Original Article

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Effect of Short Duration versus Long Duration Muscle Energy Technique in Hamstring Tightness: A Randomised Clinical Trial

Physiotherapy Section

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ABSTRACT

Introduction: Hamstring tightness, which is common in both active and sedentary people, is caused by factors such as prolonged sitting, overuse, and poor posture, resulting in reduced flexibility and range of motion in normal daily activities. Muscle Energy Technique (MET) is acknowledged as an effective intervention to address this issue, but the impact of the duration on its effect remains underexplored.

Aim: To compare the effect of short duration and long duration MET on hamstring flexibility in healthy young adults.

Materials and Methods: A randomised clinical trial was conducted at KLES Prabhakar Kore Hospital, Belagavi, Karnataka, India, from November 2024 to April 2025. A total of 72 volunteers aged 18-25 years were screened, of which 64 participants met the inclusion criteria and were randomly allocated into two groups (n=32 each). Group 1 received short duration MET (5 repetitions) with Hot Moist Pack (HMP), while group 2 received long duration MET (10 repetitions) with HMP. Outcome measures included Active Knee Extension (AKE), Straight Leg Raise (SLR), and the Sit and Reach test, which were assessed both pre- and post-intervention. Data were analysed using the Wilcoxon signed-rank and Mann-Whitney U tests (p-value <0.05).

Results: Each group demonstrated a statistically significant gain in every outcome measure (p-value =0.001). Between group comparison indicated significant post intervention differences favouring group 2 with effect sizes across AKE (2.49), sit to reach (l.95) and SLR (2.63), indicating a large treatment effect, highlighting the superior efficacy of long duration MET in improving hamstring flexibility.

Conclusion: Both short and long duration MET protocols were effective in improving hamstring flexibility, however, the long duration protocol demonstrated superior outcomes. Incorporating prolonged MET into physiotherapy practice may enhance flexibility interventions for young adults with hamstring tightness.

Keywords: Flexibility, Hamstring muscles, Range of motion, Young adults

INTRODUCTION

The hamstring, situated at the back of thigh, includes the semitendinosus, semimembranosus, and both short and long head of biceps femoris. It enables knee flexion and hip extension [1]. This muscle is essential for daily activities including walking, running and jumping. Hamstring tightness is shown by limited motion range and a feeling of constriction in the posterior thigh [2].

Flexibility is crucial for the body's biomechanical function and is a key component of physical fitness [3]. It reflects the ability of a muscle to elongate and allow the joint to move through its full range of motion. Reduced flexibility occurs when muscle extensibility is diminished, leading to restricted mobility [4]. Hamstring tightness is commonly observed in both active and inactive individuals. Sedentary lifestyle factors, prolonged sitting, and poor postural habits contribute to their onset, while intense physical activity can also predispose individuals to tightness [5]. This condition leads to decreased joint excursion and a reduction in overall flexibility [6]. Physiological mechanisms include reduced muscle extensibility, overuse of muscle groups, faulty postures, and repetitive strain during specific sporting or occupational activities [7]. Based on available evidence, young adults between 18-25 years exhibit a relatively high prevalence of hamstring tightness [8]. Although the prevalence and consequences of hamstring tightness are well established, there is limited evidence on the most effective therapeutic protocols for addressing these problems.

The MET has gained wide acceptance as a manual therapy intervention for improving flexibility and reducing musculoskeletal discomfort. It involves patient-generated isometric contractions against a therapist-applied resistance, followed by relaxation and stretching of the muscle [9]. Two widely applied variations include Post Isometric Relaxation (PIR) and Reciprocal Inhibition (RI). PIR reduces muscle spindle excitability after contraction, allowing increased extensibility [9], whereas RI facilitates flexibility through reflex inhibition of the target muscle by contracting its antagonist [10]. Both have applied to hamstring tightness, with studies demonstrating improvements in flexibility. Joshi TM et al., compared PIR, RI and post-facilitation stretch and concluded that PIR was more effective [11]. These studies reported improvements in flexibility, with PIR showing relatively better outcomes. However, these studies were limited in scope, and the role of treatment duration has not been fully addressed.

The mechanisms underlying MET extend beyond immediate mechanical lengthening. It is believed to improve the viscoelastic properties of muscle tissue, enhance joint mobility, and restore physiological integrity of muscle [12]. Clinical evidence supports its role in reducing stiffness and discomfort in shortened muscles [13]. Additional reports suggest that MET not only lengthens but also strengthens affected muscles by activating Golgi tendon organs and decreasing muscle spindle sensitivity [14,15]. These mechanisms make MET especially relevant for hamstrings, which are prone to adaptive shortening.

A study comparing PIR and RI methods for treating hamstring tightness found that both approaches effectively improve flexibility [9]. In 2008, Smith M and Fryer G explored two MET protocols that varied based on how long the stretch was held after isometric contraction. One using 30-second hold and the other a 3-second hold. They found that both procedures considerably improved hamstring extensibility and improvements were sustained to a one-week follow-up, but no difference was seen between the two procedures. This indicates that both procedures are similarly effective in the short-term, but differences might emerge when longer treatment durations are compared [16]. Similarly, John NA et al., compared short duration (5 repetitions) and long duration (10 repetitions) MET on neck pain and found better outcomes in the long duration protocol [17]. Smith M and Fryer G found no significant differences between short and long duration MET in hamstring flexibility, John NA et al., reported superior outcomes with long duration MET in neck pain [16,17]. These inconsistent findings highlight a lack of clarity regarding the influence of intervention duration, particularly in the context of hamstring tightness.

While the use of MET is becoming more common, an abundance of studies comparing short and long duration in hamstring tightness and indeed across sessions remains sparse. The clinical effects of the duration and repetition across sessions are under investigation. Thus, there remains a paucity of randomised clinical trials directly comparing short versus long duration MET in young adults with hamstring tightness, especially when combined with commonly used adjuncts such as Hot Moist Pack (HMP). This study was designed to address this gap. Therefore, the objective of the present study was to compare the effects of short duration and long duration MET, administered in combination with HMP, on hamstring tightness in healthy young adults.

MATERIALS AND METHODS

The randomised clinical trial was carried out at the KLES Prabhakar Kore Hospital, Belagavi, Karnataka, India, from November 2024 to April 2025. Before the research commenced, ethical clearance acceptance was granted by the Institutional Research and Ethics Committee. Committee for Institutional Research and Ethics Ref No.KIPT/2024/I2/095967. The Clinical Trial Registry, India CTR1/2024/I2/0782I0, also has the trial recorded.

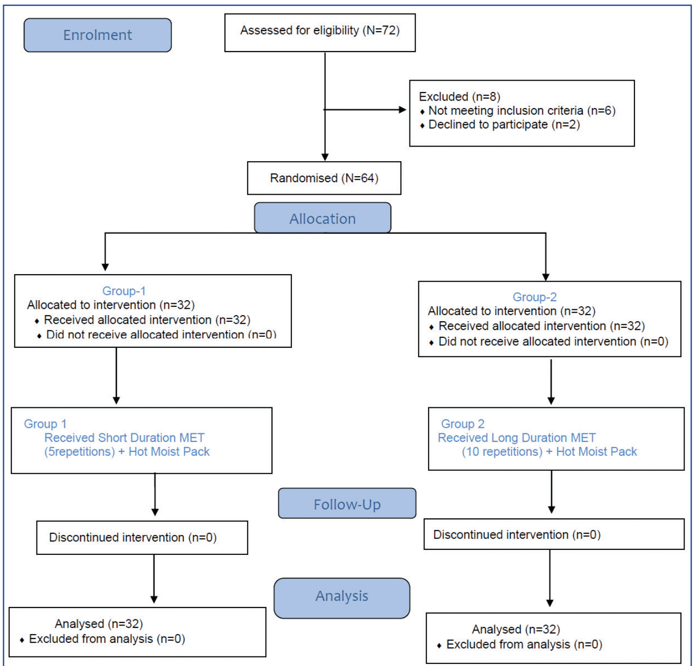
Inclusion criteria: Participants were apparently healthy individuals with hamstring tightness, of all genders, aged 18-25 years [8]. The age group of 18-25 years was specifically chosen because previous studies have reported a higher prevalence of hamstring tightness in young adults within this range [17]. Moreover, this population is frequently exposed to postures such as prolonged sitting, which contribute to hamstring shortening. Participants were included if they had a normal Body Mass Index (BMI) (18.5-22.9 kg/m^2) [17] and an AKE test reading above 20° [18]. During the AKE test, participants lay supine with the hip and knees flexed at 90°. Using a goniometer, the fulcrum was placed on the lateral femoral condyle, the stationary arm aligned with the femur toward the greater trochanter, and the moving arm aligned with the tibia toward the lateral malleolus. As participants extended their knees as far as possible, the angle was recorded. Flexibility was graded as less than 20°=normal, 21-30°=mild tightness, and 31-40°=moderate tightness [18].

Exclusion criteria: Patients with history of any recent lower limb surgery and fractures, patients with history of recent hamstring injury, patient experiencing knee pain, patient having low back pain, and individuals with diagnosed neurological conditions were excluded.

Sample size calculation: The sample size was determined using a paired t-test, at a 5% significance level, an effect size of 0.55 and 80% power [17]. Based on the calculated values, 32 participants per group were required, totaling 64, with an adjustment for a 15% dropout rate. To account for an anticipated 15% dropout rate, the number of participants to be screened increased to 72. A total of 72 subjects were initially screened depending on their inclusion and exclusion criteria. Out of the total 72 subjects, eight participants were excluded: six did not satisfy the criteria (four had an AKE angle less than 20° and two reported active low back pain), while two rejected to participate.

The study recruited apparently healthy volunteers through convenience sampling from the study Institute. A total of 72 individuals were screened for eligibility, of whom 64 met the inclusion criteria and were enrolled in the trial. Screening involved initial history taking, physical examination, and administration of the AKE to confirm hamstring tightness. The remaining 64 individuals were randomly assigned into each group by using the chit method along with non probability convenience sampling from the study Institute. Information about the study was given through word-of-mouth, and volunteers who expressed interest were screened for eligibility. This approach was chosen due to feasibility and accessibility of young adult participants within the specified time frame of the study.

- Group 1 (n=32) received short -duration MET for the hamstring muscle, while
- Group 2 (n=32) underwent long duration MET for the hamstring muscle [17]. Baseline assessments and demographic data were collected before the intervention [Table/Fig-1].



[Table/Fig-1]: Consolidated Standards Of Reporting Trials (CONSORT) diagram.

Study Procedure

Participants who gave their consent were informed about the intervention, goals and methods of study. Before assessing each participant's hamstring tightness, demographic data such as age, gender, height, weight, BMI were collected.

Outcome Measures

Active Knee Extension Test (AKE): Hamstring flexibility was assessed using AKE, which has a high reliability value of 0.92. The test required participants to lie on their backs with their knees and hips bent at a 90° angle. A goniometer was then used to measure the angle with the leg stretched to 180°. The fulcrum was placed at the lateral condyle of the femur, the moving arm was placed along the tibia towards the lateral malleolus, and the stationary arm was placed along the femur towards the greater trochanter [18,19]. The participants were told to take their knees up as much as they could [9,12]. An angle of less than 20° is considered normal, 21° to 30° indicates mild tightness, and 31° to 40° indicates moderate tightness [Table/Fig-2] [18,19].

Straight Leg Raise Test (SLR): To determine hip joint flexibility and Range of motion (ROM), with a reliability of 0.96 and validity of 0.97. Participants laid on their backs. The therapist gently and uniformly lifted the test leg while maintaining a fully extended knee. Efforts were made to prevent any abduction or rotation during the motion. The procedure continued until movement was limited by tightness or pain. According to the SLR angle, hamstring flexibility can be classified as an angle less than 60° denotes tight hamstrings, angle between 60 and 90° indicates normal flexibility, while angle exceeding 90° suggests loose hamstring [Table/Fig-3] [20,21].

[Table/Fig-2]: Active Knee Extension (AKE) test performed in supine position with the hip flexed to 90°. The knee was gradually extended, and the angle formed at the knee joint was measured using a goniometer to assess hamstring flexibility [18,19].

[Table/Fig-3] Straight Leg Raise (SLR) test performed in supine lying. The examiner passively lifted one leg with the knee extended, and the hip flexion angle was measured to evaluate hamstring extensibility [20,21].

Sit to reach test: Participants were told to take a seat on the floor with head, back, hips, and knees in alignment, keeping their legs unhindered and feet pressed flat against the Sit to Reach box. With arms outstretched and palms facing downward, the starting point from their fingertips to the box was noted. Then they were instructed to lean forward gradually, extending their reach while keeping their knees unhindered and sliding their hands along the measurement scale. The therapist ensured proper form, confirming that the heels remained in contact with the box and the knees did not bend. Zero cm mark signified the starting point, with higher values indicating greater flexibility [Table/Fig-4] [22].

[Table/Fig-4]: Sit and Reach test performed in a long sitting with legs extended. The participant leaned forward with both hands, reaching along a measurement box. The distance reached in centimetres was recorded as an indicator of posterior chain flexibility.

Intervention: Both the groups received a 10 minutes of HMP application and MET for hamstring muscle conducted four times for two weeks. The intervention protocol for MET was adapted from previously published studies that have validated the use of MET for hamstring flexibility [9,11,15,16].

Hot Moist Pack (HMP): All participants in both groups received a standardised application of an HMP for 10 minutes before the MET intervention. The HMP was placed over the hamstring muscle belly while the participant lay prone. This procedure was identical for both groups in terms of duration, placement, and temperature, ensuring that the effect of heat therapy was equally distributed. However, since both groups received the same HMP protocol, any differences in outcomes between the groups can be attributed to the variation in MET duration rather than the moist heat application [23].

MET for Hamstring Muscle: Testing the leg was kept in a flexed position at the hip along with the knee. The therapist kept straightening the leg up till the restriction point was found, then instructed the participant to “gradually bend your knee against my resistance, using minimal effort” (with contraction force capped at 25% of the patient’s ability). Participants were told to maintain the contraction for 10 seconds, followed by complete relaxation for 20 seconds, then straighten the leg towards the new barrier [9,24]. To ensure adherence to the protocol, participants were given verbal cues by the therapist to contract and relax. A stopwatch was used to monitor contraction and relaxation time consistently across all participants, and the same therapist conducted all interventions to maintain uniformity.

- Group 1: The participants received an HMP for 10 minutes, followed by short duration MET for 10 seconds, then followed by complete relaxation for 20 seconds, given for five repetitions [9,11,15,16].
- Group 2: The participants received HMP for 10 minutes, followed by long duration MET for 10 seconds, then followed by complete relaxation for 20 seconds, given for 10 repetitions [9,11,15,16].

The difference in repetitions was based on previous literature, which suggests that increasing the number of repetitions may enhance PIR and produce greater improvements in flexibility [16,17]. The comparison of short (5 reps) versus long (10 reps) durations was designed to evaluate whether a prolonged MET protocol provides superior benefits or the shorter one.

STATISTICAL ANALYSIS

Statistical analysis was done with Statistical Package for Social Sciences (SPSS) software version 23.0. To determine normality, the Shapiro-Wilk test was used because the sample size was less than 2000. Normal distribution was not followed by the data (p-value <0.05). Since none of the variables had a p-value greater than 0.05 in the observation, the data set is not normally distributed. In the parts that follow, the researcher employed non parametric tests to analyse the data. The Wilcoxon signed-rank test was used to analyse within-group changes (pre- vs post-intervention). For intergroup comparisons, the Mann-Whitney U test was applied to compare post-intervention differences between group 1 (short duration MET) and group 2 (long duration MET) for each outcome measure (AKE, Sit and Reach, and SLR). All tests were two-tailed, and statistical significance was set at p-value <0.05 with a 95% Confidence Interval (CI).

RESULTS

A total of 72 participants were screened for eligibility. Out of these, eight were excluded; six did not meet the inclusion criteria and two declined to participate. The remaining 64 participants were randomly allocated into two groups (32 in each). All participants completed the intervention and their data were analysed.

Demographic profile: Group 1 consisted of 32 participants (1 male and 31 females) and group 2 included 32 participants (12 males and 20 females). The mean age of participants in group 1 and group 2 was 23.15±1.62 years and 23.12±1.28 years, respectively. The mean BMI was 22.19±2.01 kg/m² in group 1 and 21.36±2.09 kg/m² in group 2. There were no statistically significant baseline differences between the groups in age (p-value=0.749) or BMI (p-value=0.121). The mean height of participants in group 1 was 154.66±17.93 cm, while in group 2 it was 164.03±11.01 cm, showing a statistically significant difference between the groups (p-value=0.018). The mean weight was 58.39±19.04 kg in group 1 and 57.68±9.66 kg in group 2 with no statistically significant difference (p-value=0.501). Overall, there were no significant baseline differences between the groups except for height. All participants were students from the constituent College of Health Science Institutions and hence had a similar educational background. As the sample was drawn from this setting, the participants were relatively homogeneous in socioeconomic status, belonging predominantly to the upper middle class [Table/Fig-5].

Variables	Group 1 (n=32)	Group 2 (n=32)	p-value
Age (in years) (Mean±SD)	23.15±1.62	23.12±1.28	0.749
Height (in meters) (Mean±SD)	154.66±17.93	164.03±11.01	0.018*
Weight (in kg) (Mean±SD)	58.39±19.04	57.68±9.66	0.501
BMI (kg/m²) (Mean±SD)	22.19±2.01	21.36±2.09	0.121
Gender (M/F)	1 / 31	12 / 20	—
Education	Constituents College of health science institutions	Constituents College of health science institutions	
Socioeconomic	Upper middle class	Upper middle class	

[Table/Fig-5]: Comparison of demographic characteristics.
*Independent t-test and Chi-square test were used; p-value <0.05 was considered significant.

Outcome measures: According to the Shapiro-Wilk test, the majority of the variables did not have a normal distribution, non parametric tests were used for analysis (p-value <0.05) [Table/Fig-6]. The Wilcoxon signed-rank test was used for comparisons within groups, while the Mann-Whitney U test was used for comparisons between groups. Less than 0.05 was considered a statistically significant p-value.

Variables	Time frame	Group 1	Group 2		
		z-value	p-value	z-value	p-value
Active Knee Extension (AKE) Test	Pre	0.956	0.212	0.836	0.001
	Post	0.950	0.148	0.939	0.072
Sit To Reach Test	Pre	0.893	0.004	0.931	0.042
	Post	0.961	0.289	0.888	0.003
Straight Leg Raise (SLR) Test	Pre	0.943	0.093	0.894	0.004
	Post	0.902	0.007	0.946	0.114

[Table/Fig-6]: Testing of normality.
*Normality assessed with Shapiro–Wilk test; p<0.05 indicates deviation from normal distribution.

Both groups underwent identical intervention procedures consisting of HMP application for 10 minutes, followed by MET for the hamstring muscles. The only variable that differed between groups was the duration of MET repetitions group 1 received five repetitions (short duration) and group 2 received ten repetitions (long duration).

Within-group comparison: Both groups demonstrated statistically significant improvements (p-value=0.001) across all three outcome measures following intervention. In group 1, mean improvements were 6.09° in AKE, 5.81 cm in Sit and Reach, and 9.75° in SLR. Group 2 demonstrated larger gains of 18.25° in AKE, 13.41 cm in Sit and Reach, and 22.38° in SLR [Table/Fig-7]. After intervention, there was a clear shift toward improved flexibility in both groups. In group 1 (HMP + short duration MET), 21 participants moved

Tests	Groups	Time	Mean±SD	Mean Diff.	p-value
Active Knee Extension (AKE)	1	Pre	46.69±3.67	6.09±1.78	0.001*
		Post	40.59±3.38		
	2	Pre	48.81±4.75	18.25±6.41	0.001*
		Post	30.56±4.57		
Sit to Reach	1	Pre	26.00±4.38	5.81±2.28	0.001*
		Post	31.81±4.42		
	2	Pre	31.00±7.19	13.41±3.25	0.001*
		Post	44.41±7.95		
Straight Leg Raise (SLR)	1	Pre	35.13±5.31	9.75±4.54	0.001*
		Post	44.88±7.52		
	2	Pre	39.88±5.26	22.38±7.86	0.001*
		Post	62.25±5.58		

[Table/Fig-7]: Comparison of AKE, sit to reach, SLR within groups.
*Wilcoxon paired test applied for pre-versus post-comparison; p-value <0.05 considered significant.

to the moderate category, 7 improved to mild tightness and four remained in the severe category. In group 2 (HMP + long duration MET), improvement was greater; 20 participants achieved mild, five achieved normal flexibility levels, and seven remained in the moderate category. This shows that the long duration MET protocol produced more effective improvement in hamstring flexibility compared with the short duration protocol.

Intergroup comparisons: At baseline, there were no significant differences between groups for AKE, Sit and Reach, or SLR. Post-intervention analysis using the Mann-Whitney U test revealed significantly greater improvements in group 2 compared to group 1 for AKE (p-value=0.001, effect size 2.49), Sit and Reach (p-value=0.001, effect size 1.95), and SLR (p-value=0.001, effect size 2.63). These effect sizes indicate a large treatment effect favouring the long duration MET protocol [Table/Fig-8].

Tests	Time	Groups	Mean±SD	p-value	Effect size
Active Knee Extension (AKE)	Pre	1	46.69±3.67	0.078*	2.49
		2	48.81±4.75		
	Post	1	40.59±3.38	0.001**	
		2	30.56±4.57		
Sit to Reach	Pre	1	26.00±4.38	0.003**	1.95
		2	31.00±7.19		
	Post	1	31.81±4.42	0.001**	
		2	44.41±7.95		
Straight Leg Raise (SLR)	Pre	1	35.13±5.31	0.001**	2.63
		2	39.88±5.26		
	Post	1	44.88±7.52	0.001**	
		Group 2	62.25±5.58		

[Table/Fig-8]: Comparison of AKE, sit to reach, SLR Inter- groups.
Intergroup analysis between Group 1 and Group 2 was performed using the Mann-Whitney U test. Effect sizes were calculated to indicate the magnitude of differences. Results were considered statistically significant at the 5% level (*p-value <0.05) and significant at the 10% (**p-value <0.1)

DISCUSSION

This randomised clinical trial evaluated the effect of short-versus long duration MET, in combination with heat therapy, on hamstring tightness in healthy young adults. Both interventions produced significant improvements in AKE, Sit and Reach, and SLR. However, participants receiving the long duration MET protocol showed larger mean gains and very large effect sizes, confirming that increased duration and repetitions enhance the therapeutic effect.

The present findings are consistent with Smith M and Fryer G, who compared 3 second and 30 seconds post-isometric contraction protocols and reported significant improvements in hamstring flexibility with both, although longer durations suggested additional benefit [16]. This trial expands those observations by demonstrating that longer durations with repeated applications result in superior immediate outcomes. Ahmed AR also reported that MET produced greater improvements in AKE compared to dynamic stretching [25], and Sailor S et al., found MET to be more effective than positional release therapy in improving flexibility [26]. These findings are corroborated by the current study, where both groups improved but long- duration MET yielded greater results.

Evidence from other populations further supports these outcomes. John NA et al., compared short- and long duration MET in patients with mechanical neck pain and reported greater reductions in pain and disability in the long duration group [17]. Although their study focused on a different region, the similarity in findings underscores that the enhanced effect of prolonged MET may be attributed to underlying neuromuscular mechanisms common across muscle groups.

Several studies have also demonstrated the superiority of MET compared to conventional stretching methods. Lad D and Patel P concluded that MET was more effective than static or dynamic stretching for improving hamstring flexibility in healthy young adults [27]. Sathe SS et al., compared MET with passive stretching and found that MET achieved significantly greater improvements in AKE [19]. Similarly, Naik PP et al., compared MET with positional release therapy in acute low back pain and reported better functional outcomes with MET [28]. Collectively, these studies confirm the present results, showing that MET is superior to passive and conventional approaches, and that long duration MET provides the greatest benefits.

The mechanisms underlying these outcomes involve both neurophysiological and mechanical adaptations. Smith M and Fryer G described how Post Isometric Relaxation (PIR) reduces muscle spindle excitability, thereby facilitating muscle lengthening [16]. Repeated long duration contractions may also enhance Golgi tendon organ activity, improve stretch tolerance, and promote viscoelastic changes in the muscle-tendon unit [15,17]. These mechanisms explain why long duration MET produced superior outcomes compared to short duration MET. Additionally, increased duration may allow more sustained inhibitory effects on muscle spindles, leading to longer-lasting improvements in flexibility. Although the present study did not directly assess histological adaptations, the consistent functional gains observed are in line with these mechanisms reported in the literature.

From a clinical perspective, the present study results hold significant implications. Hamstring tightness is a common musculoskeletal issue linked to reduced performance, postural deviations, and increased risk of injuries. Interventions that yield rapid and sustained improvements in flexibility are therefore essential in both preventive and rehabilitative settings. The superiority of long duration MET in the present study suggests that therapists may prioritise longer contraction protocols when designing treatment plans for young adults, athletes, or individuals at risk of hamstring strain. In the present study, the differences are expected in effect size because each outcome assesses flexibility through a different biomechanical mechanism: AKE quantifies isolated hamstring extensibility with minimal influence of neural or pelvic components hence, the treatment effect was more uniform producing a higher standardised effect size [29]. Sit and Reach reflects composite posterior chain flexibility involving lumbar, pelvic and hamstring motion. The greater variability in trunk and pelvic movement reduced the standardised effect size despite meaningful clinical gain [30]. SLR includes both hamstring extensibility and neural mechanosensitivity which vary more between individuals this combination led to a slightly higher but more variable effect size [31].Thus, the observed variation does not indicate inconsistency in findings but reflects the different sensitivity and variance structure of each outcome measure. All values however, consistently favoured the long duration MET group supporting the same treatment effect across all parameters.

A major novelty of the present study lies in its direct comparison of short and long duration MET specifically targeting hamstring tightness in young adults, an area where evidence has been limited. Previous studies, such as those by Smith M and Fryer G and John NA et al., have examined contraction duration in other muscle groups, but this study uniquely focuses on hamstrings using three validated outcome measures AKE, SLR, and Sit and Reach for a comprehensive evaluation [16,17]. Another innovative aspect is the integration of heat therapy as a standardised adjunct before MET, ensuring uniform preconditioning of tissues across participants and minimising external variability. By filling these gaps, this trial provides new insights into the influence of contraction duration and adjunct therapy on immediate flexibility outcomes, thereby advancing clinical understanding and guiding manual therapy practice. Future research should therefore include larger and more diverse samples, adopt multicenter designs, and incorporate long-term follow-up to establish the durability and clinical utility of long duration MET.

Limitation(s)

First, the study did not include follow-up to evaluate whether flexibility gains were sustained over time. Second, the trial was conducted in a single Institutional setting with a relatively homogeneous educational and socioeconomic background, which may restrict external validity. Third, blinding of participants and the therapist was not feasible, which may have introduced performance bias.

CONCLUSION(S)

The present randomised clinical trial demonstrated that both short- and long duration MET, when combined with heat therapy, significantly improved hamstring flexibility in healthy young adults. Improvements were evident across AKE, Sit and Reach, and SLR. However, participants treated with long duration MET achieved significantly greater gains, with large effect sizes across all measures. These findings indicate that treatment duration is a critical factor in maximising the effectiveness of MET. Clinically, long duration MET combined with heat therapy may be considered a preferred intervention when the goal is to achieve substantial improvements in hamstring flexibility.

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