seconds in between stretches. The investigator performed this sequence for 4 times [16].

Group B - PNF Stretch (Hold-relax): The investigator passively stretched the (right limb) hamstrings until the subject reported a mild stretch sensation and held that position for 7 seconds, while left hip was securely strapped to the plinth. Next, the subject performed sub-maximal isometric contraction of the hamstrings for 7 seconds by attempting to push his leg back against the resistance of the investigator. After the contraction, the subjects were asked to relax for 5 seconds. The investigator then passively stretched the muscle and held for another 7 seconds. The investigator performed this sequence for 5 times.

Post-test Measurement: The investigator performed AKE test (post-test) in both the group at 1st, 15th and 30th minutes after the final stretch and recorded the measurement.

Analysis of data: Paired "t" test was used to compare the pre and post test score of each individual group and independent "t" test was used to compare the difference between two groups. P <0.05 has considered as significant difference in effects of the study.

RESULTS

Table 1: Demographic physical characteristic for two groups.

GROUP	N	Age(Yrs.)	Height (M)	Weight (Kg)
		Mean(SD)	Mean(SD)	Mean(SD)
GROUP A	15	21.27(3.990)	1.72(0.08)	60.3(6.44)
GROUP B	15	20.93(2.374)	1.70(0.06)	61.6(7.62)

Table 2: Group A; Static Stretching.

Paired Samples Statistics Group A					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest AKET	135.6	15	7.908	2.042
	Post Test 1st Minute AKET	148	15	9.71	2.507
Pair 2	Pretest AKET	135.6	15	7.908	2.042
	Post Test 15th Minute AKET	142.87	15	11.307	2.919
Pair 3	Pretest AKET	135.6	15	7.908	2.042
	Post Test 30th Minute AKET	139.93	15	9.027	2.331

Table 2 Showing the data collection scores of 15 subjects from Group A. The data was taken before (Pre-test) and after (Post-test [1st, 15th & 30th Minutes]) one-time static stretching. The data mean score shows an improvement in hamstring flexibility in AKE Test.

Fig. 1: Showing the pretest & posttest mean difference scores (Group A).

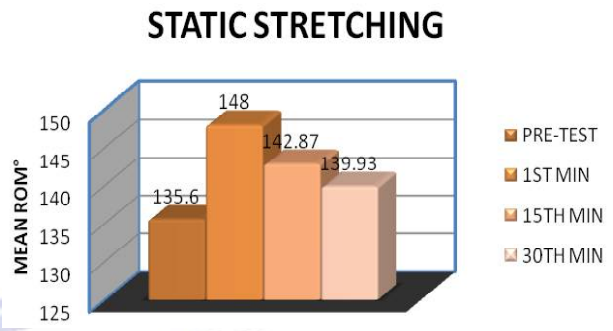


Figure 1 The bar chart shown an improvement in hamstring flexibility when compared the means of Pre-test and Post-test (1st min, 15th min, and 30th min) in Group A by using one-time static stretching protocol.

Table 3: Group B; PNF Stretching.

Paired Samples Statistics Group B					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest AKET	131.07	15	7.648	1.975
	Post Test 1st Minute AKET	147.53	15	8.008	2.068
Pair 2	Pretest AKET	131.07	15	7.648	1.975
	Post Test 15th Minute AKET	140.73	15	5.837	1.507
Pair 3	Pretest AKET	131.07	15	7.648	1.975
	Post Test 30th Minute AKET	139	15	6.856	1.77

Table 3 shows the data collection scores of 15 subjects from Group B. The data was taken before (Pre-test) and after (Post-test [1st, 15th & 30th Minutes]) one-time PNF stretching. The data mean score shows an improvement in hamstring flexibility in AKE Test.

Fig. 2: Shows the pretest & posttest mean difference scores (Group B).

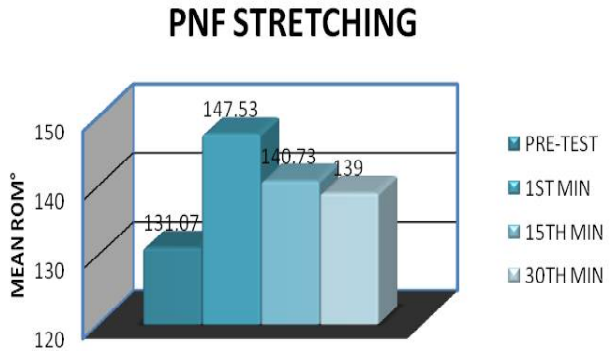


Figure 2 shows the bar chart shows an improvement in hamstring flexibility when compared the means of Pre-test and Post-test (1st min, 15th min, and 30th min) in Group B by using one-time PNF stretching protocol.

Table 4: PAIRED "t" TEST RESULT: Group A; Static stretch.

PAIRED 't' TEST GROUP A									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest AKET VS Post Test 1st Minute AKET	-12.4	5.448	1.407	-15.417	-9.383	-8.814	14	0
Pair 2	Pretest AKET VS Post Test 15th Minute AKET	-7.267	9.758	2.519	-12.67	-1.863	-2.884	14	0.012
Pair 3	Pretest AKET VS Post Test 30th Minute AKET	-4.333	6.433	1.661	-7.896	-0.771	-2.609	14	0.021

Table 4 Showing that there was a significant improvement in the hamstring flexibility after 1 time static stretching for right leg among sedentary lifestyle college students. Here, the t-value of 3 post-test measurement; t-value of 1st minute = -8.814 ($p<0.05$), t-value of 15th minute = -2.884 ($p<0.05$) and t-value of 30th minute = -2.609 ($p<0.05$).

Table 5: PAIRED "t" TEST RESULT: Group B; PNF Stretch.

PAIRED 't' TEST GROUP B									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the				
					Lower	Upper			
Pair 1	Pretest AKET VS Post Test 1st Minute AKET	-16.467	6.221	1.606	-19.911	-13.022	-10.252	14	0
Pair 2	Pretest AKET VS Post Test 15th Minute AKET	-9.667	4.716	1.218	-12.278	-7.055	-7.939	14	0
Pair 3	Pretest AKET VS Post Test 30th Minute AKET	-7.933	6.352	1.64	-11.451	-4.416	-4.837	14	0

Table 5 Shows that there was significant improvement in the hamstring flexibility after 1 time PNF stretching for right leg among sedentary lifestyle college students. The t-value of 3 post-test measurement; t-value of 1st minute = -10.252 ($p<0.05$), t-value of 15th minute = -7.939 ($p<0.05$) and t-value of 30th minute = -4.837 ($p<0.05$).

Table 6: INDEPENDENT 't'-TEST" comparison for both groups.

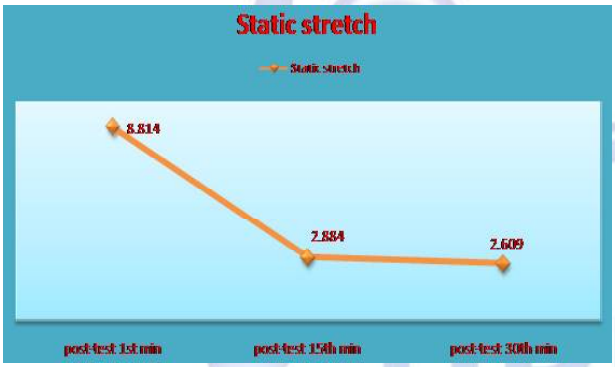
Independent Samples Test							
	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
First Minute AKET difference between 2 Groups	0.006	0.939	0.144	28	0.887	0.467	3.25
15 Minute AKET difference between 2 Groups	4.657	0.04	0.649	28	0.521	2.133	3.285
30 Minute AKET difference between 2 Groups	0.898	0.352	0.319	28	0.752	0.933	2.927

Table 6 Shows there was no significant difference in hamstring muscle flexibility when compared between Static Stretching and PNF Stretching of 3 post-test measurements. The significant of 't' value of 1st minute = 0.144 ($p>0.05$), 15th minute = 0.649 ($p>0.05$), and 30th minute = 0.319 ($p>0.05$)

Group Statistics					
	GROUPS	N	Mean	Std. Deviation	Std. Error Mean
Pretest AKET difference between 2 Groups	STATIC	15	135.6	7.908	2.042
	PNF	15	131.07	7.648	1.975
First Minute AKET difference between 2 Groups	STATIC	15	148	9.71	2.507
	PNF	15	147.53	8.008	2.068
15 Minute AKET difference between 2 Groups30	STATIC	15	142.87	11.307	2.919
	PNF	15	140.73	5.837	1.507
Minute AKET difference between 2 Groups	STATIC	15	139.93	9.027	2.331
	PNF	15	139	6.856	1.77

Table 7: Independent 't'-TEST" group Statistics.

Fig. 3: The plot chart shows 1st minute t-value from pre-test and gradually decrease in the 15th minute and 30th minute.



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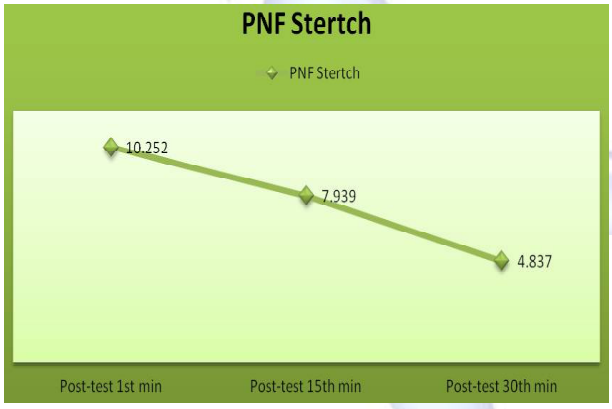
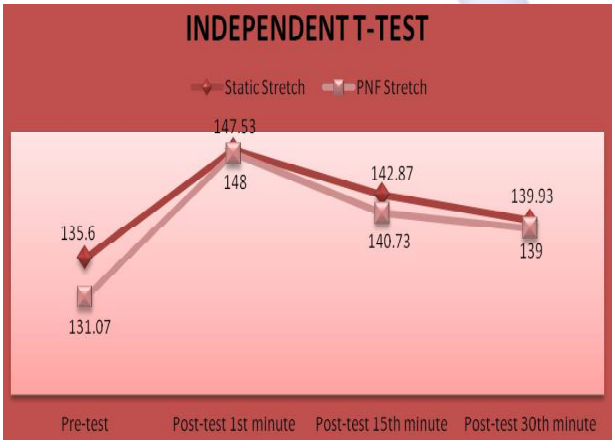


Fig. 5: Shows mean comparison of pre-pest and post-test AKET scores of 1st minute, 15th minute and 30th minute between Static Stretch and PNF Stretch.



DISCUSSION

Flexibility is an important physiological component of physical fitness, and reduced flexibility can cause inefficiency in the workplace and is also a risk factor for low back pain. Increasing hamstring flexibility was reported to be an effective method for increasing hamstring muscle performance [17].

The results of this study shows that, both the stretching were significantly effective in increasing hamstring flexibility on 1st minute, 15th minute & 30th minute of post-test measurement and also improving flexibility in 1st minute is more than that of 15th & 30th minutes. However, the study failed to reveal at which minute gained hamstring flexibility starts to reduce. This was supported a study done by Glen M. DePino et al using static stretching states that, hamstring flexibility is increased significantly but only remain for 3 minutes after the stretching. Another study was done by Scott G. Spernoga et al, states that using modified hold-relax stretching protocol, hamstring flexibility increased significantly but remain for 6 minutes after the stretching.

The relatively short time of increased hamstring flexibility of this study may be due to several factors. The most prominent are the viscoelastic and neural properties of the musculotendinous unit.

Musculotendinous units function in a viscoelastic manner, and, therefore, have the properties of creep and stress relaxation. Creep is characterized by the lengthening of muscle tissue due to an applied fixed load. Stress relaxation is characterized by the decrease in force over time necessary to hold a tissue at a particular length. The musculotendinous unit deforms or lengthens as it is being stretched

and goes through elastic and then plastic deformation before completely rupturing [18].

The results suggest that a single session of stretching does not deform tissues enough to produce a permanent change (i.e, a plastic deformation in the musculotendinous unit). Therefore, the temporary improvement in hamstring flexibility may be attributed to changes in the elastic region caused by a single session of stretching [13].

PNF stretching techniques suggest that autogenic inhibition of the stretched muscle provides increased ROM. Autogenic inhibition was defined as the inhibition of the homonymous muscle alpha motor neurons by the stimulation of the Golgi tendon organ. This inhibitory effect is thought to diminish muscle activity and, therefore, allow for relaxation so that the muscle can be stretched. Motor pool excitability significantly diminished after the PNF stretching. The ROM gains demonstrated in this study were temporary, a finding supported by the temporary inhibition of the motor pool with the PNF stretching technique [19].

Moreover, the studies subjects are not restricted to specific position to be followed after the stretch. Activities such as sitting alone are sufficient enough to be causing the hamstring muscle goes into tight or shorten. This is supported by Mc Gill (2000) who reported that during stationary activity such as chair sitting, the blood-muscle pump is not working. At 60% of maximal contraction of the muscle group, the blood flow is stopped and leads to tightness.

Independent 't' test result shows that there was no significant difference in hamstring muscle flexibility when compared between Group A; Static Stretching and Group B; PNF Stretching of 3 post-test measurements.

Limitations of study

· This study was conducted with less number of samples.

· Study duration limited up to 30th minute measurement only.

· This study measured only the short-term effects of 2 different stretching with no follow ups.

· This study failed to measure when the gained hamstring flexibility started to lose its flexibility within the study duration.

Research recommendations

· Compare study with other populations such as active life style population.

· Further study with longer follow up duration

Add more numbers of post-test measurements such as, 3rd min, 6th min and extra.

CONCLUSION

This study concluded that static and PNF stretching significantly effective in improving hamstring muscle range of motion when compared from pre-test with 1st minute post-test. However, the gained hamstring flexibility does not sustain longer on 15th minute and 30th minute measurement it gradually reduces when compared with post-test 1st minute. There was no significant effect between both the stretches by one-time stretching session.

ABBREVIATIONS

AKET: Above Knee Extension Test

PNF: Proprioceptive Neuromuscular Facilitation

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Conflicts of interest: **None**

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