Research Article

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Vibration foam rolling versus non-vibration foam rolling as a warm-up exercise on performance in collegiate athletes

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Abstract

Background: During the week, student athletes dedicate a significant amount of time to their competition sports. Warm up refers to muscle action performance prior to a higher muscle demand, typically prior to a high intensity competitive or recreational event, and is traditionally characterised by general and specific warm up exercises. **Objectives:** To determine the effect of vibrator foam rolling and non vibrator foam rolling and compare the both techniques as a warm up exercise in collegiate athlete. **Materials and methods:** For the study, 40 collegiate athletes were recruited. As a warm-up exercise, Group A received vibration foam rolling. As a warm-up exercise, Group B received non-vibration foam rolling. Before beginning the warm-up exercise, the athlete ran for 5 minutes. The T-test was used to measure agility performance before and after the test, and the vertical jump test was used to measure jump performance. **Results:** The pre-test value of the T-test and the vertical jump test differ significantly from the post-test value (p0.001) in Groups A and B. When comparing post-test values between groups, the T test reveals no significant difference. When comparing posttest values between groups, the vertical jump test reveals a difference.

Keywords: Collegiate Athletes, Vibrator Roller, Myofascial Release.

INTRODUCTION

Student-athletes spend a significant amount of time during the week to their competitive sport. As a result, student-athletes face difficulties in balancing their dual roles (i.e., student and athlete). Few student athletes expected to make it to the top levels in sports that are traditionally routes to professional jobs. Perhaps student-athletes are becoming more aware of and accepting of the poor likelihood of pursuing professional sports careers. Many colleges and universities have recently established career development initiatives and programme to help student-athletes better understand their strengths and the options accessible to them outside of athletics [1].

The number of students participating in NCAA (National Collegiate Athletic Association) athletics continues to rise each year. Since 1988, the number of female college athletes has climbed by 80%, while the number of male college athletes has increased by 20%. The number of collegiate athletes is increasing, which means the number of sports injuries is increasing as well. Injury rates during NCAA athletics participation have continuously ranged between 15-20% over a 16-year span [2].

Injury rates in college were higher than in high school, and in competitions were higher than in practises. To reduce the frequency and severity of common lower leg injuries and concussions, it is critical to focus on prevention. Warm-up (WU) refers to muscle activities performed prior to a higher muscle demand, typically before high-intensity competitive or recreational events, and includes both general and specific WU exercises [3,4].

Coaches, trainers, and players are always looking for new ways to identify and develop physical qualities that can help them perform better in sports. Physical ability testing is a standard method of evaluating athletic talent. A variety of tests can be used to assess athletic abilities such as anaerobic power, speed, and agility. These tests are used by coaches, physical educators, and conditioning specialists to assess athletic ability, identify specific weaknesses, screen for potential health risks associated with strenuous

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exercise, provide data for developing individualized exercise prescriptions, and track changes in physical characteristics over time. Many sports and recreational activities regard agility, leg power, and leg speed as critical physical components for effective performance. A popular physical ability test, for example, is the T-test. The T-test is a 4-direction agility and body control test that evaluates the ability to change directions quickly while maintaining balance and speed [5].

Warming up can have thermal, metabolic, neurological, and psychological consequences, such as increased anaerobic metabolism, faster oxygen uptake kinetics, and post-activation potentiation. According to research, there are four types of warm-ups. Warm-ups are classified into four types: static stretch warm-ups, dynamic warm-ups, and dynamic flexibility warm-ups. According to the findings of this study, warm-up has an effect on vertical jump performance [6,7].

Barnes developed myofascial release (MFR) therapy to help with the reduction of limiting barriers or fibrous adhesions seen between fascia tissue layers. Self-induced myofascial release (SMR), a new MFR technique, is gaining popularity for treating soft-tissue limitations. SMR concepts are similar to those of myofascial release. The difference between the two procedures is that instead of a therapist performing manual therapy on the soft tissue, people apply pressure to it with their own body weight on a foam roller [8].

As a result, the study's goal is to compare the effects of vibration vs. non-vibration foam rolling as part of an athletic warm-up routine. Muscle soreness and stiffness in the hamstrings and quadriceps are common during athletic movements, affecting lower limb strength and balance, which has an impact on player performance. Professional athletes frequently exercise on a regular basis before using myofascial release treatments to relieve pain. Collegiate athletes, on the other hand, may lack a regular training routine and find it difficult to stick to, making them more susceptible to lower limb injuries. Athlete performance is evaluated using T-tests and vertical jump tests.

OBJECTIVES

1. To assess the effect of vibration foam rolling as a warm-up exercise on collegiate athletes' performance.
2. To assess the effect of non-vibration foam rolling as a warm-up exercise on collegiate athletes' performance.
3. To compare the effects of vibration foam rolling versus non-vibration foam rolling as a warm-up exercise on collegiate athletes' performance.

MATERIALS AND METHODS

Source of data

- Padmashree Group of Institutions, Kengeri, Bangalore.
- Population : collegiate athletes
- Sampling method : Simple Random Sampling
- Sample size : 40
- Type of Study : Pre-Post Experimental study design
- Duration of the study : 6 months

Materials required

- Examination couch
- Vibrator foam roller
- Pencil
- Paper
- Measuring tape
- Chair

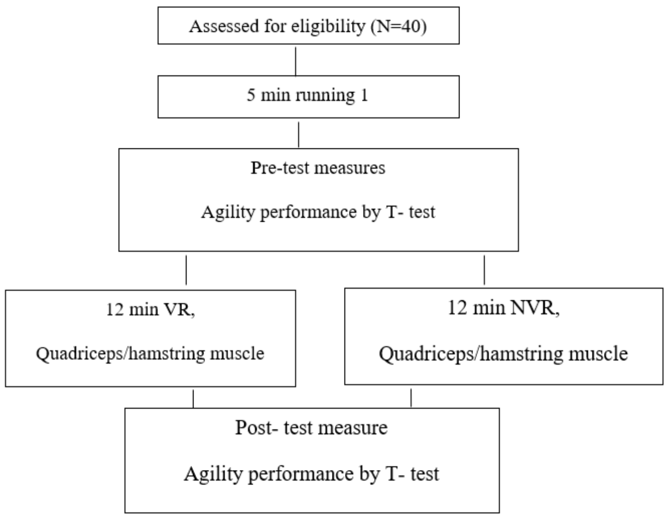
Inclusion criteria

- Age : 18-24 years
- Gender : Both Gender
- Population : Collegiate athletes (who had no reported injuries in the previous six months) agreed to take part in the study [9,10].

Exclusion Criteria

- Subjects with cardiovascular and respiratory disease.
- Subjects with Neuromuscular injury or low back pain.
- Subjects with history of soft tissue injuries (Ligament/Muscle).
- Subjects with Joint instability that limits lower limb Performance.
- Subjects with history of Head and spinal injury.
- Subjects who had a visual, vestibular, or balance disorder in the previous 6 months.
- Recent surgeries

Flow chart of Methodology



- Institutional permission was obtained, and subjects were recruited after meeting inclusion and exclusion criteria [11].
- Forty subjects were divided into two groups at random.
- Age, gender, height, and weight were all documented demographic variables.

GROUP (A)-Vibration rolling (VR)

Participants were instructed to use a vibrating foam roller (dimensions: 36 20 15 cm; weight: 1.8 kg) that consists of a vibration generating motor surrounded by an expanded polypropylene foam outer shell to perform VR.

First, the participants placed their right lower limb in the assigned position, then placed as much of their body weight as possible on the vibrating foam roller (frequency of 28 Hz), which is the lowest frequency of the vibrating featured foam roller equipment.

They then moved back and forth at 40 beats per minute for 60 seconds of VR.

- Quadriceps- subject is positioned in prone on elbow position. Place quadriceps of the right thigh on the vibrating foam roller. Roll from the proximal side of quadriceps scroll to the above patellar and back and forth 20 times in 60 seconds and 30 second rest for next set, after change to the left thigh. The total regimen included three sets for each muscle group.
- Hamstring- place hamstring of the right thigh on the vibration foam roller. Roll from approximately near to gluteal portion of hamstring scroll to the knee and back and forth 20 times in 60 seconds and 30 second rest for next set, then change to left thigh. The total regimen included three sets for each muscle group.
- The same exercise will then be performed on the left lower limb. The vibrating foam roller exercise will be performed three times in a row on the quadriceps and hamstrings.

GROUP-(B) Non- vibration rolling (NVR)

- The exercise protocols were the same as those used for the VR exercise, with the exception that the vibration generator was turned off.
- In this study, we used the same roller for both exercises to eliminate bias caused by the use of foam outer shells of varying stiffness.
- Quadriceps- The same exercise protocols as VR, but the vibrating generator power was turn off.
- Hamstring- The same exercise protocols as VR, but the vibrating generator power was turn off.

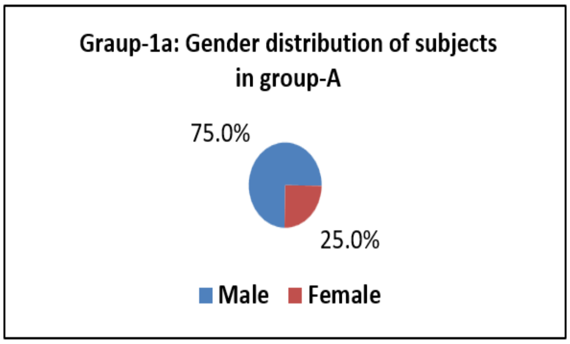
RESULTS

Table 1 shows the gender distribution of collegiate athletes. In Group-A, 15 (75.0%) of the subjects were males, while 5 (25.0%) were females. In Group-B, 16 (80.0 percent) of the participants were males, while 4 (20.0 percent) were females. There was little variation between groups based on gender, and it was found to be non-statistically significant (χ^2=0.474, df=1) at the 5% level, i.e., p>0.05. It demonstrated that the baseline gender characteristic is homogeneous in both groups. The pie diagrams below depict the proportion of subjects by gender.

Table 1: Distribution of collegiate athletes according to gender over the groups.

S.No	Gender	Group	
		Group-A	Group-B
1	Male	15(75.0%)	16(80.0%)
2	Female	5(25.0%)	4(20.0%)
Chi-Square value=0.474, df=1, p>0.05,NS			

NS-Not significant.ie.,p>0.05.



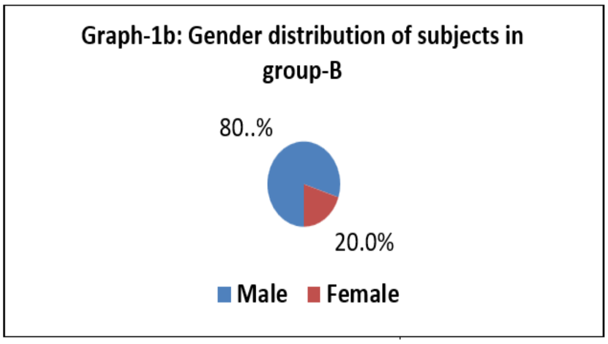


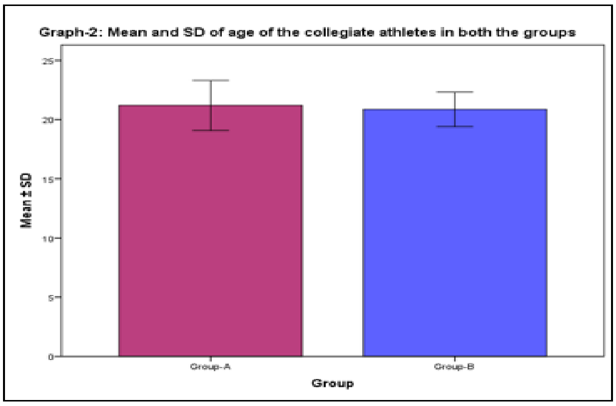
Table 2 shows the results of age in years. The subjects in Group-A ranged in age from 19 to 28, with a mean of 21.19 and a standard deviation of 2.12. The subjects in Group-B ranged in age from 19 to 23, with a mean of 20.16 and a standard deviation of 1.45. The results of weight in kg in Group-A, the subjects ranged in weight from 47 to 65, with a mean of 57.72 and a standard deviation of 5.85. Subjects in Group B ranged in weight from 52.30 to 72.20, with a mean of 60.70 and a standard deviation of 4.94. In Group-A, the subjects' BMI ranged between 16.9 - 24.0, with a mean of 19.95 and SD of 2.06. The subjects in Group B ranged from 17.3-26.0, with a mean of 21.82 SD2.57. The unpaired t-test was used to compare the means, and it was found to be insignificant at the 5% level (i.e.>0.05). It was discovered that the baseline age characteristic was similar in both groups.

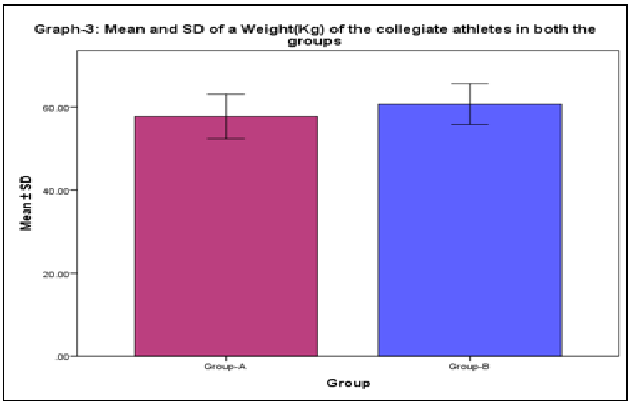
Table 2: Range, mean and SD of age of the collegiate athletes in both the groups

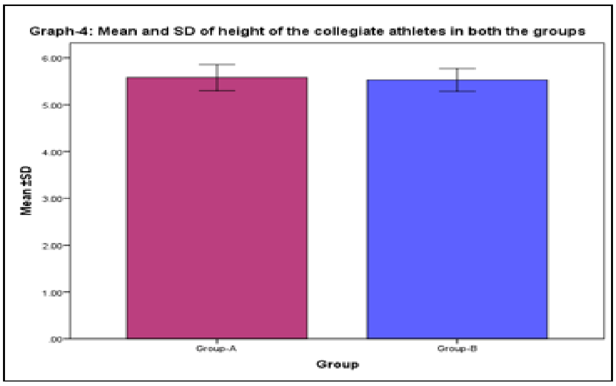
S.No	Variable	Group-A		Group-B		Unpaired t-test
		Range	Mean ± SD	Range	Mean ± SD	
1	Age (years)	19-28	21.19±2.12	19-23	20.16±1.45	t=0.595 p>0.05, NS

2	Weight(Kg)	47-65	57.72±5.85	52.30-72.20	60.70±4.94	t=1.874, p>0.05, NS
3	Height(fts)	5.11-5.90	5.57±0.27	5.10-5.90	5.52±0.24	t=0.608, p>0.05, NS
4	BMI	16.9-24.0	19.95±2.06	17.3-26.0	21.82±2.57	t=0.218, p>0.05, NS

NS-Not significant.i.e.,p. p>0.05







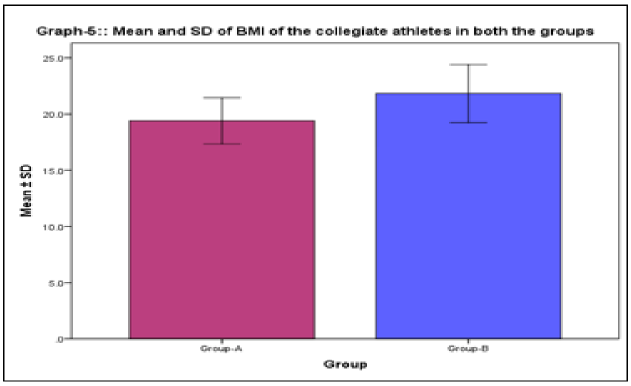
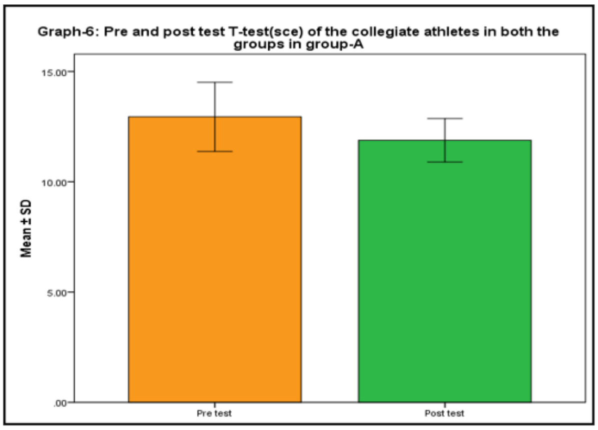


Table 3 shows the statistics for agility among collegiate athletes in Group A. The pretest mean and SD of T-test in second was 12.94 ± 1.56, which was followed by a posttest mean and SD of 16.07±3.86, which was the outcome of jump performance among collegiate athletes in group a. In the pretest, the mean and SD of the vertical jump test in cm was 11.88 ± 0.95, which increased in the posttest with a mean and SD of 18.33 ± 3.56. When the pretest score is compared to the post test score, the paired t-test for both outcomes shows a significant difference at p<0.001.

Table 3: Range, mean and SD of outcome measures of collegiate athletes in Group-A.

S.No	Outcome measures	Group-A				Paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	T-test(Sec)	10.53-16.02	12.94±1.56	10.0-27.0	16.07±3.86	t=5.902*	p<0.001
2	Vertical jump(cm)	10.15-14.00	11.88±0.95	13.00-28.00	18.33± 3.56	t=7.184*	p<0.001

Note; * denotes –Significant.,(p<0.05).



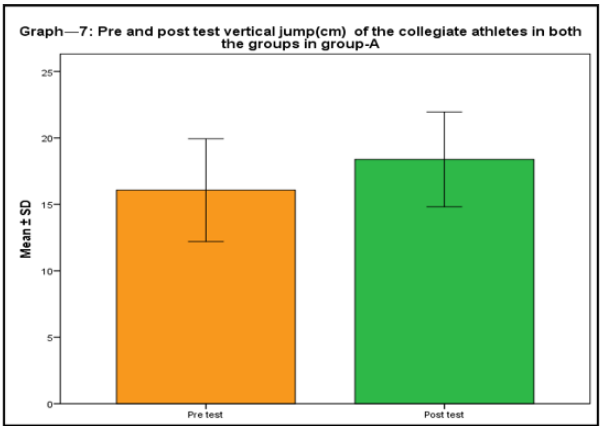
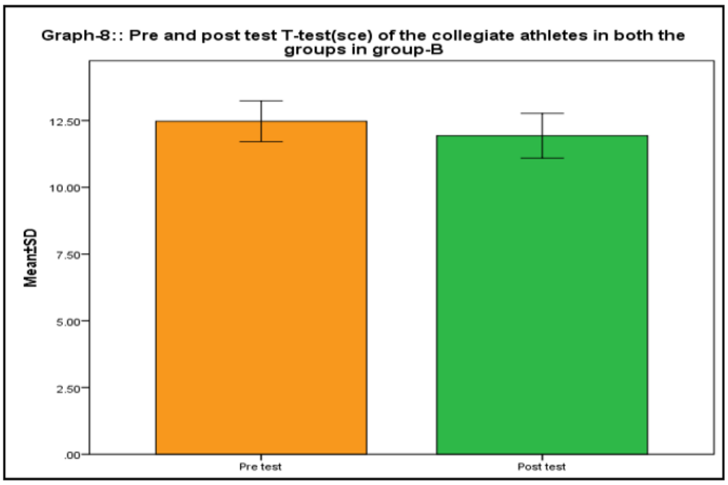


Table 4 shows the statistics for agility among collegiate athletes in Group B. In the pretest, the mean and SD of T-test in the second was 12.47 ± 0.763, and in the post test, the mean and SD was 11.93 ± 0.84, which was decreased in posttest values, resulting in the outcome of jump performance among the collegiate athletes in group b. In the pretest, the mean and SD of the vertical jump test in cm was 12.51 ± 0.83, which increased in the posttest with a mean and SD of 13.28 ± 0.733. The paired t-test for pre and post test results in a significant difference at (p<0.001).

Table 4: Range, mean and SD of outcome measures of collegiate athletes in Group-B.

S.No	Outcome measures	Group-B				Paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	T-test(Sec)	11.53-14.23	12.47±0.763	10.53-13.56	11.93±0.84	t=6.615*	p<0.001
2	Vertical jump(cm)	11.0-13.6	12.51±0.83	11.60-14.60	13.28± 0.733	t=7.530*	p<0.001

Note; * denotes –Significant.,(p<0.05).



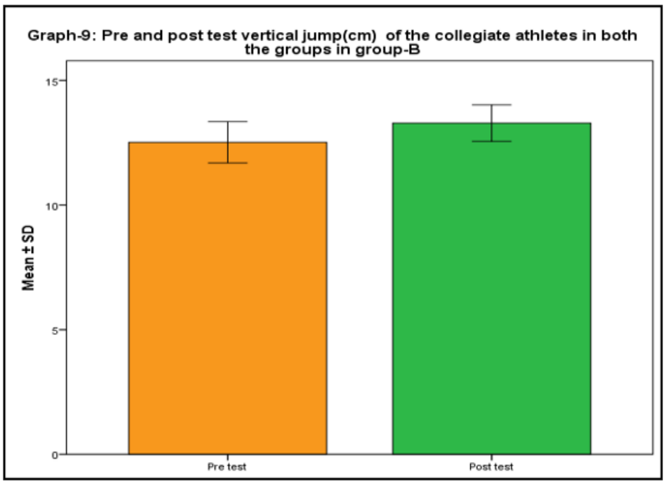


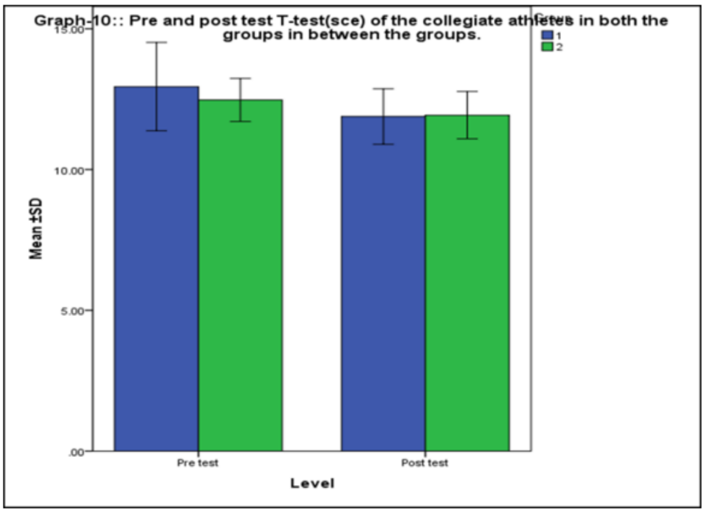
Table 5 shows the results of a between-group comparison of pre and post T test and vertical jump test results among collegiate athletes. The pretest scores of T-test were 12.94 ± 1.56 in group-A and 12.47 ± 0.763 in group-B, which was not statistically significant (p>0.05); similarly, the pretest scores of vertical jump were 11.88±0.95 in group-A and 12.51 ± 0.83 in Group-B, which was statistically significant (p<0.05); it demonstrated that initially before the intervention, the collegiate athletes were similar in t test but there was a significant difference in pretest value in vertical jump test.

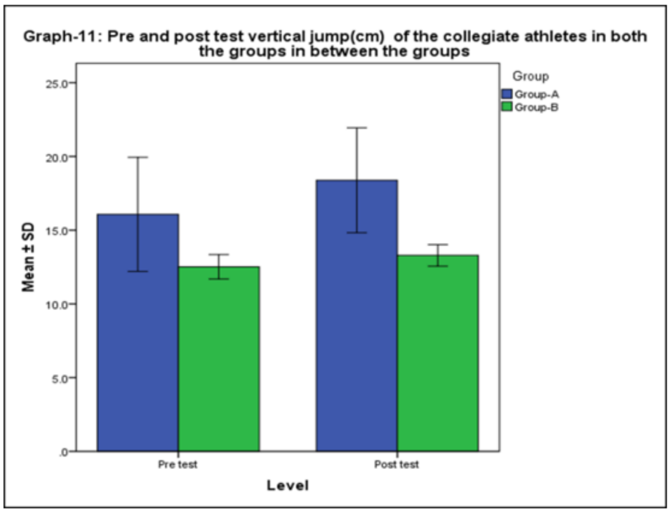
Similarly, when comparing the post-test t-test scores between groups, the mean and SD of the post-t test of the collegiate athlete treated with vibration roller in group-A was 16.07 ± 3.86 and the mean and SD of the post-t test of the collegiate athlete treated with non-vibration foam roller in group-B was 11.93 ± 0.84. The unpaired t test yielded no statistically significant results (p>0.05). Similarly, the mean and SD of the post-test vertical jump of the collegiate athlete treated with a vibrator foam roller in group-A was 18.33 ± 3.56, while the mean and SD of the post-test vertical jump of the collegiate athlete treated with a non-vibrating foam roller in group B was 13.28 ± 0.733.

Table 5: Mean and SD of pre and post test outcome measure of collegiate athletes in between the groups

Sno	Outcome measures	Pre test		Post test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	T-test(Sec)	12.94±1.56	12.47±0.763	16.07±3.86	11.93±0.84
2	Vertical jump(cm)	11.88±0.95	12.51±0.83	18.33± 3.56	13.28± 0.733
Unpaired t-test		• T-test(sec): t=1.239, p>0.05, NS • Vertical jump(cm), t=4.11, p<0.05, S		• T-test(sec): t=0.175, p>0.05, NS • Vertical jump(cm), t=6.414, p<0.05, S	

S- Significant (p<0.05); NS – not significant (p>0.05)





DISCUSSION

The current study compares the effects of vibration rolling against non-vibration rolling as a warm-up exercise on collegiate athletes' performance.

This study involved 40 collegiate athletes who were separated into two groups. As a warm-up exercise before the game, Group A 20 subjects were given a vibration foam roller for 12 minutes, while Group B 20 subjects were given a non-vibration roller for 12 minutes. This study compares the acute effect of vibration foam rolling versus non-vibration foam rolling as a warm-up exercise on the performance of collegiate athletes.

In a study conducted by Chai Lun Lee *et al.* in 2018 [12]. vibration rolling, non-vibration rolling, and static stretching as a warm-up exercise on flexibility, joint proprioception, muscle strength, and balance in young athletes, the results show that vibrator roller as a warm-up exercise significantly increased ROM, balance isokinetic peak torque, muscle strength, and balance in young athletes, when compared to non-vibration roller and stretching. They discovered that the vibrator worked far better.

According to table 1, there is no statistically significant difference in gender distribution between the two groups. Other demographic data, such as age, weight, height, and BMI, show no significant differences between the groups, according to table 2. T-test pre and post-test scores improved significantly in group A. The post-test score was extremely significant when compared to the pre-test score (P<0.001). When compared to the pre-test group, there was a significant improvement in the vertical jump test in post-test group A. The post-test score was highly significant (P< 0.001) when compared to the pre-test score.

VFR has a number of benefits, including remobilizing soft-tissue compliance to allow for longer muscle length and increasing blood flow and circulation to soft tissues by rolling on them (MacDonald *et al.*., 2013). However, few studies have looked into the utility of VFR, particularly in terms of athletic performance.

The post-test value in group B is significantly higher than the pre-test value (p0.001). When the pre-test and post-test scores in Group B were compared, the post-test score was significantly higher (p<0.001).

Foam rolling is a self-myofascial release technique in which a roller tool is used to apply a compressive force to the muscles and fascia. Self-myofascial release (SFMR) has several advantages, including increased flexibility in the short and long term, as well as increased neuromuscular muscle efficiency.

There was no significant difference in pre-test scores between groups (P>0.05), and no difference in post-test scores between groups (P>0.05). The vertical jump test revealed a significant difference between the groups.

The scheme and functioning of the human body's muscles and fascia tissues reveal how foam rolling and other SFMR treatments affect muscle performance. In the Journal of Anatomy, Dr. Mike Benjamin defines superficial fascia as "a layer of areolar connective or adipose tissue just beneath the skin." Deep fascia, a dense, harder tissue found beneath the superficial layer, is typically found in sheets around muscles and tendons (Benjamin, 2009). These fascial layers move together during motion, especially when the muscles tense or relax.

Myofascial release treatments aim to rehydrate the fascia and create a fluid gel-like extracellular environment in order to increase ROM (1), which is known as the fascia's thixotropic feature (schleip R). Okamoto *et al.* discovered that using a foam roller for self-myofascial release had an immediate effect on vascular function. Self-myofascial release with a foam roll resulted in an immediate decrease in arterial stiffness and an increase in endothelium vascular function.

SMR exercises with foam roller equipment are a simple approach for reducing strain on the soft tissue, fascia, tenderness, and muscle without lowering muscle performance and increasing muscle performance and joint ROM (Okamato, Musuhara, and Ikuta, 2014) [17]. As a result, SMR exercises using foam roller equipment are particularly popular among athletes. For many years, athletes have employed local vibration application to promote muscle strength and flexibility (M Cardinale and jukic, 2004) [18]. It is being developed foam roller equipment with a vibrator that can be used for both self-myofascial release and local vibrator exercise at the same time.

Behra and Jacobson (2017) examined the effect of dynamic flexing with foam roller application on hip flexibility, knee strength, and vertical jump performance. According to the findings, there is no change in vertical leap and knee strength before and after treatment, whereas hip elasticity increased after both applications. This increase in flexibility may be due to a change in the thixotropic properties of the fascia that surrounds the muscle following foam roller use. (paolint 2010). M Low frequency vibration exercise, according to Cardinal and Lim (2004), is more dependable and effective. In his research, he also claimed that a low frequency (20 hz) boosts vertical jump performance.

Other research, on the other hand, indicates that the 50 HZ frequency is more effective for vertical jump performance than the 60 hz frequency (20-30 hz). In the current study, vibrating equipment with foam rollers with a maximum frequency of 38 hz was used.

When post-test results are compared across groups, the vertical jump test shows a significant result at the level of ($p<0.001$), but not with respect to the T-test at the level of ($p.>0.05$).

LIMITATIONS

1. Long term follow up of the subjects was not taken.
2. Because this study only included healthy population, the findings may not be applicable to the injured population.
3. The warm-up does not include any specific or skill-based exercises. Subject has difficulty to understand the procedure.
4. Anthropometric variation between the subjects was not considered

RECOMMENDATIONS

1. The study can be further done on a wider population.
2. Further study can be done to know the effect of technique on injury prevention on athletes.
3. Further study can be done to know the effect of vibration roller in post injury rehabilitation phase

CONCLUSION

The study's goal was to see how vibration foam rolling compared to non-vibration foam rolling as a warm-up exercise affected the performance of collegiate athletes. Positive results were observed in both groups and were clinically significant. According to statistical analysis, participants who received both vibration and non-vibration foam rolling were equally successful.

When post-test results are compared across groups, the vertical jump test shows a significant result at the level of ($p<0.001$), but not with respect to the T-test at the level of ($p>0.05$).

Conflicts of interest

None declared.

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None declared.

REFERENCES

1. Lopes Dos Santos M, Uftring M, Stahl CA, Lockie RG, Alvar B, *et al.* Stress in academic and athletic performance in collegiate athletes: A narrative review of sources and monitoring strategies. Frontiers in Sports and Active Living. 2020;2:42.
2. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. Journal of athletic training. 2007;42(2):311.
3. Kerr ZY, Comstock RD, Dompier TP, Marshall SW. The First Decade of Web-Based Sports Injury Surveillance (2004-2005 Through 2013-2014): Methods of the National Collegiate Athletic Association Injury Surveillance Program and High School Reporting Information Online. J Athl Train. 2018;53(8):729-37.
4. Andrade DC, Henriquez-Olguín C, Beltrán AR, Ramírez MA, Labarca C, Cornejo M, *et al.* Effects of general, specific and combined warm-up on explosive muscular performance. Biol Sport. 2015;32(2):123-8.
5. Pauole Kainoa, Madole Kent, Garhammer John, Lacourse Michael, Rozenek Ralph. Reliability and validity of the T-test as a measure of agility, leg power, and leg speed in college-aged men and women. Journal of Strength and Conditioning Research. 2000;14(4):443–50.
6. McGowan CJ, Pyne DB, Thompson KG, Rattray B. Warm-Up Strategies for Sport and Exercise: Mechanisms and Applications. Sports Med. 2015;45(11):1523-46.
7. Holt BW, Lambourne K. The impact of different warm-up protocols on vertical jump performance in male collegiate athletes. J Strength Cond Res. 2008;22(1):226-9.
8. MacDonald GZ, Penney MD, Mullaley ME, Cuconato AL, Drake CD, Behm DG, Button DC, *et al.* An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. J Strength Cond Res. 2013;27(3):812-21.
9. Feltroni L, Monteleone S, Petrucci L, Carlisi E, Mazzacane B, Schieppati M, Dalla Toffola E, *et al.* Potentiation of muscle strength by focal vibratory stimulation on quadriceps femoris. G Ital Med Lav Ergon. 2018;40(2):90-6.
10. Couto BP, Silva HR, Barbosa MP, Szmuchrowski LA. Chronic effects of different frequencies of local vibrations. Int J Sports Med. 2012;33(2):123-9.
11. Cheatham SW, Stull KR. Roller massage: Comparison of three different surface type pattern foam rollers on passive knee range of motion and pain perception. J Bodyw Mov Ther. 2019;23(3):555-60.
12. Lee CL, Chu IH, Lyu BJ, Chang WD, Chang NJ. Comparison of vibration rolling, nonvibration rolling, and static stretching as a warm-up exercise on flexibility, joint proprioception, muscle strength, and balance in young adults. J Sports Sci. 2018;36(22):2575-82.
13. García-Gutiérrez MT, Guillén-Rogel P, Cochrane DJ, Marín PJ. Cross transfer acute effects of foam rolling with vibration on ankle dorsiflexion range of motion. J Musculoskelet Neuronal Interact. 2018;18(2):262-67.
14. Romero-Moraleda B, González-García J, Cuéllar-Rayo Á, Balsalobre-Fernández C, Muñoz-García D, Morencos E, *et al.* Effects of Vibration and Non-Vibration Foam Rolling on Recovery after Exercise with Induced Muscle Damage. J Sports Sci Med. 2019;18(1):172-80.
15. De Benito AM, Valldecabres R, Ceca D, Richards J, Barrachina Igual J, Pablos A, *et al.* Effect of vibration vs non-vibration foam rolling techniques on flexibility, dynamic balance and perceived joint stability after fatigue. PeerJ. 2019;7:e8000.
16. Okamoto T, Masuhara M, Ikuta K. Acute effects of self-myofascial release using a foam roller on arterial function. J Strength Cond Res. 2014;28(1):69-73.
17. Markovic G, Dizdar D, Jukic I, Cardinale M. Reliability and factorial validity of squat and countermovement jump tests. J Strength Cond Res. 2004;18(3):551-5.
18. Germann D, El Bouse A, Shnier J, Abdelkader N, Kazemi M. Effects of local vibration therapy on various performance parameters: a narrative literature review. J Can Chiropr Assoc. 2018;62(3):170-81.