LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

IMMEDIATE EFFECTS OF STATIC HAMSTRING STRETCHING PROTOCOLS ON FLEXIBILITY, RANGE OF MOTION, AND PAIN IN STRENGTH-TRAINED MALES

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1| ABSTRATCT:

Background: Keeping hamstrings flexible is important for strength-trained individuals, not only to boost performance but also to help prevent injuries. Static stretching is often used to improve flexibility and range of motion (ROM), but there's still some uncertainty about how different stretching styles affect the body in the short term—especially right before or after training.

Objective: This study set out to evaluate the immediate effects of two types of static stretching—**intermittent** (short stretches with rest in between) and **continuous** (one long, uninterrupted stretch)—on hamstring flexibility, ROM, and pain levels in trained young men.

Methods: Thirty healthy male strength trainers (ages 17 to 25) took part in the study. They were randomly split into two groups: one performed a 60-second **continuous stretch**, while the other followed an **intermittent routine** of two 30-second stretches with a 10-second rest in between. We used the **Sit-and-Reach Test** to assess flexibility, the **Popliteal Angle Test** for ROM, and a **Numeric Pain Rating Scale** to gauge discomfort—before and right after stretching. Results were compared using independent t-tests.

Results: Both stretching methods led to noticeable improvements in flexibility, ROM, and a reduction in pain ($\mathbf{p < 0.05}$). However, the **intermittent stretching group** showed slightly better outcomes in all areas:

- **Sit-and-Reach Test:** +1.43±0.44 cm (intermittent) vs. +1.20±0.38 cm (continuous)
- **Popliteal Angle (ROM):** +0.98±0.45° (intermittent) vs. +0.34±0.46° (continuous)
- **Pain Reduction:** -1.02±0.45 (intermittent) vs. -0.13±0.43 (continuous)

Conclusion: Intermittent static stretching (30-second holds with rest intervals) is more effective than continuous stretching for acutely enhancing hamstring flexibility and ROM while reducing discomfort. These findings support incorporating shorter, interrupted stretches into athletic warm-ups to optimize performance and injury prevention. **Keywords:** Flexibility, Hamstrings, Intermittent and Continuous Stretching, Popliteal Angle, Strength Training.

2| INTRODUCTION:

Flexibility is defined as "The ability of the joints or a group of joints, and muscles to move through a range of motion effectively unrestricted and pain free".[1] Flexibility is a crucial part when it comes to activity. Hamstring flexibility is imperial for the proper functioning of the body. Hamstrings play essential role in gait as well as sprinting.[2] Hamstring flexibility is often compromised in weightlifters. Poor flexibility reduces the ability of muscles to perform tasks of daily living and also make them prone to injury, especially injuries of musculoskeletal system. It also reduces the range of motion at respective joint eventually making the health status of a person very low. Their tightness effects the body from head to toe. It not only effects the lower limb muscles but also the curvatures of spine.[3] The more the flexibility, the better the range of motion is. But excessive flexibility can lead to the joint instability.

Static stretching has greater impact on hamstrings flexibility in previously injured subjects or lessens the probability of anticipating injuries. There is substantial proof to propose that static stretching concludes notable increase in flexibility than usual warm-ups and can be uphold with routine exercises. A study elucidates that the previously injured subjects indicate a considerable increase in ROM or flexibility than uninjured individuals after stretching (static stretching), However, this did not reach the statistical significance level. The outcomes stipulate that static stretching should be executed if the aim is to improve the flexibility. On the other hand, lack of flexibility can restrict the ROM of joint, cause muscle stiffness and even muscle strain. Muscles that are inflexible tire more quickly, causing opposing muscle to work harder.[4] As the hamstring muscles group cross and work over two joints – the hip joint and the knee joint – thus in this way they are called as bi-articular muscles. Semitendinosus and semimembranosus provide hip extension as the trunk is being fixed; they also flex the knee and medially (inwardly) rotate the lower leg when the knee is bent. The long head of the biceps femoris does hip extension, when starting to walk; knee flexion is carried out by both short and long heads and when the knee in bent it does the lateral (outward) rotation of the lower leg. Connective tissues are located all around the muscle and its fibers.

The range of motion is greater when there is more elastic component in the tissue. Connective tissues consist of fascial sheaths, tendons, and/or ligaments that cover, or wrap down

the muscles into several different groups. The fascia, get their names according to their location in the muscle i.e.; Endomysium: The inner layer of fascial sheath that wraps separate muscle threads. Perimysium: The middle fascial sheath that hold together groups of muscle fibers into single fasciculi. Epimysium: The outer layer of fascial sheath binding the entire fascicles. These sheaths of connective tissues provide ductility and tone to the muscle groups. In walking, hamstrings are most essential as an antagonist to quadriceps in deceleration of knee extension. The foremost purpose of the hamstrings is to flex the knee joint and extend the hip enabling some of crucial lower limb movements. The hamstrings have a prime stabilizing function. They are inactive when the body weight is equally distributed between both lower limbs in standing position. However, when a person starts tilting forward, these muscles counteract the tilting movement in order to stabilize the hip joint and prevent from falling. Also due to placement of their insertions, the hamstrings perform along with the collateral ligaments to stabilize the knee joint.

Hamstrings plays important role in the activity of daily living like jogging, walking and every other activity. The movement is carried out by the hamstrings include knee flexion and extension of trunk from bended position. Stretching is a type of physical activity in which a particular muscle/tendon (muscles group) is purposely flexed or stretched orderly to enhance the muscle's elasticity and attain good muscle tone.[5] Stretching is defined as the extension of muscle to its full length. Formerly it was only used for relaxing but now the world has changed a lot. Stretching has become a technique with a larger domain of interest. LC Decoster and J Cleland reported that stretching is a gold standard technique which improves the flexibility and range of motion of hamstrings.[6] The reason behind it is because it improves the hamstring extensibility and also improves hip proprioception immediately after the session.[7] Stretching is relaxing and non-competitive, leaving your muscle tendon more flexible and more compliant.

The methods of static stretching include intermittent and continuous stretching. Hamstring stretching is preferred among the physical therapists, athletic trainers, gymnasts and weightlifter professionals who all have a heed to ameliorate the hamstring flexibility or ROM in their career. In contrast to many techniques of stretching, Bandy et al revealed that static stretching on hamstring muscles yielded twice the range of motion gains, as the static stretching is the type in which muscle is stretched through its full range and hold there for 15 to 30 seconds.

Stretching the hamstring muscles for 30 to 60 seconds is more effectual than 15 seconds or stretching for 10 seconds 3 to 6 times per day is consummate. It also asserts the purpose of prevention from the injury, muscle soreness and even magnify the performance. Immediate and long-term outcomes on muscle tissue achieve stretching brings out increase in range of motion in hamstrings. The immediate outcomes are those occurring within 60 minutes after stretching.

The stretch tolerance is crucial for relieving pain linked with muscle stiffness. Increased stretch and stretch tolerance mean that same force brings out less pain and may arise through an increase of muscle strength. Stretching de-stresses muscle tension and empowers lengthening and is a desired warm up exercise. Increase in ROM of hamstring empower the lower extremities for enhanced physical movements and eliminates the probability of tendon distortion or muscle sprain. Warm up and stretching exercises yield a notable growth in hamstring muscle's length. As the length of hamstring muscles plays an essential role in both effectiveness and capability of basic body. Lower extremities locomotory patterns such as walking, jumping and running require tremendous amount of control and strength of hamstrings. If there is short length of muscle, numerous complications occur in locomotory movements or long-standing postural position. Stretching should be tailored to particular muscular structure, flexibility and varying tension levels.[8] Ayala reported that stretch held for different durations enhanced muscle flexibility and ROM. however, the change in the flexibility was influenced by intensity and time period of stretch.[9]

The popliteal angle is a measure which shows the extensibility and range of motion of hamstrings. Popliteal angle is also called active knee extension test. An abnormally high flexibility will lead to the instability of joint while on the other hand low flexibility will lead to the compromised performance and risk of injury. Many researches have studied the effect of stretching on hamstring but a very few has studied the effects of changes in the rest times. However, a very less studies have compared the effects of intermittent and continuous stretching thus, this study will fill the gap and compare the efficacy of intermittent and continuous stretching by evaluating flexibility and ROM. We have hypothesized that the intermittent stretching is more effective than continuous stretching on flexibility and range of motion.

Rationale: The rationale of study was to see the immediate effects of intermittent and continuous hamstring static stretching on the muscle flexibility and range of motion in strength training participants.

Purpose: Purpose of the study was to elaborate that intermittent static stretching has more enhanced effects on hamstring muscle's flexibility and range of motion in strength trainers as compared to continuous static stretching.

3| METHODS:

Data Collection Procedure:

In this study both right and left leg of the participants were assessed. The study design includes two groups i.e., continuous group (no rest interval n=15) and intermittent group (with rest interval n=15). The session was conducted in three steps. The first step was pre-testing. Before pre-testing, participants were advised to sit for 5 minutes to relax the hamstring muscles. The measurements of popliteal angle were recorded. In the second step, the researcher performed stretching. The stretching duration for the continuous group was for 60s straight without any rest interval. The stretching duration for the intermittent group was for 30s with 10s of rest followed by another 30s stretch. In the third step, the post testing was done. Then popliteal angle values were recorded. The range of motion was measured using popliteal angle test. Goniometer was involved in this measurement. The flexibility of hamstrings was measured using Sit and Reach Test and the pain assessment using Numeric Pain Rating Scale.

Statistical analysis:

The data was analyzed using SPSS version 16. Shapiro-Wilk test was applied to check the normality of the data. The data was normally distributed. Independent t test was applied to compare the means of the two groups. 95% confidence interval was selected. The null hypothesis which states that there is no difference between the groups was rejected if significant values were less than 0.05. ($p<0.05$)

Ethical considerations:

Before performing any technique, the whole process was explained to the participants and consent form was signed. Ethical approval was properly obtained from relevant ethics committee.

4| RESULTS:

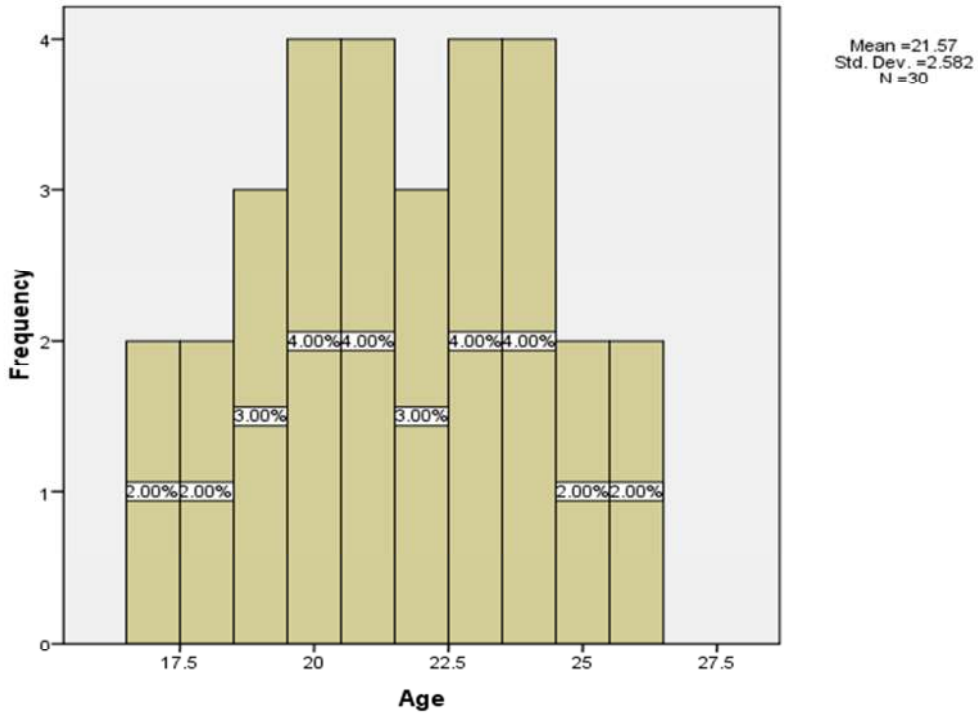
The results are summarized as follows:

Table No.1:

Age				
Sr no.	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
1	15	50.0	50.0	50.0
2	15	50.0	50.0	100.0
3	30	100.0	100.0	

This table shows equal distribution of frequency among all age groups.

Histogram.No.1:

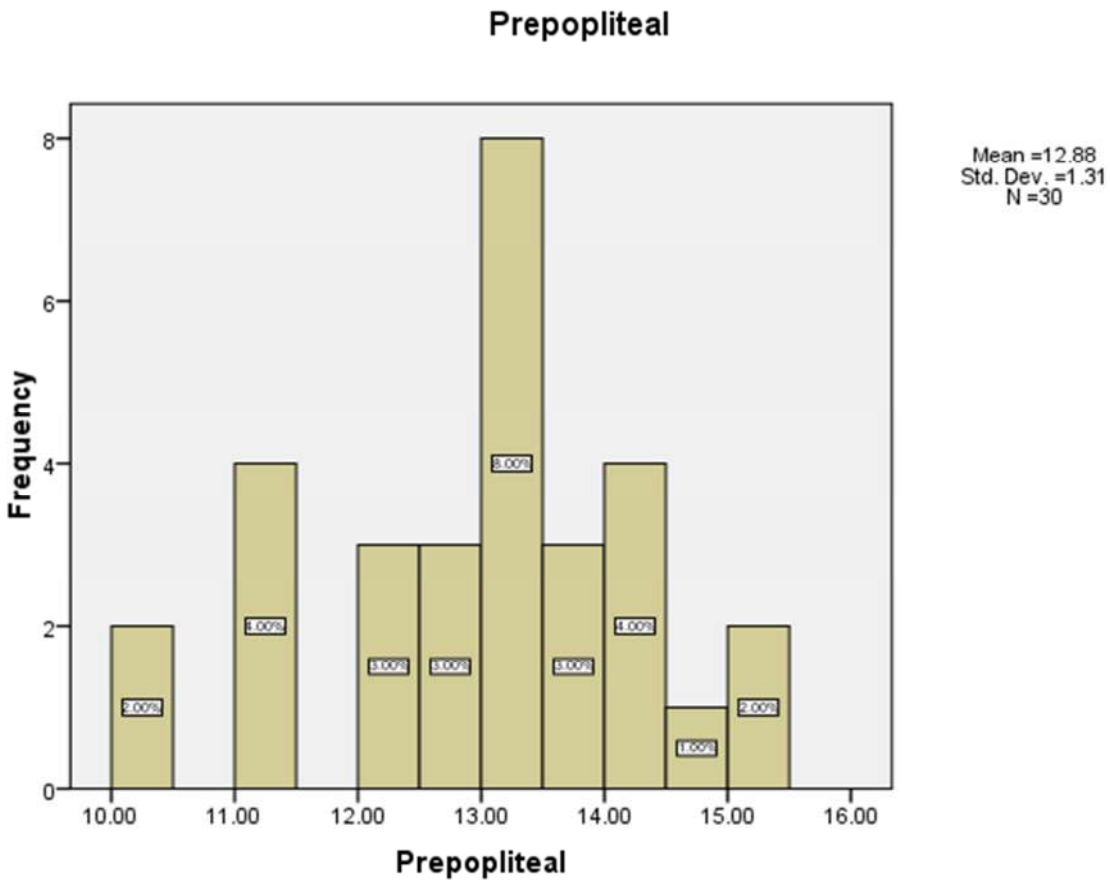


This graph shows frequency distribution of 17-20 ratio n=11%, 21-24 ratio n=14% and 25-28 ratio n=4%.

Popliteal-Angle Measurement

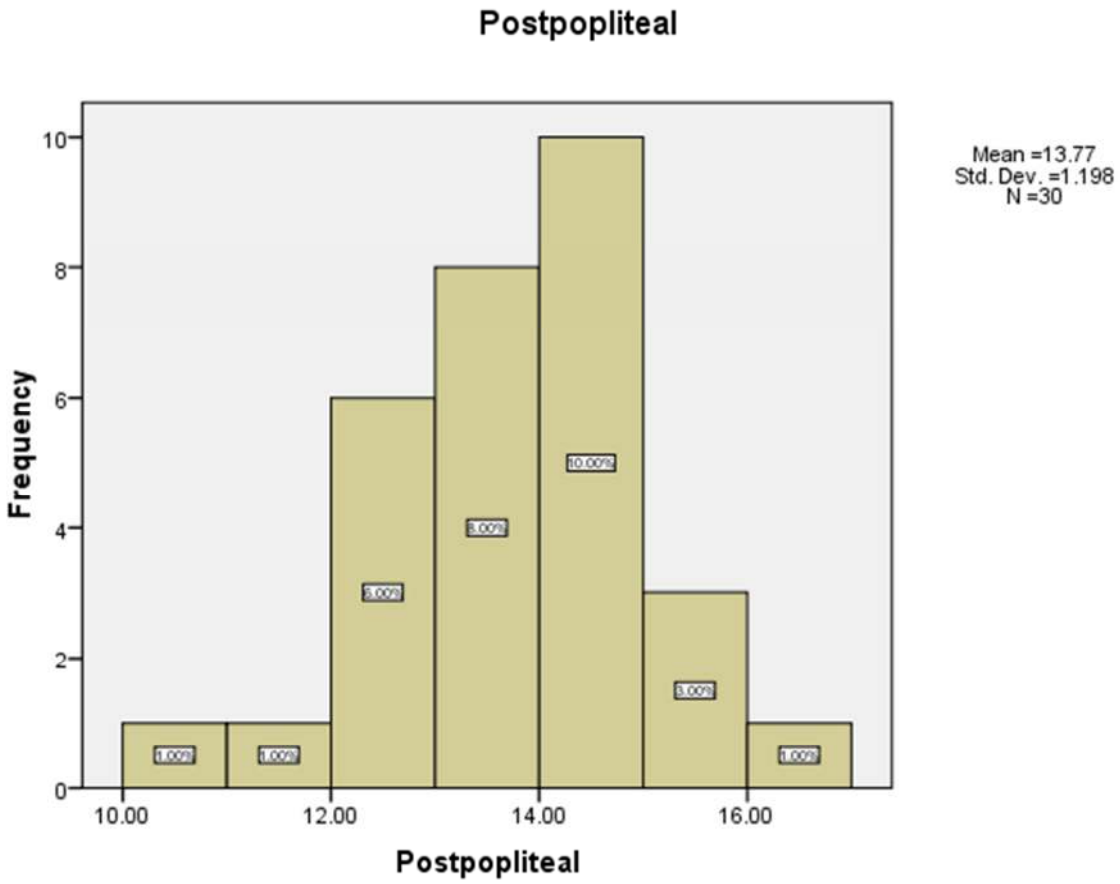
The popliteal angle before and after stretching to track real-time changes

Histogram:2



This histogram shows pre popliteal frequency distribution of 10-12 ratio n=6%, 12-14 ratio n=17% and 14-16 ratio n=7%.

Histogram.No.3:



This graph shows the frequency distribution of 10-12 ratio n=2%, 12-14 ratio n=14% and 14-16 ratio n=4%.

Popliteal Angle	Mean±S.D	T(df)	P-value
Pre right side value	-.45±0.47	-0.95(27.5)	.347
Pre left side value	-.34±0.46	-0.72(27.8)	.475
Post left side value	0.98±0.45	2.16(28)	0.040
Post right side value	0.89±0.41	2.18(28)	0.038

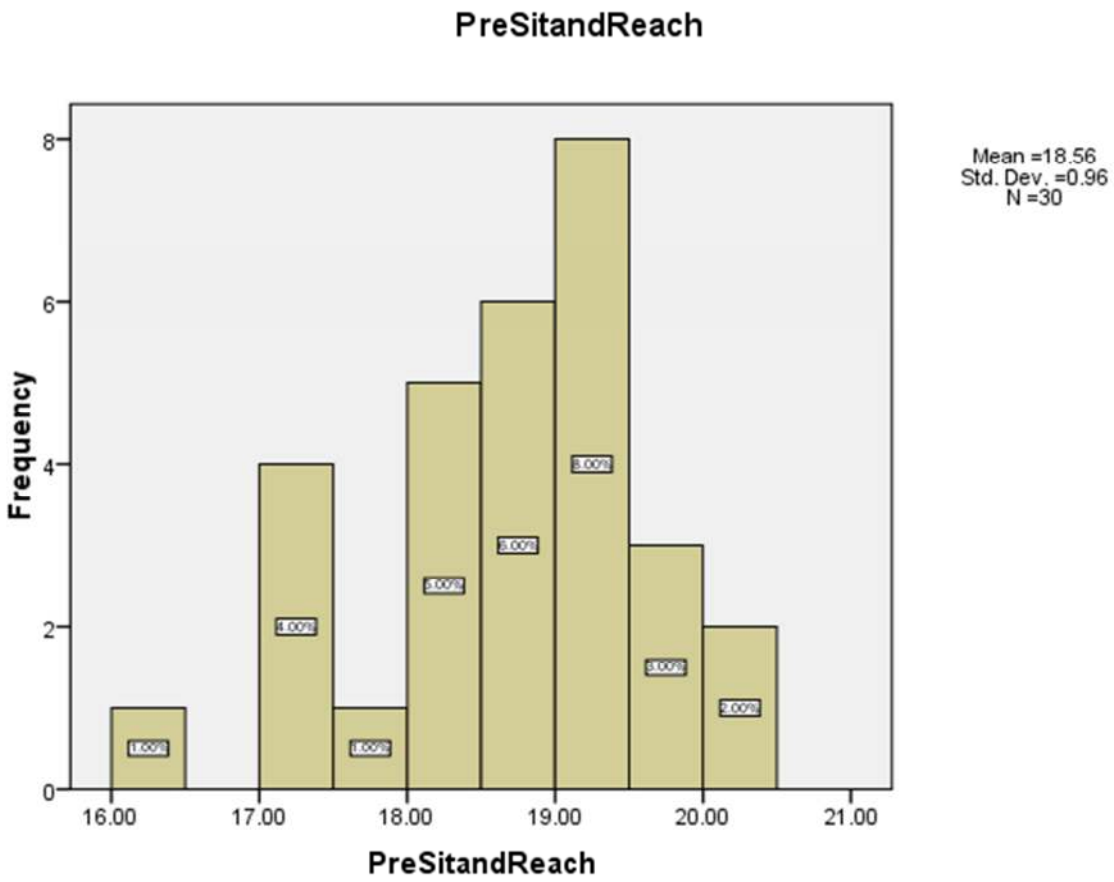
Table-2 Popliteal-Angle Measurement

This table evaluates knee extension range of motion (ROM in degrees). Post-left side values (0.98±0.45) show improved ROM with a significant p-value (*p*=0.04). Pre-test values (*p*>0.34) confirm baseline uniformity. The lack of post-right side data limits conclusions, but the left-side improvement (*p*<0.05) supports intermittent stretching's efficacy in boosting hamstring extensibility

Sit and Reach Test

This test was performed to measure practical, functional hamstring and lower back flexibility—like how easily someone can bend or lift.

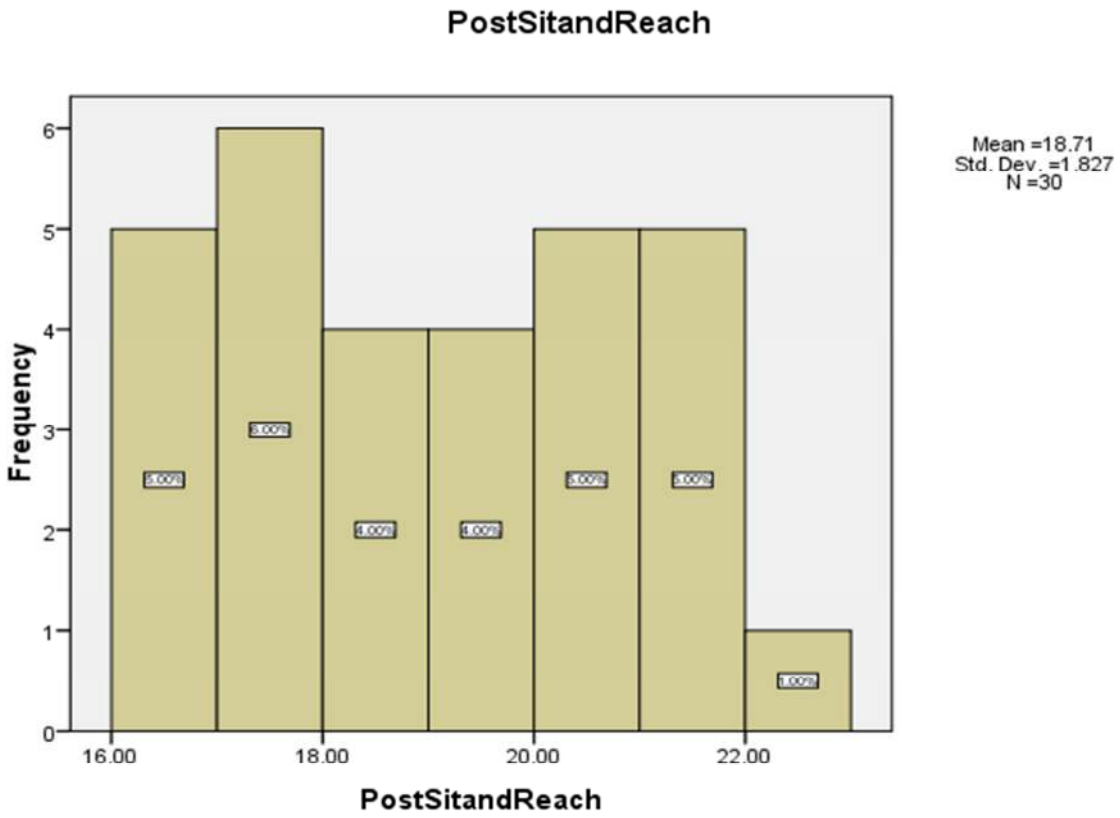
Histogram.No:4



LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

This graph shows the frequency distribution of 16-18 ratio n=6%, 18-20 ratio n=22% and 20-21 ratio n=2%.

Histogram.No.5:



This graph shows the frequency distribution of 16-18 ratio n=11%, 18-20 ratio n=8% and 20-22 ratio n=11%.

Sit and Reach Test	Mean ± SD	T(df)	P-value
Pre right side value	-.98±0.41	-2.36(27.6)	.025
Post right side value	1.43±0.44	3.24(28)	0.003
Pre left side value	0.03±0.33	0.098(23.7)	.92
Post left side value	1.20±0.38	3.1(28)	0.004

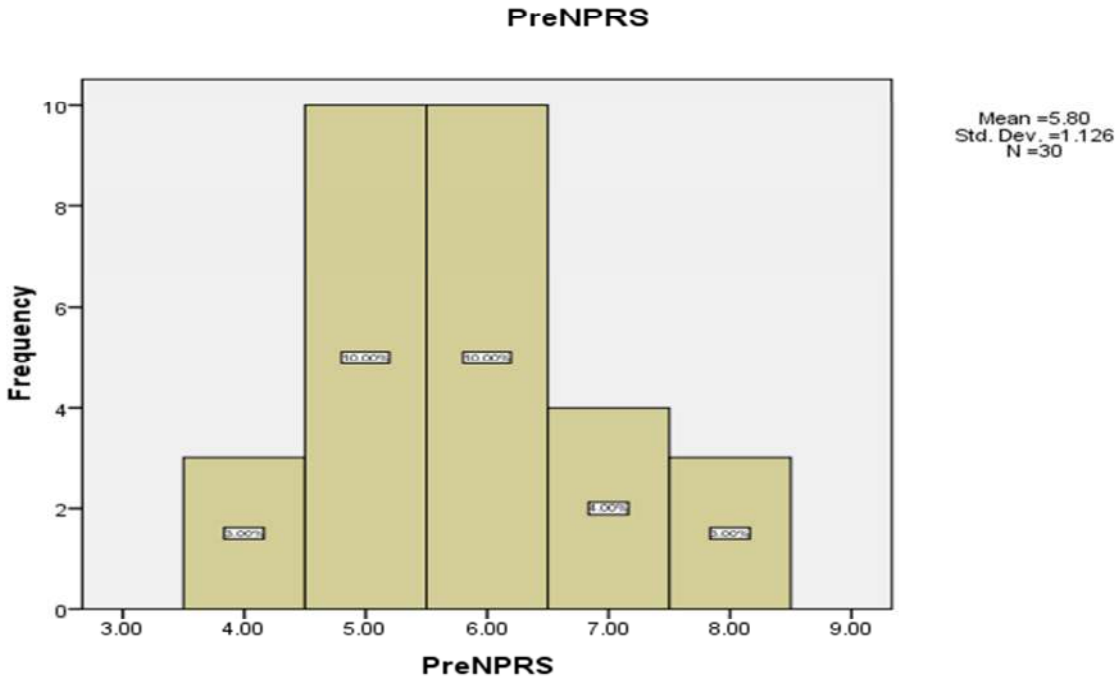
Table-3 Sit and Reach Test

This table measures hamstring flexibility (in cm). Post-test scores (e.g., 1.43±0.44) reflect improved flexibility. The p-values (right: *p*=0.003; left: *p*=0.004) are highly significant (*p*<0.01), indicating large gains from stretching. Pre-test values (*p*=0.92 left) confirm no initial differences. The results suggest intermittent stretching enhances flexibility more effectively than continuous stretching.

Numeric Pain Rating Scale

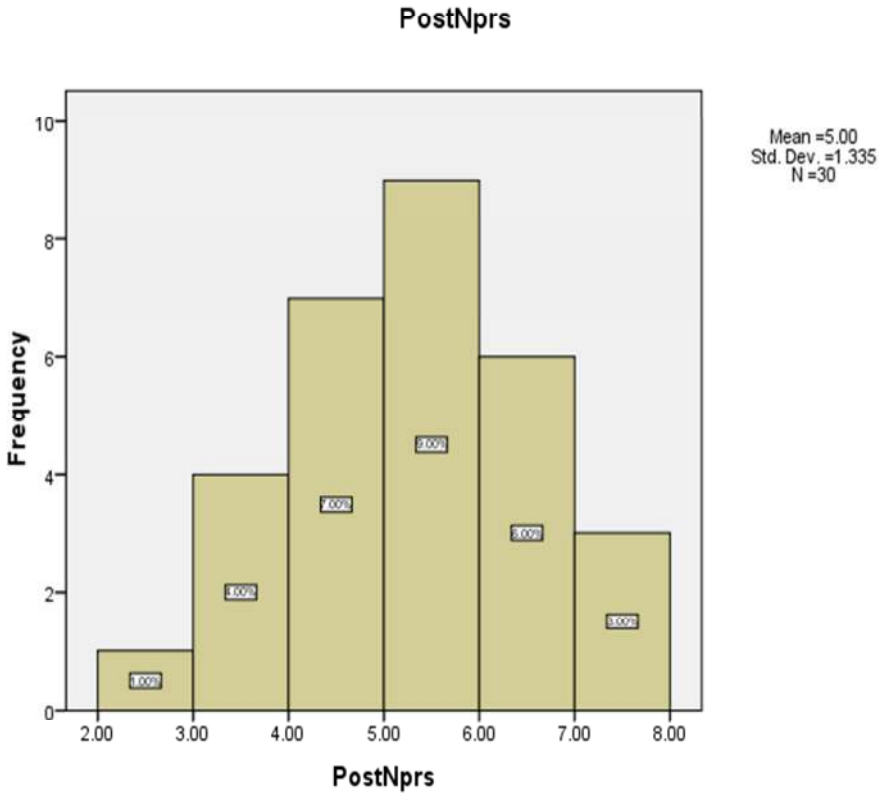
The Numeric Pain Rating Scale (NPRS) was used to assess acute pain perception during and after stretching, providing an objective assessment of tolerance and potential side effects. This allowed researchers to weigh the effectiveness of flexibility increases against participant pain, ensuring that stretching regimens were not only biomechanically helpful but also practicable for strength-trained groups.

Histogram.No.6:



This graph shows distribution of frequency with 4-5 ratio n=13%, 6-7 ratio n=14% and 8 ratio n=3%.

Histogram.No.7:



This group shows frequency distribution of 2-4 ratio n=5%, 4-6 ratio n=16% and 6-8 ratio n=8%.

Sit and Reach Test	Mean ± SD	T(df)	P-value
Pre right side value	-.98±0.41	-2.36(27.6)	.025
Post right side value	1.43±0.44	3.24(28)	0.003
Pre left side value	0.03±0.33	0.098(23.7)	.92
Post left side value	1.20±0.38	3.1(28)	0.004

Table-4 Numeric Pain Rating Scale

This table compares pain scores (0–10 scale) before and after stretching for both legs. Negative post-test values (e.g., −1.02±0.45) indicate reduced pain. The p-values for post-test scores (right: *p*=0.03; left: *p*=0.04) are statistically significant (*p*<0.05), confirming that stretching reduced discomfort meaningfully. Pre-test values (*p*≥0.52) show no baseline differences, ensuring groups started similarly.

5| DISCUSSIONS:

The present study entitled "Immediate Effects of Static Hamstring Stretching Protocols on Flexibility, Range of Motion, and Pain in Strength-Trained Males" was executed in Gyms or fitness centers of Faisalabad. In this study two groups were entailed the experimental group and the control group which received intermittent static stretching technique and continuous static stretching technique respectively. 30 subjects were selected in this study analysis and divided into two groups of 15 subjects. Experimental group received intermittent static stretching (<30s) and control group received continuous static stretching (>30s). In this Qausi experimental study, findings were supported by the previous study done by who studied the immediate effects of intermittent and continuous static stretching on hamstring muscle flexibility and range of motion.[10] This study concluded that there was a greater improvement in hamstring muscle flexibility and range of motion in experimental group with intermittent stretching than control group with continuous stretching.

The previous study done by the observed the effects of intermittent and continuous static stretching muscle range of motion and musculotendinous properties.[11] Range of motion was collected prior and after executing both static stretching protocols. Prior to stretching there was no notable difference between the range of motion of muscle (p=0.15) and elasticity, but range of motion was notably enhanced after intermittent (ES=0.42; p<0.01) and continuous static stretching (ES=0.36; p<0.01). Range of motion was prominently differed between intermittent and continuous stretching (p=0.04), which shows intermittent is more beneficial than continuous. Findings of this study were in accordance with recent study which showed greater achievement in range of motion with intermittent static stretching than continuous static stretching.

A previously documented study revealed some crucial effects of regular types of static stretching protocols applied on athletes, gymnasts and sports teams mostly investigated by.[12]

There is clear evidence which reveals that short duration (<30s) static stretch has no detrimental effect on muscles and with a significant decrement in muscle performance with long duration (>30s-60s) static stretches. These observations contradict with current research which states that there is an increase in muscle range of motion and flexibility with intermittent short duration static stretching and continuous long duration static stretching but shorter duration static stretching has notable greater effect.

Results of a preceding study analyzed by revealed that effects of static stretching on speed and agility performance were duration dependent shorter stretch durations (<20 seconds) may result in improvement of speed and agility tests whereas longer duration stretches do not affect negatively or positively.[13] These finding contradict with current study which reveals that both longer duration (>20s) and shorter duration (<20s) static stretching effected positively on the muscle range of motion and flexibility furthermore shorter duration has greater effect.

A previously discussed study stated a comparison between effects of intermittent and continuous static stretching training on hamstring range of motion. Seventy-seven gymnasts were divided into stretching and a control group. in stretching group one leg performed intermittent static stretches (3 × 30 s with 30 s rest) and the other leg performed with a continuous static stretch (90s). training program reveals that results that range of motion was increased with both intermittent and continuous static stretching protocol but remained unchanged during in the control group, while it was observed that intermittent static stretching protocol inferred greater improvement in range of motion as compared to both control group and continuous static stretching group. pre and post ^{values} of ROM shows greater difference in significance (p= 0.045 to p=0.001). these findings are in accordance with our present study which states that intermittent and continuous static stretching has immediate effects on both hamstring muscles flexibility and range of motion, but short duration intermittent static stretching impose a greater effect for both acute or long-term training programs in preadolescent gymnasts or athletes. The referred study was investigated by.[14]

Our currents study compared the immediate effects on intermittent and continuous static stretching. Two groups were selected with total 30 participants, intermittent static stretching was applied on experimental group and continuous static stretching was executed on control group

which manifested that experimental group with intermittent static stretching concluded greater progress in muscle tone and range of motion than control group measured by sit and reach test and popliteal angle test with help of measuring tape and goniometer. Findings of this study were in correlation with a previous study by which conveyed the influence of continuous vs intermittent static stretching on repeated jump performance including hamstring muscles.[15] This previous study analyzed that there was a prominent difference between pre values and post values ($p<0.05$) as there was notable improvement in flight time when the duration of stretch was shorter than 45 seconds (intermittent stretch) with rest intervals as compared to the continuous static stretching.

One of the previous studies done by elaborated that static stretching exercises executed prior to the strengthening activities induce an impairment of performance and impedes with attaining best results in the competition.[16] Majorly this study analyzed that static stretching concluded a significant acute decline of approximately 5-30% in strength and power generation and states that during the most realistic warmup session. As little as 2 minutes of static stretching can impair the power generation in athletes which majorly contradicts with our current study which demonstrates that static stretching is effectual even before warm up sessions or any aggressive sports activity.

Earlier study done by the looked into the acute effects of intermittent and continuous static stretching on hip or knee muscles in athletes with varying flexibility training fields. Two groups were compared one with the artistic and rhythmic gymnasts getting continuous static stretching (180s) without rest and other group with team sports athletes getting intermittent static stretching (6 × 30 s with 30 s rest) with equal time duration.[17] Both stretching protocols manifested the rise in flexibility and range of motion, however greater increase in range of motion was noted in team sports athletes due to intermittent static stretching with rest intervals. Outcomes of this study were in consistency with the current study that elaborated greater improvement in flexibility and joint range of motion with intermittent static stretching than continuous static stretching.

One of the recent previous studies done by stated the acute effect of intermittent and continuous static stretching in hip joint range of motion in trained or untrained subjects which

includes the hamstring muscle group.[18] This study analyzed that in untrained or trained subjects intermittent static stretching has significant effect of progress on range of motion ($p=0.001$) than continuous static stretching ($p=0.99$) while we know ($p<0.05$) and in trained. results of this study agree with current study which stated that intermittent static stretching of short duration with rest intervals marks greater improvement in joint range of motion and flexibility than continuous static stretching of longer duration without rest intervals.

The study of was the only study identified the effects of intermittent static stretching followed by a stretching program or warmup session in routine.[19] Thirty-five subjects volunteered to participate in this study and if they are not involved currently in any hamstring stretching program. Prior to study subjects were randomly assigned the stretching and standard interventional group or control group. 4 weeks of examining the subjects with intermittent static stretching showed the improvement in range of motion not only in interventional group but also in control group but the difference was that gain in range of motion was ceased during the final stage of 4-week static stretching program but in intermittent static stretching gain in range of motion continued to increase also during the during final stage of 4 weeks. These finding are in accordance with present study which demonstrated that in comparison to control group on continuous static stretching programs there is notable increase in range of motion and flexibility of muscles following a single session of intervention or a long-term plan.

In the recent times a study analyzed by investigated the effect of static stretching protocols tie duration on the flexibility and force output of muscle groups.[20] As compared our current study they selected an experimental group of 15 males and applied two contrasting types of static stretching with non-identical intensities of (<30s to >30s) with and without resting bouts between stretches. The subjects with 2 stretches of 30 seconds with rest interval between each stretch showed notable improvement in gaining range of motion and force output as compared to the subjects with a single stretch of 60 or >60 seconds without rest interval which is continuous static stretching type with low intensity and long duration. So, this study concluded that range of motion was increased with both intensities of static stretching types, but the gain was notably higher in short duration high intensity stretching (intermittent static stretching) but decreased the peak force level immediately after the session. Findings of this study coincided with current research that elaborated joint range of motion increased with both intermittent and continuous

static stretching protocols but there is more improvement between pre and post values of interventional group with intermittent (<30s) type of stretching with rest intervals following each stretch.

Limitations:

There were some limitations in the study regarding a specific age group (17-25yo) so the results collected were not comprehensive to all age groups. Time was also limited for this type of study if this study is elapsed for more time analyzed results could be more accurate and authentic. Financial funding was one of the major limitations for this study as the working researchers are students and could not afford the funds all alone on their own without a proper sponsor. Limitation of available resources for the researchers to perform data collection procedures because there were equal to no labs present for the proper practical and tests so that's why further investigations are still required for the evaluation effects of both static stretching protocols on participants of overall community.

Authors Contributions:

All authors contributed ideas, discussed results and wrote the manuscript.

Conflict of interest:

There is no conflict of interest.

6| CONCLUSION:

The current study observed notable difference between the effectiveness of intermittent and continuous static stretching protocols. Increase in flexibility and decrease in muscle stiffness manifested in both static stretching techniques. However intermittent static stretching technique showed major improvement in joint range of motion and flexibility. There was also improvement in popliteal angle test with the short interval with rests. It was concluded that intermittent static stretching (~30s) was more effectual than continuous static stretching (>30s) technique due its short intervals (~10s) with rest. This conclusion can be helpful in training of weight lifters and athletes.

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