THE EFFECTIVENESS OF DSTM VERSUS ICE WITH DSTM ON HAMSTRING FLEXIBILITY ON COLLEGIATE RECREATIONAL ATHLETES - A RANDOMIZED CONTROL TRIAL

by

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MASTER OF PHYSIOTHERAPY (MPT)

In

SPORTS PHYSIOTHERAPY

Under the guidance of

Prof. Joseph Oliver Raj

Dean

Abhinav Bindra Sports Medicine & Research Institute
Bhubaneswar, Odisha

2023

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"The Effectiveness of DSTM versus ICE with DSTM on Hamstring Flexibility on Collegiate Recreational Athletes** - **A Randomized Control Trial"** is a bona fide and genuine research work carried out by me under the guidance of **Prof. Joseph Oliver Raj, DEAN, ABSMARI**.

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Place

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LIST OF ABBREVIATIONS

1. **ABSMARI-** Abhinav Bindra Sports Medicine and Research Institute.
2. **ACSM -** American College of Sports Medicine.
3. **AKET-**Active Knee Extension Test
4. **ANOVA** - Analysis of Variance
5. **BMI -** Body Mass Index
6. **CON** – Control
7. **DSTM-** Dynamic Soft Tissue Mobilization
8. **MCID**- Minimal Clinical Important Difference
9. **SD-** Standard Deviation
10. **SPSS -** Statistical package for social science

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ABSTRACT

The Effectiveness of DSTM versus ICE with DSTM on Hamstring Flexibility on Collegiate Recreational Athletes - A Randomized Control Trial

Background: Recreational athlete aims for social engagement with a less psychological commitment toward sports mostly due to fitness purpose in day-to-day life. Hamstring flexibility is vital for any athlete to attain his/her best performance level as it gives the full range of motion. Any decrease in the flexibility of hamstrings or tightness can cause hamstring injuries which are the most common type of injury among athletes and have a slow recovery rate, making health expenditures high, also decreasing the athlete's performance level. In contact sports, the prevalence of hamstring tightness is very high. There are several techniques to increase hamstring flexibility and Dynamic Soft tissue Mobilization (DSTM) is gaining more popularity in the sports Industry. Unfortunately, there is very less evidence of DSTM on Hamstring muscle flexibility especially when combined with Cyro application.

The study aimed to see the effectiveness of DSTM versus ICE with DSTM on Hamstring flexibility on collegiate recreational athletes

Methods: Sixty collegiate recreational athletes aged between 18-30 years were randomly assigned to DSTM(n=20), ICE+DSTM (n=20), and Control(n=20) groups for 3 weeks. Each intervention was about 10 minutes including a rest period for a total of 9 sessions. Group A -4 min DSTM followed by 2 min Rest followed by 4 min DSTM; Group B-4 min ICE followed by 2 min Rest followed by 4 min DSTM; Group C- 30-sec static hold straight leg Raise for both legs for 3 sets.

Results: Both the DSTM group's Post1 p-Value (0.002), and post2 p-value(0.004) for the right leg and Ice with the DSTM group's post1 p-value(0.000), and post2 p-Value(0.001) for the right leg shows a significant increase in hamstring flexibility whereas Control group post1p-value(0.094)which is not significantly,post2 p-value(0.000) is significant for the right leg. For the Left leg DSTM group post1 p-Value (0.000) which is significant, the post2 p-value(0.17) is not significant compared to Ice with DSTM having both post1 and post2 p-value (0.00) whereas the Control group post1 p-value(0.23) not significant but post-p-value (0.00) shows highly significant in increasing hamstring flexibility.

Interpretation and Conclusion: The study concluded that DSTM with and without Ice application are equally effective in increasing hamstring flexibility but DSTM alone shows a significant increase in hamstring flexibility compared to the Ice with DSTM and Control group the study was limited to recreational athletes so, further research can be done on specific sports populations.

Keywords: Dynamic Soft tissue Mobilization, Flexibility, Ice, Recreational athletes.

INTRODUCTION

Physiotherapists around the globe have been conducting newer trials and have used many different methods to increase joint Range of motion, and flexibility and maintain it for a long period as the hamstring muscle is the most common muscle to be injured in sports, moreover, recreational athletes have fewer insights about muscle flexibility and its advantages. They are at risk of more injury compared to elite competitive athletes. Maintaining adequate hamstring flexibility helps to have better performance and injury prevention. Traditionally stretching is used to increase hamstring flexibility but cryotherapy and Dynamic soft tissue mobilization are newer technique which is being used for better results.

Hamstring Muscle

The word ‘Ham’ referred to the fat and muscle behind the knee and ‘String’ referred to tendons. Thus, Hamstring is a string-like tendon felt on either side of the back of the knee.

The hamstring is the knee flexor and the hip extensor which is placed in the back of the thigh.

It consists of 1. Bicep femoris 2. Semi-tendinous 3. Semi membranous**(1)**

Hamstring muscle injuries are one of the most common musculotendinous injuries in the lower extremity.

These injuries tend to occur and re-occur and limit participation in the competition. **(2)**

RECREATIONAL ATHLETES

Recreational activities are believed to be less psychologically or physically demanding as expectancies regarding performance and commitment to the sports are lower compared with competitive sports.

Recreational sport includes all kinds of physical activity played for fun, participation, or aiming at social engagement. **(3,4)**

FLEXIBILITY

Adequate flexibility, which is the ability to move through a full range of motion (ROM), may aid in the prevention of injuries and enhance athletic performance.

Any decrease in the flexibility of hamstrings or tightness can cause hamstring injuries which are the most common type of injury among athletes and have a slow recovery rate, making health expenditures high, and decreasing the athlete's performance level. In contact sports, the prevalence of hamstring tightness is very high.

It is important to have the normal flexibility of hamstring muscles to move smoothly because the tightness of the hamstrings can lead to various problems like Patellofemoral pain syndrome, and abnormal pelvic tilting, especially in sitting. **(5)**

DYNAMIC SOFT TISSUE MOBILIZATION

DSTM was developed to increase muscle length. It utilizes a combined technique of massage followed by a dynamic component. Where the limb is moved through half of its range or full range.

A significant increase in hamstring length could be achieved by identifying treatment to the specific area of hamstring tightness and targeting treatment to that specific area within the 8-minute time frame, in a single treatment by dynamic soft tissue mobilization.

The beneficial increase in hamstring flexibility post-intervention in DSTM might be due to the dynamic technique which concentrated on one specific area of muscle tightness and incorporates active contractions into a massage protocol which may increase muscle perfusion and decrease muscle stiffness. **(6,7)**

CRYOTHERAPY

Sports scientists are constantly searching for techniques and methods that can help enhance athletic performance and prevent sports injuries. Cryotherapy is a technique that has been widely used in recent years to enhance performance.

The main effects of cryotherapy are probably locally induced and do not interfere with the surrounding tissues. These effects are as follows: 1. cold-induced analgesia; 2. hypometabolism; 3. vascular response.

Cold-induced analgesia - nerve conduction is continually slowed down by decreasing temperature until nerve fiber conduction ceases completely.

Hypometabolism - Recent reports have suggested that the decrease in inflammatory response due to hypometabolism is of greater importance than the vascular response when it comes to limiting the extent of an injury.

Vascular-The blood flow appears to decrease most rapidly at the beginning of the cooling period reflex sympathetic activity and a cold-induced increase in the affinity of the postjunctional a-receptors of the vascular wall. Together with reduced activity in the noradrenaline metabolizing enzymes (MAO and COMT), the increased blood viscosity and aggregated activated platelets which release 5HT and thromboxane A, probably explain the decrease in blood flow. **(8,9)**

NEED OF STUDY

- The effect of a heating modality before stretching has already been proven to have a significant effect on the muscles, however, a cooling modality before stretching is yet to be proven whether it has a significant effect on the muscle before stretching.
- The literature shows that lack of hamstring flexibility may result in major muscle imbalances, predisposing athletes to muscle injuries, patellar tendinopathy, and patellofemoral pain as well as facilitating the development of low back pain.
- Some studies have shown that cryotherapy can improve muscle flexibility when combined with stretching (Lin, 2003; Kennet et al, 2007). Consequently, cryotherapy has been used to decrease pain, swelling, and cellular metabolism (Brukner et al, 2015). Cryotherapy has also been claimed to decrease muscle guarding, which could improve muscle flexibility. **(10,11)**
- Larsen et al (2015) examined the application of crushed ice, and ice cubes to muscles, observing that as muscle temperature decreased the nerve conduction velocity decreased, potentially resulting in an increased range of motion. **(5)**
- However, a systematic review by Bleakley and Costello (2013) argued that there is no conclusive evidence to prove that cryotherapy can affect soft

tissues. They concluded that the poor quality of evidence and the small number of participants within the many included studies meant that findings should be interpreted with some degree of caution. Therefore, research is warranted to examine the effects of cryotherapy on flexibility in physically active individuals. **(8)**

- Study shows that dynamic soft tissue mobilization had an immediate effect as well as the long-term effect on hamstring muscle length, and hence flexibility. These results are unique, have not been previously reported in the literature, and may be worthy of Examination in young athletes. **(12)**
- some studies show immediate effects but no study on its long-term effect.

AIM OF THE STUDY

- To compare the effect of DSTM versus ICE Combined with DSTM on the Hamstring flexibility of collegiate recreational athletes**.**

OBJECTIVES OF STUDY

- To Observe the effect of DSTM on hamstring flexibility in collegiate Recreational Athletes by active knee extension test (AKET).
- To Observe the effect of DSTM combined with Ice on hamstring flexibility in collegiate recreational Athletes by AKET.
- To Compare the effectiveness of DSTM versus ICE with DSTM on hamstring flexibility in collegiate recreational Athletes by AKET.

HYPOTHESES

NULL HYPOTHESIS:

- There is no significant difference between the DSTM Vs Control group on hamstring flexibility in collegiate recreational athletes
- There is no significant difference between the ICE + DSTM Vs Control group on hamstring flexibility in collegiate recreational athletes.
- There is no significant difference between DSTM Vs ICE + DSTM on hamstring flexibility in collegiate recreational athletes.

ALTERNATIVE HYPOTHESIS:

- There is a significant difference between the DSTM Vs Control group on hamstring flexibility in collegiate recreational athletes
- There is a significant difference between the ICE + DSTM Vs Control group on hamstring flexibility in collegiate recreational athletes.
- There is significant difference between DSTM Vs ICE + DSTM on hamstring flexibility in collegiate recreational athletes

REVIEW OF LITERATURE

1. A study was done by **Mohammad Suhail et al, International Journal of Physical Education Sports and Health (2022)**, aimed to compare the effect of dynamic soft tissue mobilization & passive stretching to improve hamstring flexibility in stroke patients. 80 subjects were equally divided into two groups group A & group B. The universal goniometer was used for the measurement of the hip and knee joint range of motion. The Active Knee Extension Test is used to assess hamstring muscle length and the range of active knee extension in the position of hip flexion. The study concluded that the DSTM technique is more effective to improve hamstring flexibility than the Passive stretching technique in stroke patients with hamstring tightness.

2. A study was done by **Devyani Raghwani, and Maximilian M Wdowski, International Journal of Therapy and Rehabilitation (2020)** aimed to compare the effects of stretching with heat, stretching with cryotherapy, and stretching alone on hamstring flexibility in physically active women. A total of 30 physically active women aged 18–25 years, with average norm scores for hamstring flexibility of 19–20 inches (50 cm) in sit and reach tests, were recruited for the study. A sit and reach test and the 90/90 active knee extension test were conducted before and after a 20-minute stretching routine to measure hamstring

flexibility. The study concluded that Combining stretching with cryotherapy or heat application potentially provides no additional benefit to stretching alone in short-term enhancements to hamstring muscle flexibility in physically active females.

3. A Study was done by **Mohsin Abbas et al in the Journal Pak Med Assoc (2017) aimed to compare the effectiveness of Dynamic Soft Tissue Mobilization DSTM with Passive Stretching Technique to improve the flexibility of tight hamstrings in cricket players** A total of 120 cricket players having tightness hamstrings were enrolled and randomized into two groups A and B using lottery method. Group-A was treated with DSTM and Group B with PS to improve the flexibility of the hamstrings. Active Knee Extension Angle AKEA with goniometer was used as an indicator of hamstring flexibility range. The study concluded that dynamic soft tissue mobilization (DSTM) produces better results than PS to improve hamstring flexibility in cricket players.

4. A Study was done **by Leyla Sefiddashti et al, Journal of Bodywork and Movement Therapies (2017)**aimed to compare The effects of cryotherapy versus cryo-stretching on clinical and functional outcomes in athletes with an acute hamstring strain,37 elite athletes with an acute grade I or II hamstring strain were randomly assigned to either cryotherapy (n = 19) or cryo-stretching (n = 18) group, receiving 5 sessions of supervised treatment plus home-based intervention monitored by the therapist. Conclusion: A rehabilitation protocol

involving gentle stretching following cryotherapy is more effective than cryotherapy alone in the improvement of function and passive knee range of motion in patients with grade I and II hamstring strain.

5. A Study was done by **Mc-Bernard S. Gregorio et al, UERM health sciences Journal (2016) aimed to compare the long-term effects of stretching with ice compared to stretching with heat.** Students from a physical therapy school in Quezon City who were determined to have tightness of the hamstring muscle participated in the study. A paired t-test was used to compare the ROM of the subject's hamstrings before and after the treatment.19 An unpaired t-test was used to compare the ROM of the hamstrings of the hot and cold groups. The study concluded that n Cold therapy before stretching appears to be a more effective option than heat in addressing hamstring muscle extensibility problems.

6. A study was done by **Chelsea C. Larsen et al the Journal of Strength and Conditioning Research (2015)** aimed to determine which type of cryotherapy, crushed or wetted ice, would produce the greatest gains in hamstring ROM followed by proprioceptive neuromuscular facilitation (PNF) stretching. Fifteen healthy subjects, 8 men and 7 women. 3 ROM measurements of the hip joint were taken by the same using a standard goniometer and averaged for a baseline measurement. The study concluded that there were no differences between wetted ice and crushed ice. It can increase ROM with both forms of ice in combination with PNF stretching more so than when using no ice at all.

7. A study was done by **Tiago Neto et al The Journal of Sport Rehabilitation (2015) aimed to establish the reliability of the active knee extension and straight leg raise test in subjects with flexibility deficits**,102 recreationally active participants (48 male, 54 female) with no injury to the lower limbs and with flexibility deficits in the hamstrings muscle group. Intra-rater reliability was determined using the ICC, complemented by the SEM and MDD. The ICC values found for AKE and SLR tests were, respectively, .87–.94 and .93–.97. The values for SEM were low for both tests (2.6–2.9° for AKE, 2.2–2.6° for SLR), as well as the calculated MDD (7–8° for AKE; 6–7° for SLR). Conclusions: These findings suggest that both AKE and SLR have excellent intra-rater reliability. The SEMs and MDDs recorded are also very encouraging for the use of these tests in subjects with flexibility deficits.

8. A Study was done by **Chris M. Bleakley et al Dove Press Journal (2014) aimed to review the efficacy and effectiveness of WBC using empirical evidence from controlled trials.** We found ten relevant reports; the majority were based on small numbers of active athletes aged less than 35 years. There were no adverse events associated with WBC; however, studies did not seem to undertake active surveillance of predefined adverse events. Until further research is available, athletes should remain cognizant that less expensive modes of

cryotherapy, such as local ice-pack application or cold-water immersion, offer comparable physiological and clinical effects to WBC.

9. A study was done by **Mohamad Shariff A Hamid et al. Physical Therapy. Sci 2013, aimed to determine the reliability of the active knee extension (AKE) test among healthy adults.** A convenient sample of 16 healthy participants 10 men and 6 women taken in the study. The test-retest reliability in this study was excellent, with ICC values ranging from 0.78 to 0.92.

10. A Study was done by **Chris Bleakley et al. The American Journal of Sports Medicine (2004)** systematic review assessing the evidence base for cryotherapy in the treatment of acute soft-tissue injuries. Twenty-two trials met the inclusion criteria. There was a mean PED-ro score of 3.4 out of 10. There was marginal evidence that ice plus exercise is most effective, after ankle sprain and post-surgery. There was little evidence to suggest that the addition of ice to compression had any significant effect, but this was restricted to the treatment of hospital inpatients. Conclusion: Many more high-quality trials are needed to provide evidence-based guidelines in the treatment of acute soft-tissue injuries.

METHODOLOGY

- Study design –Randomized control trial
- Study population – Colligate recreational athlete
- Sample size – 60
- The sample size was calculated by using the formula -$2K \times sd^2/d^2$
- Sample technique – Purposive sampling
- Study setting – Abhinav Bindra Sports Medicine and Research Institute.
- Study duration -6 months

INCLUSION CRITERIA

- Age -18-30
- Gender – male and female
- Playing a recreational field sport for more than 1 year
- Play at least 3 days per week and for at least 1-2 hours.
- Mechanical active extension knee angle less than 165 degrees.

- Subjects who have given consent.

EXCLUSION CRITERIA

- Any recent Musculoskeletal injuries such as pelvic or lower limb fractures, or hamstring tears within 6 months.
- Paresthesia in the hamstring region due to any neurological conditions.
- Any kind of communicable skin disease.
- Subjects having cold allergies.

MATERIALS USED:

1. Stopwatch
2. Universal goniometer
3. Couch
4. Yoga mat (13mm thickness)
5. Inclinometer

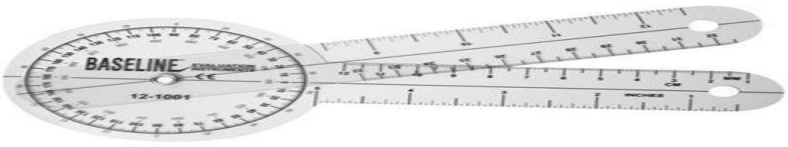

FIG 6.1 UNIVERSAL GONIOMETER

OUTCOME MEASURE:

- **AKET- Active Knee Extension Test(13–15)**

FIG 6.2 Active Knee Extension Test

STUDY PROCEDURE

The present study was reviewed and approved by the institutional ethical committee. A total of 70 samples were selected by using purposive sampling where 60 subjects were selected based on inclusion criteria and by exclusion criteria 10 subjects were excluded.

They were included in this study with some criteria like collegiate recreational athletes who were playing field sports for at least 3 days per week. The study

protocol was explained to all participants and their consent was filled by all participants,

Groups allocation was done by using Block Randomization (2 boxes for male and

2 for females each box contains 15 pieces of paper (5 -A, 5-B, 5-C))

20 subjects (10 males, 10 females) were placed in Group A (Experimental group)

20 subjects (10 males, 10 females) were placed in Group B (Experimental group)

20 subjects (10 males, 10 females) were placed in group C (Control group)

Baseline assessments were taken by using AKET.

All groups took intervention for 10 min per day including a rest period.

Group A subjects were given Dynamic soft tissue mobilization; Group B subjects were given ice followed by Dynamic soft tissue mobilization; Group C subjects were asked to do active static stretching of the hamstring muscle.

Subjects were given intervention for 3 days per week (alternative day) for 3 weeks.

At the end of 3rd-week post-intervention (9 sessions) was taken and at the end of the 4^{th} week using AKET.

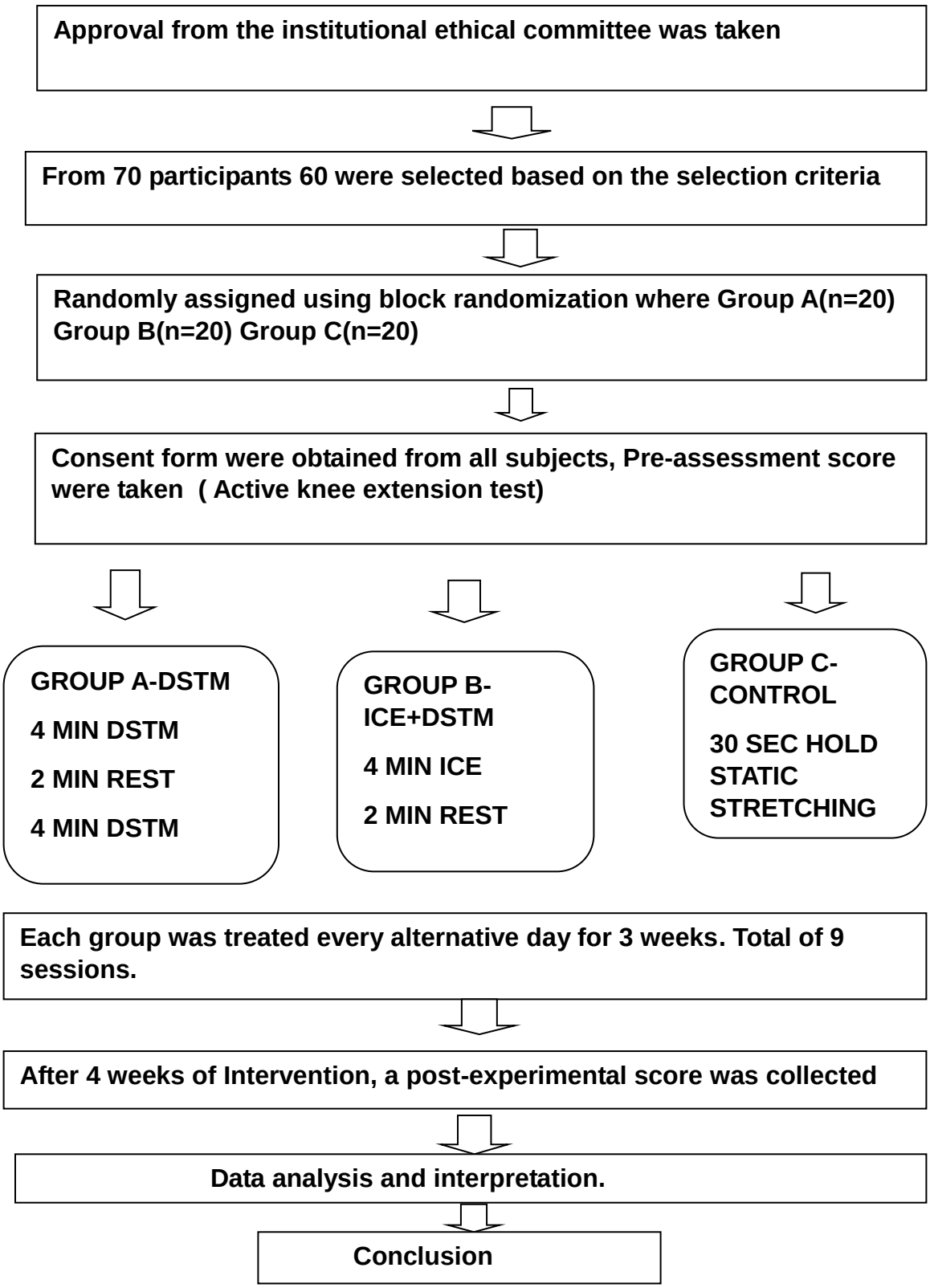

FIG 7.1 FLOW CHART OF STUDY PROCEDURE

INTERVENTION

GROUP A-Dynamic soft tissue mobilization

- To assess the hamstring muscle group, the subject remained in the prone position, and deep longitudinal strokes were applied to this entire muscle group.
- Once the specific area of hamstring muscle tightness was located, the remaining treatment was limited to this target area only.
- For DSTM, prone position, Deep longitudinal strokes were applied in a distal to proximal direction to the area of hamstring tightness when the leg was passively moved to the hamstring lengthened position.
- Next part of this technique, the subject was required to actively extend their leg, to achieve reciprocal inhibition of the hamstrings. In the final technique, the subject was required to work for the hamstring muscle group eccentrically by creating tension in the therapist's hand as the muscle was elongated to the end ROM.
- During this movement, the therapist performed five deep distal to proximal longitudinal strokes over the reduced hamstring area of muscle tightness.
- Intervention was given in two-phase= 4-MINUTE DSTM -2 MINUTE REST-4 MINUTE DSTM.
- Total protocol was 10 min including Rest time for all 9 sessions for 3 weeks. **(6,16–18)**

FIG 7.2 Application of Dynamic Soft Tissue Mobilization

GROUP B – ICE +Dynamic Soft Tissue Mobilization

- To assess the hamstring muscle group, the subject remained in the prone position, and deep longitudinal strokes were applied to this entire muscle group.
- Once the specific area of hamstring muscle tightness was located, the remaining treatment was limited to this target area only.
- Subjects were applied with stroking of ice cubes on the whole length of the hamstring muscle.
- Followed by 2 minutes of rest.

- For DSTM, prone position, Deep longitudinal strokes were applied in a distal to proximal direction to the area of hamstring tightness when the leg was passively moved to the hamstring lengthened position.
- Next part of this technique, the subject was required to actively extend their leg, to achieve reciprocal inhibition of the hamstrings. In the final technique, the subject was required to work for the hamstring muscle group eccentrically by creating tension in the therapist's hand as the muscle was elongated to the end ROM.
- During this movement, the therapist performed five deep distal to proximal longitudinal strokes over the reduced hamstring area of muscle tightness.
- Intervention was given in two-phase= 4-MINUTE ICE -2 MINUTE REST-4 MINUTE DSTM
- Total protocol was 10 min including Rest time for all 9 sessions for 3 weeks. **(5,8,19)**

FIG 7.3 Application of Ice+ Dynamic Soft Tissue Mobilization

GROUP C- STATIC STRETCHING

- Subjects were instructed to lie supine on the yoga mat and to keep their left leg straight while performing a straight leg raise with the right leg and right leg straight while performing a straight leg with the left leg.
- When performing straight leg raise, the participant was constantly reminded and prompted to keep the leg straight and not bend the knee.
- Intervention-30-second static hold -15 second rest- 30-second static hold for alternative leg for a total of 3 sets.
- Total protocol was a maximum of 5-10 min including Rest time for all 9 sessions for 3 weeks. **(6,9,10)**

GROUP	INTERVENTION	TREATMENT PROTOCOL	REST
GROUP A	DSTM	DSTM	2 MIN
GROUP B	ICE+DSTM	ICE+DSTM	2 MIN
GROUP C	CONTROL	STATIC STRETCHING	15 SEC

TABLE 5.1. TREATMENT PROTOCOL

SAMPLE SIZE ESTIMATION

Sample size calculation was done by using the formula for experimental studies

(Outcome – AKET)

$n=2k\ SD^2 / d^2$

n= Number of samples

k= Power

SD=Standard Deviation

d = MCID Value

K =10.5

SD= 0.97

d (MCID)=1.8

$n= 2k \times SD^2/d^2$

$n=21 \times (0.97)^2/ (1.8)^2$

=16.27 added 3 dropouts

=20 per group (3 groups are there so a total of 60 subjects**)**

STATISTICAL ANALYSIS

Data were analyzed using the statistical package SPSS 29.0 **(SPSS Inc, Chicago, IL), and the level of significance was set at** $p<0.05$ Descriptive statistics **were performed to assess the mean and standard deviation of specific groups. The normality of the data was assessed using the** Kolmogorov-Smirnov test. Interferential statistics **to find out the difference between groups was done using** paired t-test **and analysis between three groups was done using** ONE WAY ANOVA followed by Tukey's HSD post hoc analysis **to find out the difference between any two groups.**

TABLE 6.1. MEAN AGE ANALYSIS

GROUP AGE	MEAN± SD
1	**22.50±3.052**
2	**19.95±1.877**
3	**21.60±2.981**

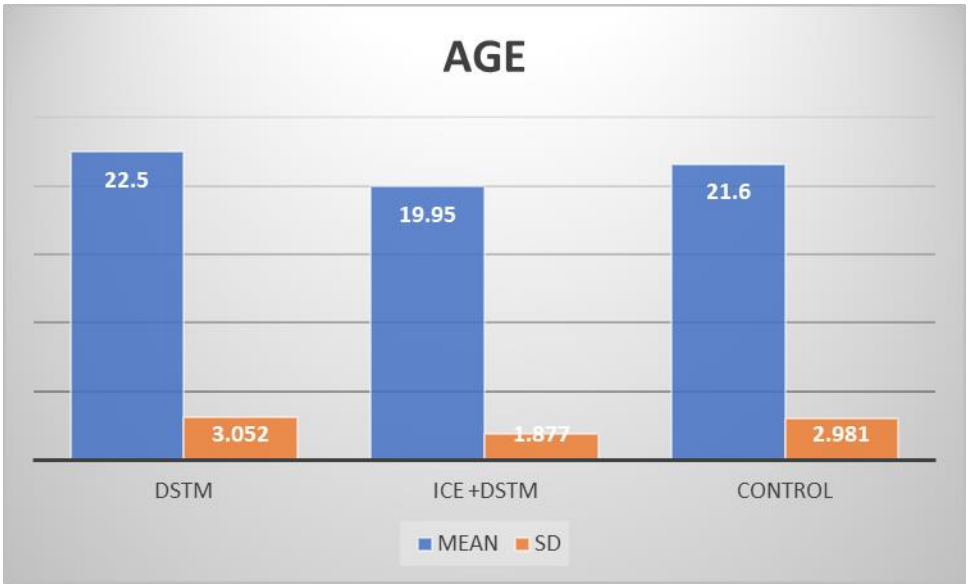

FIG 8.1 GRAPHICAL REPRESENTATION OF MEAN AGE

TABLE 6.2. MEAN BMI ANALYSIS

GROUP BMI	MEAN± SD
1	23.53±4.212
2	23.22±4.295
3	23.33±3.129

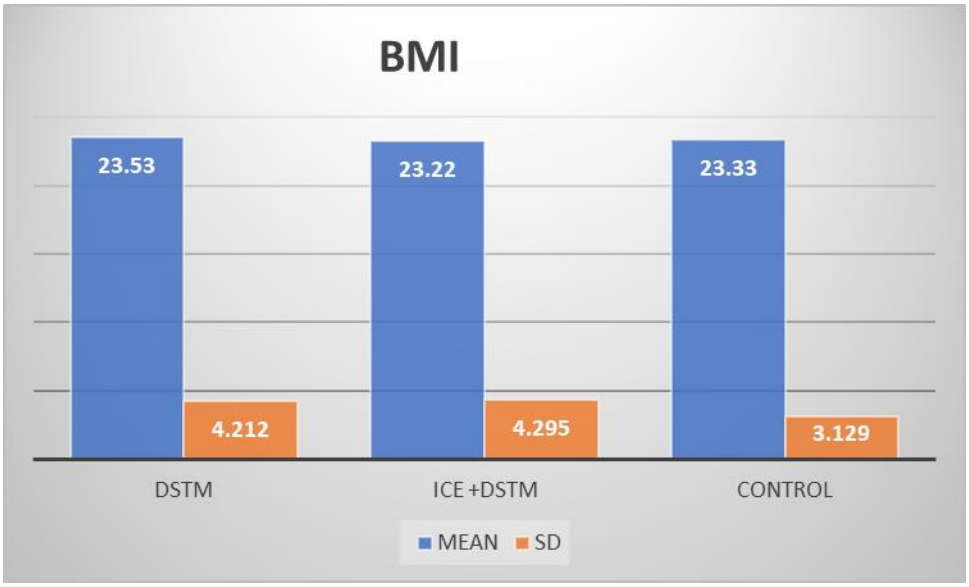

FIG 8.2 GRAPHICAL REPRESENTATION OF MEAN BMI

Group	Pre	Post1	MD	p-value	Post2	MD	Sign	Post1-2 MD	p-value
1.	130.75	136.25	5.50	0.002	132.25	1.50	0.445	4.000	0.004
2.	123.50	133.25	9.75	0.000	128.75	5.25	0.015	4.500	0.001
3.	122	124.75	2.75	0.094	118.50	3.50	0.027	6.25	0.000

TABLE 6.3. WITHIN THE GROUP FOR RIGHT LEG

Within the group for right leg analysis with paired t-test indicates Statistical difference within the group DSTM($p<0.005$), ICE+DSTM($p<0.005$), CON ($p>0.005$). The difference in mean value was reported as follows ICE+DSTM>DSTM>CON

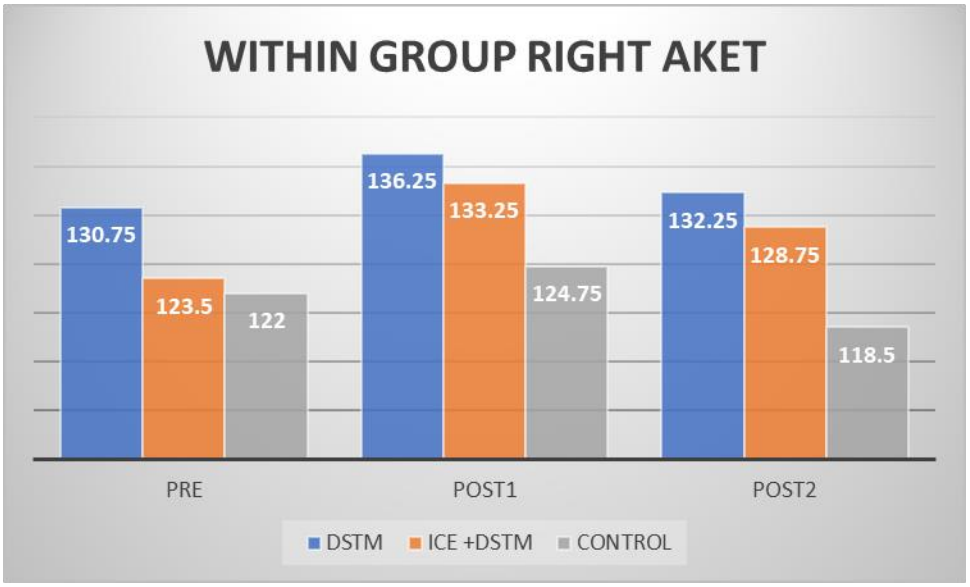

FIG 8.3 WITHIN THE GROUP RIGHT LEG

TABLE 6.4. WITHIN THE GROUP FOR LEFT LEG

Group	Pre	Post1	MD	p-value	Post2	MD	Sign	Post1-2	p-value
1	130.25	137.10	6.85	0.00	134	3.75	0.131	3.10	0.17
2	124.5	133.75	9.25	0.00	128.25	3.75	0.056	5.50	0.00
3	122.50	124.75	2.25	0.23	118	4.50	0.014	6.75	0.00

Within the group for Left leg analysis with paired t-test indicates Statistical difference within the group DSTM($p<0.005$), ICE+DSTM($p<0.005$), CON ($p>0.005$). The difference in mean value was reported as follows ICE+DSTM>DSTM>CON

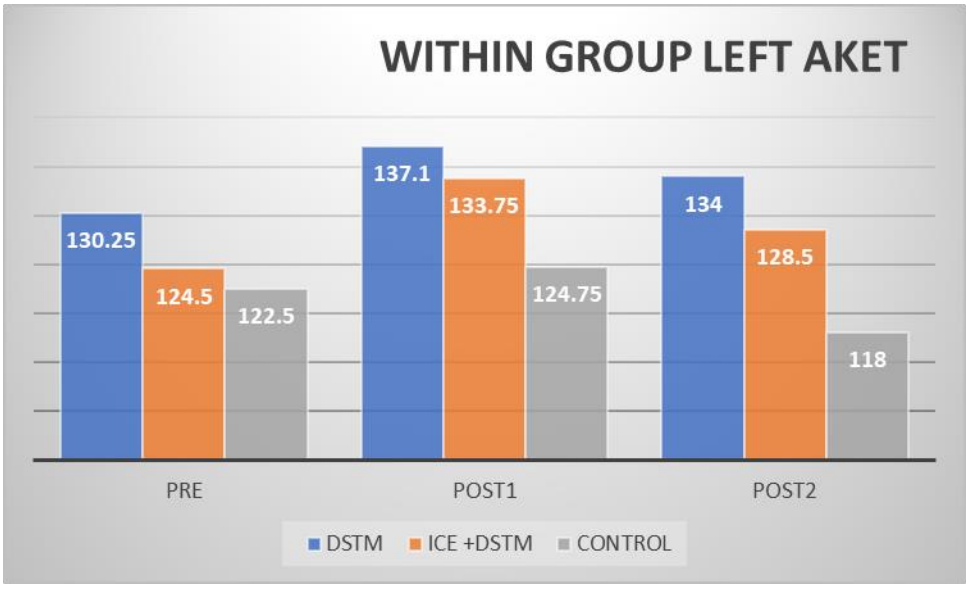

FIG.8.4 WITHIN THE GROUP LEFT LEG

TABLE 6.5 BETWEEN GROUP

OUTCOME	GROUP	MEAN DIFFERENCE BETWEEN GROUPS	P-VALUE
POST 1 RIGHT	GROUP1 VS GROUP 2	3.000	0.657
	GROUP 1 VS GROUP 3	11.500	0.004
	GROUP 2 VS GROUP 3	8.500	0.42
POST 2 RIGHT	GROUP1 VS GROUP 2	3.500	0.607
	GROUP 1 VS GROUP 3	13.750	0.001
	GROUP 2 VS GROUP 3	10.250	0.019
POST 1 LEFT	GROUP1 VS GROUP 2	3.350	0.646
	GROUP 1 VS GROUP 3	12.350	0.005
	GROUP 2 VS GROUP 3	9.000	0.051
POST 2 LEFT	GROUP1 VS GROUP 2	5.750	0.330
	GROUP 1 VS GROUP 3	16.000	0.001
	GROUP 2 VS GROUP 3	10.250	0.035

Between-group analysis by one-way ANOVA followed by Tukey post hoc test indicates a statistically significant difference between post 1(DSTM) vs post 3(CON), post 2(ICE+DSTM) vs post 3(CON) group ($p<0.05$) and no statistically significant difference between Post 1(DSTM) vs post 2(ICE+DSTM).

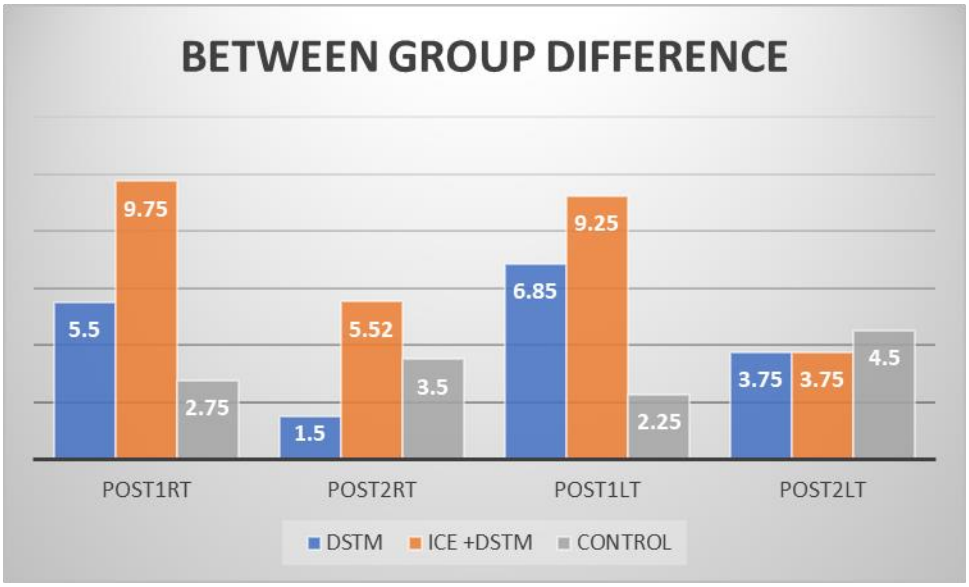

FIG.8.5. BETWEEN GROUP COMPARISON

DISCUSSION

The present study aimed to investigate the effectiveness of Dynamic Soft Tissue Mobilization (DSTM) and Ice Application with Dynamic Soft Tissue Mobilization (ICE with DSTM), on improving hamstring flexibility in collegiate recreational athletes. The randomized controlled trial design allowed us to compare the outcomes of both interventions, providing valuable insights into their respective contributions to hamstring flexibility enhancement.

Our findings demonstrated that both interventions, DSTM and ICE with DSTM, significantly improved hamstring flexibility among collegiate recreational athletes compared to the baseline measurements. These results suggest that incorporating a targeted intervention, whether with or without ice application, can be beneficial for improving flexibility in this specific population.

Notably, the DSTM intervention showed a statistically significant improvement in hamstring flexibility when compared to the ICE+DSTM group. This difference suggests that Dynamic Soft Tissue Mobilization alone may be more effective in increasing hamstring flexibility than when combined with ice application. The possible explanation for this finding could be attributed to the fact that dynamic Soft Tissue Mobilization enhances blood flow and activates muscle spindle receptors, promoting greater flexibility gains. On the other hand, the application

of ice might have led to temporary vasoconstriction and muscle stiffness, potentially limiting the immediate effects of the tissue mobilization intervention.

As we incorporate 8 minutes of Dynamic soft tissue mobilization to the DSTM group compared to only 4 minutes of DSTM to the ICE+DSTM group, this may be the reason why the DSTM group shows a significant increase in flexibility when compared to ICE with the DSTM group.

In the present study, the subjects were chosen from the age group 18 to 30 years which was supported by the previous study. **(20)**

Cold, with its ability to inhibit stretch reflex and pain, inhibiting the protective responses of muscle spindles and Golgi tendon organs, also promotes increased flexibility.

A 2014 study by Park, Kwon, Weon, Choung, and Kim however found that the application of local cryotherapy improved both passive and active ROM in subjects with tight muscles by reducing stretch sensitivity and increasing pressure pain threshold, even without stretching maneuvers. **(5)**

Post-follow-up Maintenance in DSTM and Control group is significant and all other groups are equally effective in both the right and left leg.**(17)**

Our results align with previous studies that have demonstrated the benefits of dynamic soft tissue mobilization in improving flexibility and athletic performance. Moreover, our study extends these findings by assessing the potential impact of combining ice application alongside DSTM. While both interventions led to

positive outcomes, the data indicate that the DSTM group exhibited superior improvements in hamstring flexibility.

It is important to acknowledge some limitations of our study. First, the sample size was relatively small, which might limit the generalizability of the results. Future research with larger and more diverse participant groups could provide further insights into the effectiveness of these interventions. Second, the duration of the intervention period might have influenced the extent of improvements observed. Longer-term studies could shed light on the sustainability and durability of the flexibility gains achieved with these interventions

CONCLUSION

In conclusion, our study investigated the effectiveness of two interventions, Dynamic Soft Tissue Mobilization (DSTM) and Ice Application with Dynamic Soft Tissue Mobilization (ICE with DSTM), on improving hamstring flexibility in collegiate recreational athletes. The findings from this randomized controlled trial provide valuable insights into the efficacy of these interventions for enhancing flexibility in this specific population.

Both DSTM and ICE with DSTM interventions demonstrated significant improvements in hamstring flexibility compared to baseline measurements, indicating that incorporating targeted interventions can effectively enhance flexibility in collegiate recreational athletes. However, the DSTM intervention showed a statistically significant advantage over the ICE+DSTM group,

suggesting that Dynamic Soft Tissue Mobilization alone may be more effective in increasing hamstring flexibility than when combined with ice application.

These results reinforce the importance of Dynamic Soft Tissue Mobilization as an effective intervention for improving flexibility and athletic performance in collegiate recreational athletes. Moreover, our study highlights the potential benefits of incorporating manual therapy alongside dynamic stretching exercises. Coaches, trainers, and therapists can utilize these findings to design evidence-based flexibility training programs for their athletes, optimizing performance and reducing the risk of injuries. Further research is warranted to explore these interventions' long-term effects and practical implications in various athletic contexts.

BIBLIOGRAPHY

1. **Grays anatomy.**

2. **Ekstrand J, Gillquist J. The frequency of muscle tightness and injuries in soccer players. Am J Sports Med. 1982;10(2):75–8.**

3. **Coronado VG, Haileyesus T, Cheng TA, Bell JM, Haarbauer-Krupa J, Lionbarger MR, et al. Trends in Sports- and Recreation-Related Traumatic Brain Injuries Treated in US Emergency Departments: The National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP) 2001-2012. J Head Trauma Rehabil. 2015;30(3):185–97.**

4. **Mountjoy M, Rhind DJA, Tiivas A, Leglise M. Safeguarding the child athlete in sport: a review, a framework, and recommendations for the IOC youth athlete development model. Br J Sports Med. 2015 Jul;49(13):883–6.**

5. **Larsen CC, Troiano JM, Ramirez RJ, Miller MG, Holcomb WR. Effects of crushed ice and wetted ice on hamstring flexibility. J Strength Cond Res. 2015;29(2):483–8.**

6. **Abbas M, Bashir MS, Noor R. A comparative study of dynamic soft tissue mobilization vs. passive stretching technique to improve the flexibility of hamstrings in cricket players. JPMA J Pak Med Assoc. 2017 May;67(5):779–81.**

7. **Hopper D, Deacon S, Das S, Jain A, Riddell D, Hall T, et al. Dynamic soft tissue mobilization increases hamstring flexibility in healthy male subjects. Br J Sports Med. 2005;39(9):594–8.**

8. **Brodowicz GR, Welsh R, Wallis J. Comparison of stretching with ice, stretching with heat, or stretching alone on hamstring flexibility. J Athl Train. 1996 Oct;31(4):324–7.**

9. **Medeiros DM, Cini A, Sbruzzi G, Lima CS. Influence of static stretching on hamstring flexibility in healthy young adults: Systematic review and meta-analysis. Physiother Theory Pract. 2016 Aug;32(6):438–45.**

10. **Raghwani D, Wdowski MM. The effects of stretching with cryotherapy, stretching with heat, and stretching alone on hamstring flexibility in physically active females. Int J Ther Rehabil. 2020;27(9):1–9.**

11. **Sefiddashti L, Ghotbi N, Salavati M, Farhadi A, Mazaheri M. The effects of cryotherapy versus try stretching on clinical and functional outcomes in athletes with an acute hamstring strain. J Bodyw Mov Ther. 2018 Jul;22(3):805–9.**

12. **Hopper D, Conneely M, Chromiak F, Canini E, Berggren J, Briffa K. Evaluation of the effect of two massage techniques on hamstring muscle length in competitive female hockey players. Phys Ther Sport. 2005;6(3):137–45.**

13. **Gajdosik R, Lusin G. Hamstring muscle tightness. Reliability of an active-knee-extension test. Phys Ther. 1983 Jul;63(7):1085–90.**

14. **Hamid MSA, Ali MRM, Yusof A. Interrater and Intra-rater Reliability of the Active Knee Extension (AKE) Test among Healthy Adults. J Phys Ther Sci. 2013 Aug;25(8):957–61.**

15. **Neto T, Jacobsohn L, Carita AI, Oliveira R. Reliability of the Active-Knee-Extension and Straight-Leg-Raise Tests in Subjects With Flexibility Deficits. J Sport Rehabil. 2015 Nov 1;24(4):2014–0220.**

16. **Pandya J, Tank KD. A study to find out the effect of dynamic soft tissue mobilization (DSTM) with retro-walking on hamstring flexibility and dynamic balance in young collegiate students–An interventional study. Indian J Public Health Res Dev. 2020;11(7):324–9.**

17. **Nafees K, Baig AAM, Ali SS, Ishaque F. Dynamic soft tissue mobilization versus proprioceptive neuromuscular facilitation in reducing hamstring muscle tightness in patients with knee osteoarthritis: a randomized control trial. BMC Musculoskelet Disord. 2023 Jun 2;24(1):447.**

18. **Hunter G. Specific soft tissue mobilization in the management of soft tissue dysfunction. Man Ther. 1998 Feb;3(1):2–11.**

19. **Gregorio M, Bernabe RL, Bondoc LPC, Castillo JRB. A comparison of stretching with ice vs stretching with the heat on hamstring flexibility among physical therapy students. UERM Health Sci J. 2016;5(1):15–9.**

20. **Akinpelu AO, Bakare U, Adegoke B. Influence of age on hamstring tightness in apparently healthy Nigerians. J Niger Soc Physiother. 2005;15(2):35–42.**

ANNEXURE 1

ABHINAV BINDRA
Sports Medicine & Research Institute
A Unit of the Abhinav Bindra Foundation Trust
Recognised by DMET, Health & FW Dept., Govt. of Odisha, Affiliated to Utkal University
Recognised by Odisha State Council for Occupational Therapy and Physiotherapy

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Reference No. – ABSMARI/IRB/04/2023
Date: 05th May 2023

INSTITUTIONAL REVIEW BOARD

To
Mr Nabagopal Sarkar
Post Graduate student, Department of Physiotherapy,
Abhinav Bindra Sports Medicine and Research Institute (ABSMARI).

This is to certify that your proposal for the study titled "**The Effectiveness of DSTM vs Ice with DSTM on Hamstring flexibility on collegiate Recreational Athletes - A Randomized Controlled Trial**" has been taken for discussion in the meeting held on 20th Apr 2023. Following the meeting, the committee approves the proposal and it has no objection on the study being carried out.

You are advised to familiarize yourself with the ICMR guidelines on biomedical research in human subjects and also adhere to the principles of Good Clinical Practice. You are hereby directed to submit the final report to the committee, on completion of the study. Any case of adverse reactions should be informed to this ethics committee and action will be taken thereafter.

Any such adverse reactions during the course of the study are the sole responsibility of the Principal Investigator and there is no onus on the Ethical Committee members resulting thereof.

We wish you all the best for your study.

Member Secretary

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE

Chair Person

ANNEXURE-2

MASTERCHART

SERIAL N	Age	group	Sex	Height	Weight	B.M.I	pro aket right	part 1 right	part 2 right	part1-pro R	part2-pro R	pro aket left	part 1 left	part 2 left	Part1-pro L	Part2-pro L
1	27	1	F	162	61	23.2	120	130	125	10	5	120	130	120	10	0
2	22	1	F	154	42.5	17.9	140	145	145	5	5	140	142	145	2	5
3	18	1	F	160	66	25.8	125	140	140	15	15	125	140	135	15	10
4	19	1	F	161	63	24.3	150	160	155	10	5	150	170	170	20	20
5	19	1	F	151	54	23.7	140	150	145	10	5	140	150	150	10	10
6	23	1	F	157	54	21.9	140	130	130	-10	-10	140	140	130	0	-10
7	22	1	F	159	79	31.2	130	135	150	5	20	135	135	170	0	35
8	24	1	F	163	51	19.2	135	140	130	5	-5	130	140	130	10	0
9	27	1	F	158	52	20.8	120	130	125	10	5	120	130	120	10	0
10	19	1	F	153	50	21.4	130	135	130	5	0	120	130	125	10	5
11	25	1	M	158	57	22.8	145	145	135	0	-10	140	145	140	5	0
12	24	1	M	179	66	20.6	150	155	145	5	-5	150	155	150	5	0
13	25	1	M	165	76	27.9	125	125	120	0	-5	120	125	120	5	0
14	26	1	M	165	88	32.3	130	130	125	0	-5	135	130	125	-5	-10
15	21	1	M	169	73	25.6	115	110	105	-5	-10	110	110	110	0	0
16	26	1	M	172	72	24.3	130	140	135	10	5	130	140	130	10	0
17	19	1	M	165	43	15.8	130	135	135	5	5	130	140	135	10	5
18	24	1	M	177	69	22	120	125	115	5	-5	120	125	120	5	0
19	22	1	M	169	60	21	120	125	120	5	0	130	130	120	0	-10
20	18	1	M	185	99	28.9	120	140	135	20	15	120	135	135	15	15
21	19	2	F	163	56	21.1	120	130	125	10	5	130	140	125	10	-5
22	19	2	F	153	57	24.3	120	135	135	15	15	120	140	135	20	15
23	18	2	F	160	47	18.4	130	135	135	5	5	130	135	130	5	0
24	18	2	F	154	67	28.3	110	130	125	20	15	120	130	120	10	0
25	19	2	F	154	52	21.9	120	140	135	20	15	120	140	135	20	15
26	21	2	F	164	48	17.8	130	135	130	5	0	130	140	130	10	0
27	22	2	F	150	50	22.2	140	150	145	10	5	150	150	140	0	-10
28	22	2	F	156.5	61	24.9	140	140	135	0	-5	140	140	135	0	-5
29	25	2	F	155	62	25.8	120	125	120	5	0	120	125	120	5	0
30	19	2	F	153	69	29.5	110	120	110	10	0	105	110	115	5	10
31	20	2	M	166	44	16	120	120	120	0	0	125	130	120	5	-5
32	19	2	M	178	61	19.3	120	130	130	10	10	120	130	125	10	5
33	21	2	M	170	58	20.1	160	160	150	0	-10	145	150	145	5	0
34	23	2	M	163	45	16.9	120	130	120	10	0	120	125	120	5	0
35	18	2	M	161	62	23.9	120	135	130	15	10	120	140	130	20	10
36	20	2	M	177	76	24.3	120	130	135	10	15	125	130	140	5	15
37	20	2	M	171	69	23.6	120	140	140	20	20	120	145	140	25	20
38	19	2	M	163	51	27.6	110	120	110	10	0	110	115	110	5	0
39	19	2	M	171	90	30.8	125	130	115	5	-10	120	125	120	5	0
40	18	2	M	145	58	27.6	115	130	130	15	15	120	135	130	15	10
41	24	3	F	154	45	19	120	115	110	-5	-10	110	105	110	-5	0
42	26	3	F	165	58	21.3	130	135	125	5	-5	130	130	125	0	-5
43	24	3	F	155	60	25	120	130	125	10	5	120	125	120	5	0
44	24	3	F	168	51	18.1	120	120	110	0	-10	120	120	110	0	-10
45	23	3	F	160	60	23.4	120	115	115	-5	-5	120	115	115	-5	-5
46	25	3	F	168	74	26.2	120	125	115	5	-5	120	120	120	0	0
47	24	3	F	149	41	18.5	140	140	130	0	-10	140	140	130	0	-10
48	21	3	F	158	62	24.8	145	150	150	5	5	145	160	150	15	5
49	18	3	F	153	47	20.1	125	125	125	0	0	125	130	125	5	0
50	19	3	F	161	58	22.4	110	125	120	15	10	110	130	120	20	10
51	26	3	M	174	77	25.4	110	110	110	0	0	110	120	110	10	0
52	21	3	M	170	65	22.5	120	125	110	5	-10	120	125	115	5	-5
53	19	3	M	174	88	29.1	130	130	130	0	0	130	135	130	5	0
54	18	3	M	171	59	20.2	120	115	115	-5	-5	130	120	115	-10	-15
55	18	3	M	183	93	27.8	110	120	110	10	0	110	120	110	10	0
56	18	3	M	176	73	23.6	110	125	105	15	-5	115	120	105	5	-10
57	18	3	M	172	69	23.3	110	120	115	10	5	110	115	110	5	0
58	23	3	M	162	60	22.9	120	115	110	-5	-10	120	115	105	-5	-15
59	19	3	M	177	84	26.8	120	110	105	-10	-15	125	110	105	-15	-20
60	24	3	M	173	78	26.1	140	145	135	5	-5	140	140	130	0	-10

ANNEXURE 3

CONSENT FORM

Title of the study – The effectiveness of dynamic soft tissue mobilization vs dynamic soft tissue mobilization combined with Ice on hamstring flexibility on collegiate recreational athletes.

I have been informed by Mr. Nabagopal Sarkar; that pursuing MPT (sports) and conducting the above-mentioned study under the guidance of Prof. Joesph Oliver Raj, Dean, Department of Physiotherapy, and co-guide Dr. Ambika Bera (PT), assistant professor, department of physiotherapy, ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE (ABSMARI), BHUBANESWAR

I have explained to MR/MISS/MRS the purpose of the research, and the procedure required in the language he/she could understand to the best of my ability.

(Investigator) (Date)

I confirm that Mr. Nabagopal Sarkar (investigator) has explained to me in a language I can understand, the purpose of the study and the procedure. Therefore, I agree to give my assent for participation as a subject in this study and I will be accountable for the decisions.

(Signature) (Date)

ANNEXURE 4

ASSESSMENT FORM

ASSESMENT FORM:

DEMOGRAPHIC DATA:

Name-

Age-

Gender-

Address-

Phone number-

Height –

Weight-

Date of examination-

- Pre test-
- Post test –

GROUP
