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EFFECT OF NON BALLISTIC ACTIVE KNEE EXTENSION ON IMPROVING FLEXIBILITY IN HAMSTRING TIGHTNESS AMONG COLLEGE-GOING STUDENTS

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ABSTRACT

BACKGROUND: The person's ability to move without any difficulty is mainly depends upon flexibility. Hamstrings are related to such a muscle group which has ability that their flexibility can be reduced due to many factors. Prolonged sitting position which is adopted in many work places, educational institutions and sedentary daily lives are related to hamstring muscle tightness. After a long period of sitting or inactivity, people develop tight hamstrings because of negative biomechanical and physiological effects, as Static forces absorb more energy than dynamic movements to maintain the body immobile while resisting gravity. Presently there is a limited literature on hamstring tightness among college going students and there is a paucity of literature on the effectiveness of non ballistic active knee extension on hamstring muscles tightness. So the study aimed to find out the effect of non ballistic active knee extension on improving hamstring flexibility among college going students

METHODS: Quasi experimental study design. Hamstring tightness prevalence study was conducted through active knee extension test among college going students. The participants of the study include 120 students with average age of 21 with hamstring tightness and they received non ballistic active knee extension for 6 weeks intervention total 30 sessions and 6 weeks follow up. The outcome measure of this intervention was an active knee extension test to test the popliteal angle.

RESULTS: Anova test was used to assess the statistical significance difference within the pre- test , post - test and follow up. Statistical analysis of the data revealed that there was a significant difference within pre - test, post - test and follow up which results non ballistic active knee extension showed an improvement in hamstring flexibility among college going students.

CONCLUSION: The present study concluded that non ballistic active knee extension was effective in improving hamstring flexibility among college going students and it was not effective in maintaining the long-term effects.

KEY WORD: Hamstring tightness, Hamstring flexibility, Non ballistic active knee extension, Active knee extension test.

INTRODUCTION

Flexibility is an essential component of physical fitness that refers to the ability to move joints freely, smoothly, and comfortably through their full range of motion. This attribute plays a significant role in enhancing overall mobility, reducing the risk of injury, and improving performance in physical activities. Flexibility is influenced by several factors, including the condition and elasticity of muscles, tendons, ligaments, and the structural alignment of bones. When these elements are healthy and function optimally, they work together to allow the body to achieve greater freedom of movement.[1]

Flexibility issues are prevalent among both the general population and athletes, particularly affecting the hamstring muscle group. Insufficient flexibility is recognized as a primary cause of muscle tightness, which in turn increases the risk of muscular injuries.

The hamstrings play a crucial role in stabilizing the hip and knee during movements, when flexibility is compromised, these muscles may become overstrained during dynamic activities, leading to a higher chance of injuries such as strains, tears, or compensatory issues in other muscle groups.[2]

A decrease in muscle flexibility can lead to musculoskeletal damage and a decline in functional ability. This reduction in flexibility primarily affects muscles that span multiple joints and are involved in dynamic movements.[3]

Adequate flexibility of soft tissues such as muscles, skin, and connective tissue around the joints, combined with sufficient joint mobility, is crucial for maintaining a normal range of motion.[4]

Muscle tightness refers to a reduced ability of a muscle to stretch. When the hip is flexed, and the knee cannot fully extend, this condition is known as hamstring muscle tightness.[5] Hamstring muscle tightness is characterized by a popliteal angle exceeding 20 degrees. The prevalence of hamstring muscle tightness is approximately 45%.[6]

Hamstring tightness is a common musculoskeletal problem observed among university students. The prevalence of hamstring tightness among students aged between18-25 is found to be very high, which is 68%. Prolonged sitting is a predisposing factor for tight hamstrings. Hamstring tightness may lead to hamstring strain and other injuries which may impede the activities of university students.[7]

As per the results of current study about 68.8% of the athletes engaged in contact sports as cricket and football experienced hamstring tightness assessed through Active knee extension test The results of the current study were in consistent with previous study conducted in 2010 which also shows that about 88% of the athletes involved in contact sports experienced hamstring tightness.[8]

The hamstrings (HMS) consist of three muscles: semimembranosus, semitendinosus, and both the long and short heads of the biceps femoris. They are situated in the posterior compartment of the thigh, spanning from the hip to the knee and from the medial to the lateral aspect. These muscles cross both the hip and knee joints. Their primary functions include knee flexion and hip extension.[9]

The semitendinosus muscle originates from the ischial tuberosity and inserts at the medial side of the tibia. The semimembranosus also arises from the ischial tuberosity and inserts at the medial aspect of the tibia. The long head of the biceps femoris originates from the ischial tuberosity and inserts at the lateral side of the fibula, while the short head originates from the femur and inserts at the lateral side of the fibula.[10]

Hamstring tightness can result from prolonged sitting in workplaces and educational institutions, insufficient physical activity, a sedentary lifestyle, genetic factors, and previous hamstring injuries. Extended periods of sitting in these environments can notably reduce the flexibility of soft tissues, particularly in muscles with multiple attachments.[11]

College going students are expected to be seated for long hours. During prolonged sitting, the constant shortened position may cause muscle tightness. There is posterior tilting of the pelvis in sitting position, and continuous knee flexion leading to the hamstring muscles being held in shortened position.

Prolonged sitting exerts negative biomechanical and physiological effects, as static forces absorb more energy compared to dynamic movements. In this sedentary state, approximately 50 percent of the body's muscles contract to maintain immobility and resist gravity.[12]

Further, hamstring flexibility may be affected by modifiable factors that include body mass index (BMI), physical activity and Non-modifiable factors such as: age and gender. Increased BMI may reduce hamstring flexibility due to excess adipose tissue limiting movement or increasing strain on muscles and Active individuals tend to have better hamstring flexibility due to regular stretching and dynamic muscle use. Sedentary lifestyles, particularly prolonged sitting, contribute to hamstring tightness by promoting shortened muscle length over time.[13]

Age is a significant factor contributing to hamstring flexibility and tightness, alongside prolonged sitting. Flexibility decreases with age due to changes in muscle elasticity, joint mobility, and overall tissue compliance. Older individuals are more prone to hamstring

tightness compared to younger populations and women generally exhibit greater hamstring flexibility than men, likely due to anatomical and hormonal differences affecting muscle and joint characteristics. [14]

Maintaining normal flexibility in the hamstring muscles is crucial for smooth movement of the hip and knee joints, as tightness in these muscles can predispose individuals to various issues. Tight hamstrings affect the muscle's length-tension relationship and its ability to absorb shock in the limb. Reduced flexibility initiates a cycle where range of motion decreases, potentially leading to increased postural problems. Tight muscles also compress blood vessels, reducing optimal performance.[15]

Hamstring tightness is linked to dysfunctional motor control patterns, resulting in suboptimal firing of postural muscles. This leads to hamstrings functioning more as stabilizers rather than their primary role as prime movers. This shift in function contributes to the manifestation of hamstring tightness.[16]

Musculoskeletal problems associated with hamstring tightness include knee pain syndrome, abnormal pelvic tilting in sitting position, disc protrusion or disc bulge, sciatic pain and spondylolisthesis.[17]

Tight hamstrings impact the lumbar-pelvic rhythm, affecting pelvic and thoracic angles and range of motion during forward bending.[18] Reduced hamstring flexibility is also linked to conditions such as plantar fasciitis, patellar tendinopathy, and patellofemoral pain syndrome.[19]

Studies indicate a connection between hamstring tightness and mechanical low back pain, with research showing a positive correlation between tight hamstrings and the severity of low back pain. [20]

Tight hamstring muscles restrict anterior pelvic tilt during spinal flexion, increasing muscle and ligament tension in the lumbar region and placing higher compressive loads on the lumbar spine.[21] Additionally, postural changes due to hamstring tightness can indirectly affect the stability of the sacroiliac joint. [22]

Considering the importance of hamstring flexibility in posture and day to day activities, there is a need to identify effective interventions to improve hamstring flexibility for hamstring tightness among young individuals. Different stretching techniques have traditionally been employed to enhance hamstring flexibility.

Researchers have compared the effectiveness of various methods, such as proprioceptive neuromuscular facilitation (PNF) relaxation techniques, modified PNF relaxation techniques, ballistic stretching, and static stretching. [23]

Hamstring muscles can become tight due to increased tension in neural structures in addition to musculoskeletal structures. Alongside the hamstrings, the deep fascia of the lower limb and soft tissues of the pelvis, including neural tissues, are also affected. These non-contractile tissues can experience tension during both passive and active movements involving hip flexion or knee extension. The tension in these non-contractile tissues limits indirect measures of hamstring flexibility. To address this, non-ballistic active knee extension is utilized, which emphasize neural tissues along with the hamstring muscles.[24]

Research also indicates that integrating neural mobilization techniques, such as slump mobilization, into treatment programs can effectively restore normal neural tension and mechanics of the nervous system.[25]

The most effective treatment among the different physical therapy interventions specific to hamstring tightness among college going students, to ensure if the time and cost spent by the individuals is worth it. So, this study aims to find out the effect of non ballistic active knee extension which is a simple neural stretch that can be administered for only 30s and can be done with out supervision.

NEED OF THE STUDY

The person's ability to move without any difficulty is mainly depends upon flexibility. Hamstrings are related to such a muscle group which has ability that their flexibility can be reduced due to many factors. Prolonged sitting position which is adopted in many work places, educational institutions and sedentary daily lives are related to hamstring muscle tightness. After a long period of sitting or inactivity, people develop tight hamstrings because of negative biomechanical and physiological effects, as Static forces absorb more energy than dynamic movements to maintain the body immobile while resisting gravity. Presently there is a limited literature on hamstring tightness among college going students and there is a paucity of literature on the effectiveness of non ballistic active knee extension on hamstring muscles tightness. So, the need of the study is to find the prevalence of hamstring muscle tightness among college going students and to know the effect of non ballistic active knee extension on hamstring muscle flexibility.

MATERIALS AND METHODS

STUDY DESIGN **:** Quasi experimental study

ETHICAL CLEARANCE AND INFORMED CONSENT: The study protocol was approved by Ethical committee of GSL Medical College & General Hospital (Annexure I), the investigator explained the purpose of the study and given the patient information sheet. The participants were requested to provide their consent to participate in the study. All the participants signed the informed consent and the rights of the included participants been secured.

STUDY POPULATION : Students with hamstring muscle tightness

STUDY SETTING : The study was conducted at Tertiary care teaching Centre, Rajamahendravaram

STUDY DURATION : Study was conducted for a period of one year from 1st August 2023 to 31st July 2024

INTERVENTION DURATION : 30 sessions, 5 days a week for 6 weeks, follow up at 12th week

SAMPLING METHOD : Consecutive sampling method

SAMPLE SIZE : A total number of 230 subjects were screened. In that 127 subjects had hamstring tightness. Out of 127 subjects 7 subjects has not given consent to participate in the study. A Total number of 120 subjects, both male and female with hamstring tightness were participated in the study by consecutive sampling method.

TOTAL NUMBER OF SUBJECTS SCREENED	230
SUBJECTS WITH HAMSTRING TIGHTNESS	127
NORMAL SUBJECTS	103

MATERIALS:

1. Universal goniometer
2. Straps
3. Couch
4. Stepper
5. Pillow
6. Bed sheet, etc.

CRITERIA FOR SAMPLE COLLECTION

INCLUSION CRITERIA:

- Study population were college going students who were willing to participate
- Age group of 18-30 years
- Individuals with lack of flexibility in hamstring muscles confirmed by AKE test (Popliteal angle >20 degrees)

EXCLUSION CRITERIA:

- Any recent trauma history (within 3 months)
- Previous surgery
- Spinal and limb deformities
- Congenital anomalies

OUTCOME MEASURES:

1. Active Knee Extension Test

ACTIVE KNEE EXTENSION TEST (AKET):

The AKE test is an objective and reliable tool for measuring hamstring muscle tightness The AKE consists an active extension movement at the knee joint (with the hip flexed at 90^0), in which the subject is instructed to stop when he feels strong resistance to the movement. Goniometer was used to measure the popliteal angle. When the popliteal angle is greater than 20 degrees then it is considered as HMS tightness.[26]

Fig no: 1 Starting position of AKET

Fig no: 2 End position of AKETINTERVENTION

The exercise programme was given for 5 days a week for 6 weeks, follow up at 12th week.

WARM UP EXERCISES:

Subjects were given a warm-up routine consisting of 3 minutes of jogging on the spot followed by 10 minutes of Hydrocollator pack HCP) application to prepare the muscles and joints for further exercises[27]

Fig no: 3 Jogging

Fig no: 4 Hydrocollator pack

NON BALLISTIC ACTIVE KNEE EXTENSION:

Subjects were in sitting position on the table at a height which didn't allow the foot contact with the floor with thighs supported, leg flexed and popliteal fossae touching the table edge, maintaining the cervical and thoracolumbar flexion by interlocking both hands behind the neck.

Subjects was then instructed to perform 30 repetitions of active knee extension maintaining the full dorsiflexion, up to the point where the firm resistance or stretch was felt at the posterior thigh, knee or calf and position was held for the self-count of one, two, three, four by the patient. The position was held for 6 seconds.[28]

After 6 weeks of intervention, the patients were assessed by active knee extension test and follow up was done at 12 th week.

Fig no: 5 Non ballistic active knee extension

STATISTICAL ANALYSIS

All statistical analysis was done by using SPSS software version 20.0 and MS excel – 2019.

All descriptive statistical data was presented as mean ± standard deviation and percentage and main difference was calculated and presented.

Within the group: ANOVA was performed to assess the statistically significant difference in mean value within the group for popliteal angle from pre- test, post- test and follow up values.

Data also tabulated and graphically represented.

For all statistical analysis $P < 0.05$ was considered as statistically significant.

RESULTS

A total of 230 participants of age group 18 to 30 years were included in the survey. The subjects were participated in the survey through active knee extension test. The results of this study were analysed in terms of reduction in the popliteal angle.

The majority of the responders 75(59%) were females while 52(41%) were males. The mean age of our study subjects were 21.25±2.53years.

The prevalence of hamstring tightness was 55% documented in 127 students. The female students affected with hamstring tightness were 75 (59%) and male students affected with hamstring tightness were 52(41%). The age group which was most affected was 21.25.

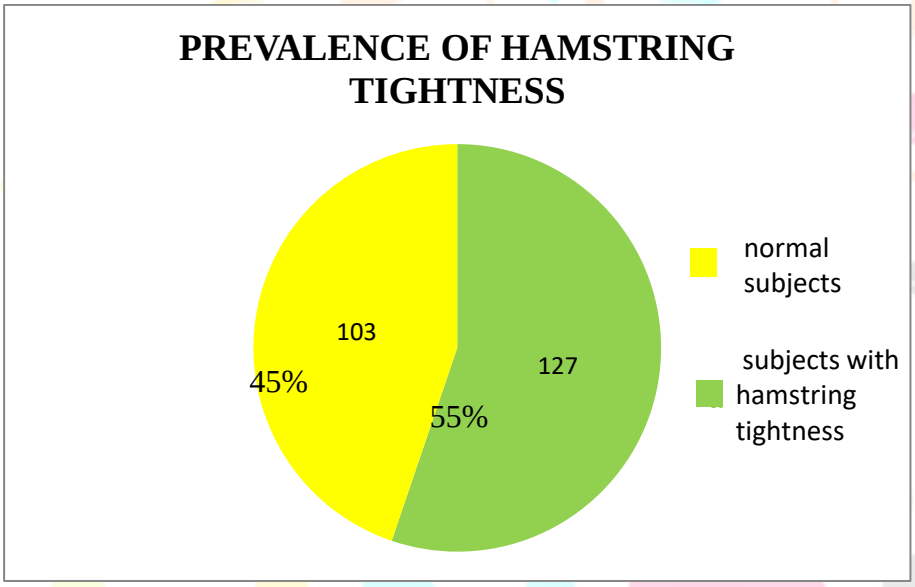
Subjects with hamstring tightness were screened for eligibility, amongst 120 subjects were included in the study trail. All the 120 subjects who met inclusion criteria have undergone baseline assessment.

Comparison was done within the pre - test , post - test and follow up, so as to evaluate the effectiveness of the intervention.

ANALYSIS OF PREVALENCE OF HAMSTRING TIGHTNESS AMONG COLLEGE - GOING STUDENTS

	No of participants	Percentage
Hamstring tightness	127	55%
Normal	103	45%
Total	230	

TABLE-1



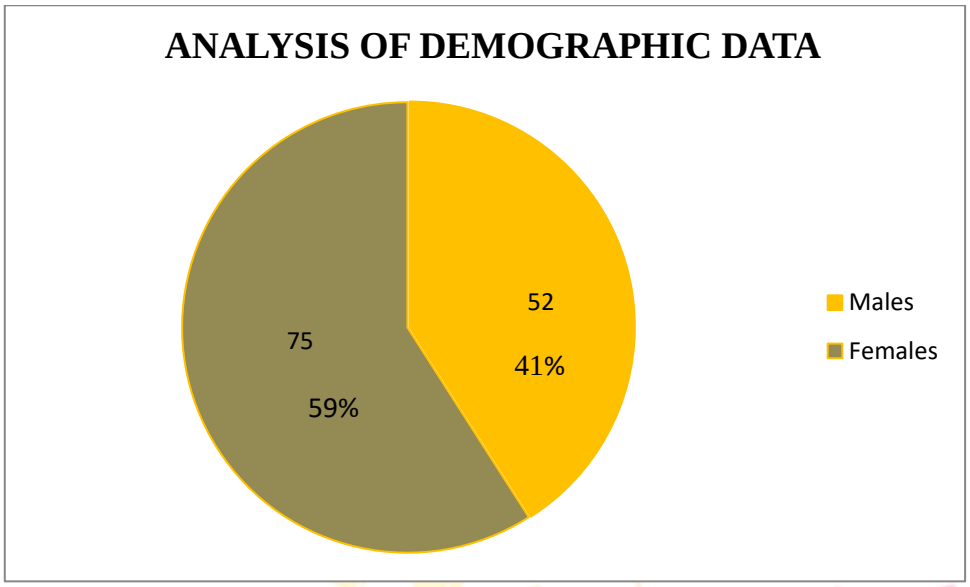
GRAPH -1

RESULTS: The above table and graph shows that the prevalence of hamstring tightness among college going students which was 55 %.

ANALYSIS OF DEMOGRAPHIC DATA

Variables	N	Percentage
Females	75	59%
Males	52	41%
Mean Age	21.25±2.53	

TABLE-2



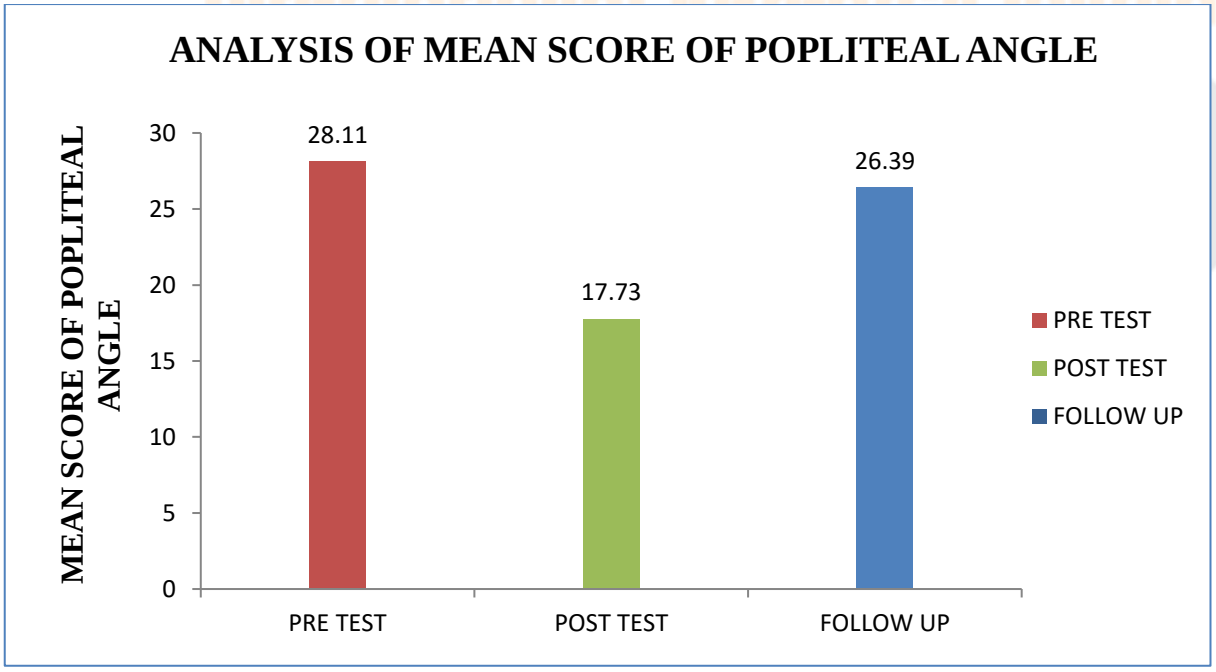
GRAPH -2

RESULTS: According to table-2 we can infer the demographic data of the participants. The percentage of Females is 59% (75) and the percentage of Males is 41% (52). The mean age of the participants is 21.25±2.53.

ANALYSIS OF MEAN SCORE OF POPLITEAL ANGLE

GROUP		MEAN	SD	P VALUE	INFERENCE
POPLITEAL ANGLE	PRE	28.11	2.68	0.001	SIGNIFICANT
	POST	17.73	2.49		
	FOLLOWUP	26.39	2.85		

TABLE – 3



GRAPH – 3

RESULTS: The above table and graph shows that the mean score of popliteal angle changes from pre test to post test and follow up within group were found to be statistically highly significant (p <0.005).

DISCUSSION

The aim of our present study was to know the effectiveness of non ballistic active knee extension on improving flexibility in hamstring tightness among college going students. The study was done among college going students to know the hamstring tightness by using active knee extension test (AKE test). The AKE test consists an active extension movement at the knee joint (with the hip flexed at 90^0), in which the subject is instructed to stop when he feels strong resistance to the movement.

The AKE test was the outcome measure used to measure the hamstring flexibility and improvement in the poplieteal angle shows the flexibility of the hamstring muscle. The results showed that non ballistic active knee extension was effective in improving hamstring flexibility in subjects.

This prevalence study was done among 230 Physiotherapy students studying in GSL Educational Institutions, Rajanagaram from the age group 18-30 years as our sample population. Demographic information of 230 respondents who participated in the survey can be described by gender in Table 2, from which 75(59%) were females while 52(41%) were males. The mean age of the participants was 21.25±2.53.

In this study out of 230 samples, 55% (127) were affected with hamstring tightness in which 75 were females and 52 were males.

The non ballistic active knee extension showed statistically significant differences within the group pre-test and post-test and non-ballistic active knee extension was more effective in improving hamstring flexibility in the subjects.

Mostly the college going students are suffering with hamstring tightness due to prolonged sitting during listening classes and during studying. Due to lack of maintaining proper posture the biomechanics of the body are altered and it leads to development of abnormal stress and strain over the muscles and it leads to development of pelvic tilt, lack of knee complete extension and forward neck postures are mostly seen in college going students.

Prevalence of hamstring tightness was seen in all health care workers of research that was 59.40% and the younger age healthcare workers from 20 to 29 years were more affected according to komal jamil et.al[29].

The prevalence of hamstring tightness in youngsters is 82% when assessed by using an active knee extension test & prevalence of hamstring tightness is more in females than males, which was concluded by Sheetal Mahadik et al[30]

Dipesh Thakur et al conducted a study. All subjects had hamstring tightness. The result of the study conclude that there was a significant correlation between the right and left hamstring muscle in both the group but there was no similar connection of hamstring length when compared with right hamstring length and left hamstring length group. The male subject had comparatively more tightness on the left and in female had more on the right is the result study found out. The prevalence of the hamstring tightness was greater in female subjects when compared with male subjects.[31]

Hamstring flexibility in adults can be improved with static stretching and nonballistic stretching more effectively than static stretching alone, which may be seen in improvements in the accuracy of active knee extension assessment according to Nishant Kumar Bali et al[32]

A study which compared the effectiveness of static and nonballistic active stretching on hamstring flexibility and sprint acceleration performance in collegiate level football players, they concluded that both static hamstring stretching and nonballistic active stretching may be equally effective in enhancing hamstring flexibility and sprint performance among collegiate football players according to Vadivelan Sundaramurthy et al,[33]

A muscle and its tendon has both viscous and elastic mechanical properties.[34]The viscous properties within a musculotendinous unit will elongate in response to a slow sustained force and will resist rapid changes in length. While the musculotendinous unit is under stretch, the amount of force generated by the viscous material to resist the elongation decreases over time (stress relaxation). As a result of this property, if the force attempting to lengthen the musculotendinous unit is sustained, the musculotendinous unit will gradually elongate, a property known as creep. The amount of force required to elongate the musculotendinous unit is mostly dictated by the elastic properties of the musculotendinous unit(MTU).[35]

Supporting this study finding a study done by Gadpal Pratiksha, et al., showed immediate effect on hamstring flexibility by comparing non ballistic active knee extension in neural slump position and static stretch technique and found slump stretch to give better results.

According to shacklok ,damaged or inflamed nerves leads to increase in mechanosensitivity which is a direct response to mechanical loading of the neural structures. This can lead to increased knee flexion angle in AKE. The possible mechanism of reduced knee flexion angle post neural stretch can be attributed to the improved physiological functions of nervous system, including improved axoplasmic flow, vascular perfusion and reduced neuromeningeal mechanosensitivity (perceptions of stretch or pain were altered). Thus there are many proposed mechanism of improvement of hamstring flexibility by neural slump position. But reduced mechanosensitivity is the chief mechanism by which the nervous system becomes more tolerant to source of pain with movements and postures.[24]

According to the findings of the current study, 6 weeks of non ballistic active knee extension shows significant improvement in hamstring flexibility in college going students . The current study results showed that non ballistic active knee extension was more

effective in improving hamstring flexibility and it can be used as a effective treatment choice for students suffering with hamstring tightness.

LIMITATIONS

- No blinding of evaluators
- This study has less sample size
- Lack of control group
- No home exercise program was given between post intervention and follow up
- Short intervention duration
- The study only focused on college going students which may not be representative of the general population

RECOMMENDATIONS FOR FURTHER RESEARCH

- Replicate the study with a larger sample size and diverse population
- Add a home exercise program to the intervention to enhance long term flexibility gains
- Develop a comprehensive stretching program incorporating non- ballistic active knee extension and compare its effectiveness with existing programs
- Examine the effects on functional activities and sport performance

CONCLUSION

The present study concluded that there is greater prevalence of hamstring tightness among college going students. The study findings suggest that non ballistic active knee extension is an useful exercise for improving hamstring flexibility. However the failure to maintain these results at the 6-weeks followup suggests that the non ballistic active knee extension does not have long-term effects in maintaining the hamstring flexibility or the participants may have reverted to their pre-intervention habits.

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ANNEXURE – I

CHAIRMAN
Mr. Naveen
Social Activist

INSTITUTIONAL ETHICS COMMITTEE
GSL MEDICAL COLLEGE & GENERAL HOSPITAL,
NH-16, RAJAHMUNDRY [ANDHRAPRADESH] – 533296

GSLMC/ RC:1090-EC/1090-07/2023 *Date: 26.07.2023*

Communication of Decision of the Institutional Ethics Committee [IEC] - Institutional Review Board [IRB]

To: Ms. DUDI VINEELA,1st YEAR MPT (ORTHOPAEDICS), GSL College of Physiotherapy & Rehabilitation, Rajahmundry.

IEC/IRB Ref No: *1090-EC/1090-07/2023*

Protocol Title: "EFFECT OF NON BALLISTIC ACTIVE KNEE EXTENSION ON IMPROVING FLEXIBILITY IN HAMSTRING TIGHTNESS AMONG COLLEGE-GOING STUDENTS"							
Principal Investigator: Ms. DUDI VINEELA							
Name & Address of Institution: GSL College of Physiotherapy & Rehabilitation, Rajahmundry							
New review	√	**Revised Review**		**Expedited review**			
Date of review [D/M/Y]	2 6	0 7	2 0 2 3				
Date of previous review (if revised application)							
Documents reviewed:							
Current CV of the investigator	√	Trial protocol	√	Investigator's Brochure	√		
Proposed methods	√	Informed consent form	√	Agreement with the Sponsor			
Compensation protocol	√	Investigators undertaking	√	Case Report Form	√		
Any other/ additional documents (Specify)							
Decision of the IEC / IRB:							
Recommended √	Recommended with suggestions	Revision	Deferred	Rejected			
Suggestion/Reasons/Remarks: APPROVED √							
Recommended for a period of :							
One Year	Three Years √	Five Years					

Please note:

- Inform IEC/ IRB immediately in case of any Advance events and Serious adverse events
- Inform IEC/IRB in case of any change of study procedure, site and investigator.
- This permission is only for period mentioned above. Annual report to be submitted to IEC/IRB.
- Members of IEC/IRB have right to monitor the trial with prior intimation.

Signature of MEMBER SECRETARY
IEC/IRB

MEMBER SECRETARY
INSTITUTIONAL ETHICAL COMMITTEE
GSL Medical College & General Hospital
NH-5, Rajahmundry 533 296

GSL Medical College
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