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Effectiveness of Muscle Energy Technique and Dynamic Stretching on Calf Muscle Group for Speed and Physical Endurance on Healthy Sprint Runners in School Level

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ABSTRACT

BACKGROUD: Running is a popular form of exercise worldwide for athletes of all ages and capabilities. Propulsion in running gait is primarily performed by the calf muscle complex. Due to the high forces created in the gastrocnemius during the push off phase of running, the gastrocnemius appears to be at risk for injury. Injury to the calf muscle region has been reported to be up to 30% of the running injuries reported each year. In addition, calf injuries have been described as calf pain, calf spasm, lower leg pain, gastrocnemius pain or strain and in combination with Achilles tendon injuries.

AIMS OF THE STUDY: Aim of the study is to evaluate the effect of MET and Dynamic Stretching on calf muscle group for speed and physical endurance on healthy sprint runners in school level.

METHODS: Thirty-two subjects were divided into two groups. Group-A received Muscle energy technique (n=16) and Group-B trained with Dynamic stretching (n=16). Both groups received training of 5 sessions per week for 6 weeks. Outcomes were assessed by Bruce treadmill test and 40-yard sprint test before and after treatment.

RESULTS: The study shows statistically significant improvement ($p<0.05$) in both groups for all the outcomes. After 6 weeks of training period, the group trained with muscle energy technique scored significantly higher in improving the endurance and speed than the group trained with dynamic stretching when the pre &post test values of Bruce treadmill Test and 40 yard sprint test were statistically analyzed using an independent 't' test.

CONCLUSIONS: Muscle energy technique was found to be much effective in improving the endurance and speed of sprint runners with improving flexibility of calf muscles than dynamic stretching technique.

KEYWORDS: Muscle Energy Technique, Dynamic Stretching, Endurance, Speed, Flexibility, Calf muscles; Bruce Treadmill Test, 40 Yard Sprint Test.

INTRODUCTION

Physical Fitness and Running in Childhood Education-Physical fitness has become a precarious health marker in childhood, with many countries focusing on improving young people's fitness through various initiatives and Schools are seen as key environments for recognizing children with low fitness levels and promoting healthy lifestyles, particularly through physical education (PE). [1]In many schools, physical education programs aim to improve students' physical fitness offering long-term benefits such as reduced risks of obesity ,cardiovascular disease, and type II diabetes.[2]

Running and Cardiovascular Health-Running is an effective cardiovascular exercise, offering various health benefits, including improved heart health and reduced obesity. [3]Endurance running, defined as any distance above 3000 meters, and ultra-distance running (above a marathon) are vital aspects of long-term cardiovascular training. While humans are slower compared to animals in sprinting, running at high speeds, especially in sprint races, require increased force production in the lower limbs, leading to a stronger and more efficient running performance.[3,4]

Leg Stiffness and Running Efficiency-Leg stiffness plays a important role in running performance. Faster runners usually have increased leg stiffness and shorter ground contact times, resulting in better propulsion and more efficient energy use[5]and this stiffness is related to the muscles, ligaments, and tendons' ability to absorb and release elastic energy during the stance phase of running. A well-functioning calf muscle complex especially the gastrocnemius, soleus, and plantaris muscles contributes significantly to propulsion and running efficiency.[4,5]

Neuromuscular Adaptations and Running Economy-Running performance is not only influenced by aerobic capacity but also by the neuromuscular system. Training adaptations improve muscle recruitment patterns and coordination leading to improved efficiency and faster running times with less strength. These neuromuscular changes improve muscle pre-activation and body's ability to consume stored elastic energy, enhancing running capacity.[6]

Calf Muscle Function and Injury Risks-The calf muscle complex particularly the gastrocnemius plays a major role in running propulsion. Injuries in these muscles, for example strains are common in sprinters and long-distance runners. "Tennis Leg" a calf muscle strain caused because of rapid knee extension and ankle dorsiflexion, is a typical injury in sprinting.[6,7]Runners are more prone to gastrocnemius injuries as speed increases and muscle demand for propulsion becomes more intense.[1,7]

Prevention of Injuries and Recovery Techniques-To prevent calf injuries, stretching and flexibility exercises like dynamic stretching are advised.[8]Dynamic stretching in contrast to static stretching, involves controlled movement through the muscle's range of motion and warming up muscles for more intense physical activity. [9]This type of stretching has been shown to improve performance metrics such as leg power and vertical jump height, which are vital for runners.[8,9]Muscle Energy Techniques are used by physiotherapists to address muscle imbalances, improve flexibility, and reduce muscle strain.[10] Muscle Energy Techniques involves voluntary contractions of muscles in a controlled direction against a counterforce, helping to restore normal muscle function and reduce injuries.[10,11]

Role of Physical Education in Schools-Physical Education is an essential part of the school curriculum and plays a significant role in promoting physical activity, health, and social interaction skills.[12] However, many schools face challenges, such as limited class time, insufficient resources, and competing priorities, which hamper the effectiveness of Physical Education programs.[13]Addressing these barriers and ensuring effective PE delivery could help improve children's muscular fitness and health status.[13,14] To promote physical fitness in children, schools must recognize the importance of physical education and running. [15]By focusing on improving muscle strength, flexibility, and running efficiency, students can develop healthier fitness levels. Implementing effective PE programs that overcome existing barriers can significantly contribute to students' health and well-being.[16]

Endurance Training and Testing Methods-Endurance training is significantly influenced by various physiological factors like energy system efficiency, aerobic capacity (VO2max), lactate threshold, muscle strength, power, and muscular endurance.[13,16] VO2max, plays a pivotal role in determining an athlete's endurance capacity. [17]In addition to these physiological components, neuromuscular adaptations and psychological factors are also essential in achieving success in endurance sports.[18]One of the most commonly used clinical tests for assessing cardiovascular fitness is the **Bruce Test**, a treadmill exercise stress test designed to estimate VO2max and evaluate cardiovascular health. The test progressively increases treadmill incline and speed at three-minute intervals, with participants continuing until fatigue or discomfort arises.[18,19]Modifications to the standard Bruce protocol now offer a more comfortable and efficient method for improving both exercise testing and training, with significant clinical benefits in enhancing aerobic capacity and patient safety.[20]

In addition to endurance-focused assessments, sprint-based tests like the **40-meter Maximum Sprint Test (MST)** are used to evaluate speed and endurance, especially in sports requiring multiple sprints. The test involves a single maximum effort sprint over 40 yards, with the aim of recording the fastest time.[21]While it primarily tests speed, it also evaluates an athlete's ability to sustain high-intensity efforts across multiple sprints. To ensure reliable results, athletes are encouraged to perform practice trials to minimize learning effects.[22,23]Both of these tests-endurance-based and sprint-based, are fundamental tools in evaluating an athlete's physical fitness, informing training decisions, and guiding interventions for performance improvement.[23,25]

NEED OF THE STUDY

This study is needed to:

1. Evaluate and compare the effects of MET and DS on calf muscle flexibility, strength, and function.
2. Determine their influence on sprint speed and physical endurance in healthy school-level sprinters.
3. Identify the more effective intervention for enhancing athletic performance and preventing musculoskeletal injuries in young runners.
4. Contribute evidence-based guidelines for incorporating stretching or manual therapy techniques into PE and athletic training programs at the school level.

By addressing these points, the study aims to fill a critical gap in current literature and support the development of optimized training protocols for young athletes.

OBJECTIVE OF THE STUDY

- To evaluate the muscle energy technique on the calf muscle group for speed and physical endurance on healthy sprint runners at the school level.
- To evaluate dynamic stretching on the calf muscle group for speed and physical endurance in healthy sprint runners at the school level.
- To evaluate the comparison between muscle energy technique and dynamic stretching on the calf muscle group for speed and physical endurance on heal the sprint runners at the school level.

MATERIALS AND METHOD

Study Design : Quasi Experimental study

Sample Design: Random sampling

Sample Size: n =32, both male and female was included[25]

Group A–Muscle energy technique (n=16)
Group B–Dynamic stretching(n=16)
Study Duration: 5sessionsperweekfor6weeks
Study center- OCDC, Dept. Of Physiotherapy, JRNRV (Deemed To Be University), Dabok, Udaipur.

INCLUSION CRITERIA:
Age,12-15years,Both male and female, Subjects willing to participate, Only sprint runners.

EXCLUSION CRITERIA-
Distance runners, Inadequate strength in lower limbs or any vestibular or balance disorders, Subjects with open wounds, bruises and lacerations, recent fractures or incomplete bony union, and varicose veins.
Study Materials-Track or field where the distance can be measured, Tape measure, Stop watch or timing gate, Cones or tape to indicate start and finish lines, Personnel at the finish line or at both the start and finish lines.

OUTCOMEMEASURES-
Bruce Treadmill test[26](ENDURANCE)
Bruce protocol is a standardized diagnostic test used in the evaluation of cardiac function and physical fitness, developed by American cardiologist Robert A. Bruce. According to the original Bruce protocol the patient walks on an uphill treadmill graded exercise test with electrodes on the chest to monitor. Every 3 min the speed and incline of the treadmill are increased. There are 7 such stages and only very fit athletes can complete all 7 stages. The modified Bruce Protocol is an alteration in the protocol so that the treadmill is initially horizontal rather than uphill, with the first few intervals increasing the treadmill slope only. The Bruce treadmill test estimates maximum oxygen uptake using a formula and the performance of the subject on a treadmill as the work load is increased. The test is easy to perform in a medical office setting, does not require extensive training or expensive equipment, and it has been validated as a strong predictor of clinical outcomes.
Procedure: Exercise is performed on a treadmill. The leads of the ECG are placed on the chest wall. The treadmill is started at 2.74 km/h (1.7mph) and at an inclined gradient of 10%. After 3min incline of the treadmill is increased by 2%, and the speed increases. Indications to terminate the test include signs or symptoms of impaired blood flow to the heart, irregular heart rhythm, fatigue, shortness of breath, wheezing, leg cramps, or any impairment in walking or pain, discomfort, numbness or tiredness in the legs.
Stages: Stages of the standard Bruce protocol are as follows:

Stage	**Minutes**	**%grade**	**MPH**	**min/mile**	**km/h**	**min/km**	**METS**	**m/s**
1	3	10	1.7	35:18	2.7	22:13	3	0.75
2	3	12	2.5	24:00	4.0	15:00	4-5	1.11
3	3	14	3.4	17:39	5.5	10:55	7	1.52
4	3	16	4.2	14:17	6.8	8:49	10	1.89
5	3	18	5.0	12:00	8.0	7:30	14	2.22
6	3	20	5.5	10:55	8.9	6:44	17	2.47
7	3	22	6.0	10:00	9.7	6:11	21	2.69

Total Duration=21minutes

40-yard sprint test(speed)

40-yard sprint test is the most common test of speed is the 40-yard sprint. It is also used in laboratory methods classes in exercise science and physical education academic programs. This test is also easily modified to shorter and longer distances to be even more specific for sports such as baseball and basketball. As with all tests of speed, the main objective is to cover the distance as quickly as possible and usually no more than three attempts are performed to minimize the decline in performance caused by fatigue.

Procedure:

After instructing the subject on the correct performance of the test follow these steps:

1. The subject lines up behind the start line, facing forward. Sport-specific stances can also be used, such as a three-point stance or a four-point stance as in track.
2. The subject should be given a countdown ,either verbally or ,If using timing gates by using the beeps programmed into the timing gate unit. Alternatively, an electronic switch activated by the subject's movement can be used.
3. The subject should be allowed two or three trials, with three- to five minute rests between to ensure nearly full recovery.
4. If using a stopwatch, start the watch at the subject's first movement. Times are typically recorded to the nearest 0.01 second. Hand timing can result in times that are 0.24 second faster than the time recorded using a timing gate. Thus, consistency in equipment from test to test and with repeated tests of the same subject is essential.

Reliability:

The40-yardsprintisahighlyreliabletestwith test retestreliabilitiestypicallyabove.95,but ranging from .89 to .97.

HYPOTHESIS

Alternative hypothesis:

There is a significant difference between muscle energy technique and dynamic stretching on calf muscle group for speed and physical endurance on healthy sprint runners in school level.

Null hypothesis:

There is no significant difference between muscle energy technique and dynamic stretching calf muscle group for speed and physical endurance on healthy sprint runners in school level.

PROCEDURE

Pre to post test comparative study design with two groups. The study was conducted at Dept. of Physiotherapy, JRNRV (Deemed to be university),Dabok Udaipur. With n = 32 with 16 in each group both male and female sprint runners were included based on selection criteria. The duration of given for 5 sessions per week for 6 weeks. After fulfilling the inclusion criteria and obtaining informed consent subjects was recruited for this study. **Group A** subjects received Muscle energy technique and **Group B** received Dynamic stretching. A pretest was done for each subject before stating exercises using Bruce treadmill test and 40 yard sprint test.

Flow Chart for the Procedure of the Study:

Potentialparticipantswillbeidentifiedusingtheinclusion&exclusioncriteria

↓

All participants(n=32)will be provided written consent prior to enrolment

↓

Outcome measurement tool will be used to record the pre test data (Bruce protocol & 40 yard sprint test)

↓

Participantswillbeassignedrandomlyinto2groups

↓

Group A(N=16)underwent6weeksofMET

↓

Group B(n=16)underweent6weeksofDynamicStretching

↓

At the end of 6 weeks outcome measure tools will be used for both the groups to record the post test data

EXERCISEPROTOCOL

Two groups were made randomly with equal participants. Both groups were given normal warm- up activities, following the warm-up, one group was given with reciprocal inhibitory technique for the calf muscle group, and another was taught to perform dynamic stretching.

Group A

(n=16)

Received muscle energy techniques on the calf:

1. The muscle is placed in a mid-range position.
2. The patient pushes towards the restriction/barrier whereas the therapist completely resists
3. This effort(isometric) or allows a movement towards it(isotonic).
4. The patient's relaxation and exhalation follow this and the therapist applies a passive stretch to the new barrier.
5. The procedure is repeated between three to five times and more.

Group B
(n=16)
Receive dynamic stretching for the calf group of muscles.
DYNAMICSTRETCHINGFORCALF(triceps surae):

1. **BRACECALFSTRECH**

- Use a wall to lean against.
- Patient Brace himself with his arms stretched out and hands against the wall at shoulder height.
- Patient was asked to Take one step backward with his left leg.
- Keep his left leg straight while therapist bend his right leg, keeping his left heel planted firmly on the ground.
- Patient was Lean gently, by keeping his left heel down.
- Patient should feel the stretch in the left leg.

2.DOWNWARDFACINGDOG

- Get into plank position ,with hands and feet shoulder-width apart on the floor, keeping a firm line from shoulders to ankles and he was asked to Don't let his abdomen or hips drop.
- Patient was asked to Push his heels to the floor while keeping his hips elevated, and spine and legs straight.
- Holdthispositionfor30secondstoaminute.
- Then patient was asked to walk back to plank formation and repeat until he feel the calf muscle loosen.

3.ECCENTRIC CALF RAISES

- Patient was asked to Gently raise and lower his feet on his toes and back down again.
- He may also do variations that affect different parts of calf muscle. Like Turn his toes inward
- Then raise and lower his feet.
- Do at least 12repsforeachposition.

RESULT

Mean & standard deviation for continuous variables, namely BRUCE TREADMILLTEST & 40 YARD SPRINT TEST

GROUPA

INTRA-GROUPANALYSIS–(MET)

TABLE:1(Effect of pre & post test value of Bruce Treadmill Test)

TEST	MEAN		STANDARD DEVIATION		Tvalue	P value
BruceTreadmill Test	Pre-test	Post-test	Pre-test	Post-test	10.048956	0.00001
	48.83125	76.115	11.21957	7.692312		

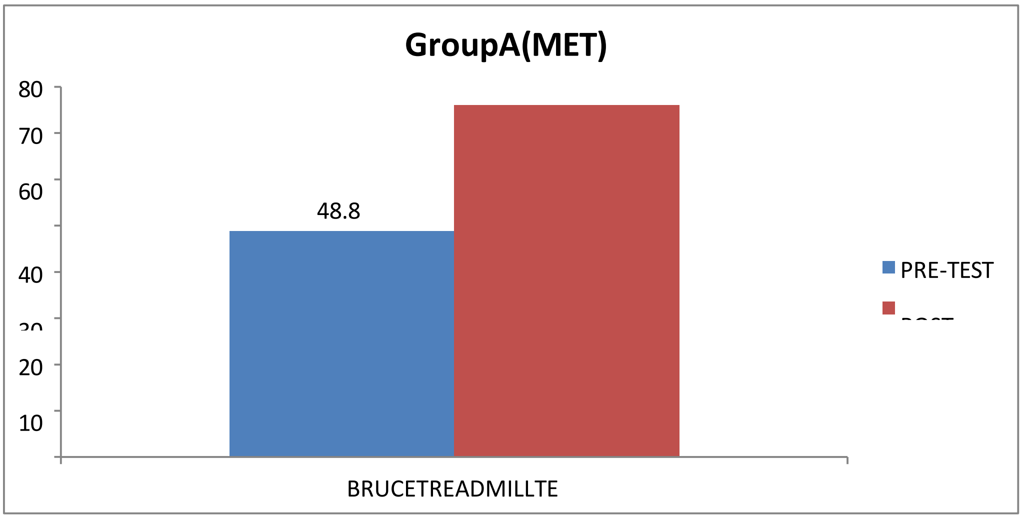


TABLE 1 concluded that there is **significant** effect of treatment A (MET) in increasing the value of **BRUCE TREADMILL TEST** (t = 10.04, p = 0.00001<0.05). In addition, the mean value of Bruce Treadmill Test has increased from 48.83 to 76.11, which confirms that treatment A is significantly effective in increasing the value of Endurance.

TABLE:2(Effectofpre&posttestvalueof40YardSprintTest)

TEST	MEAN		STANDARD DEVIATION		Tvalue	P value
40YardSprintTest	Pre-test	Post-test	Pre-test	Post-test	4.841387	0.0002
	16.9375	13.0625	5.971809	5.157115		

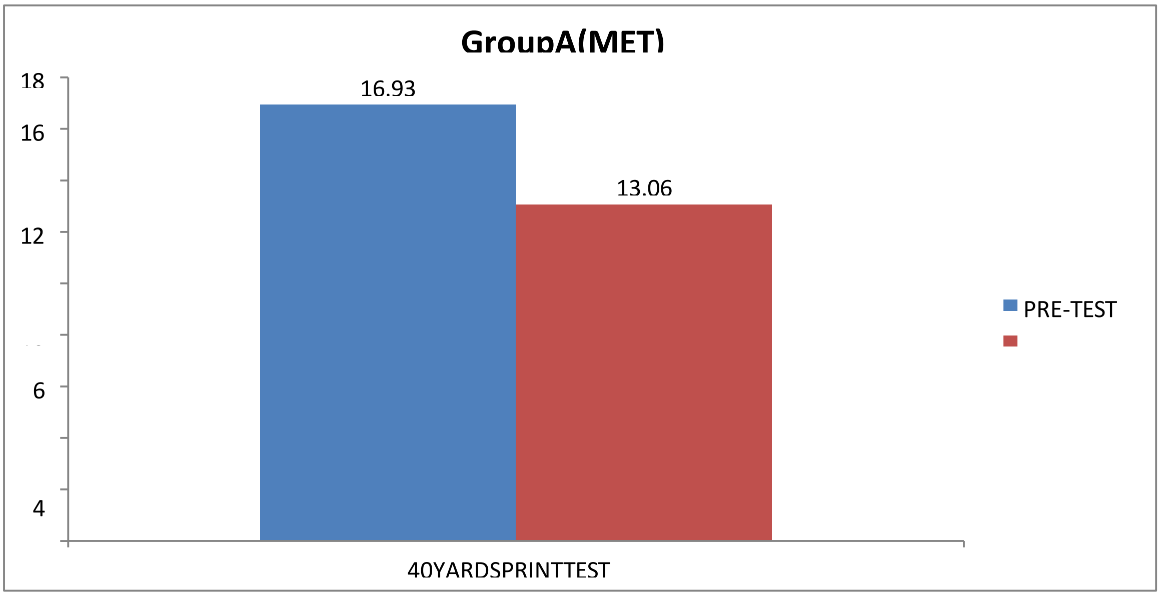


TABLE 2 concluded that there is **significant** effect of treatment A (MET) in decreasing the value of **40 YARD SPRINT TEST** (t=4.84,p=0.00022<0.05). In addition, the mean value of 40 Yard Sprint Test

has decreased from 16.93 to 13.06, which confirms that treatment A is significantly effective in increasing the value Speed.

GROUPB

INTRA-GROUPANALYSIS–(DYNAMICSTRETCHING)

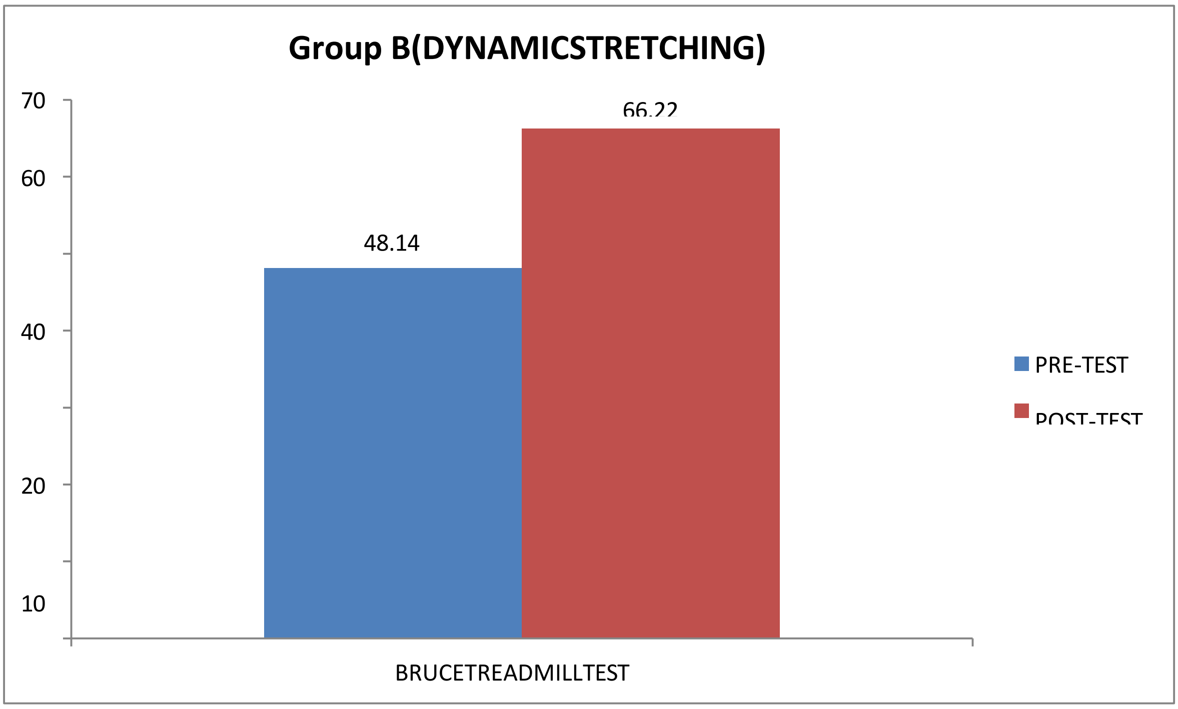
TABLE:3(Effect of pre &post test value of Bruce Treadmill Test)

TEST	MEAN		STANDARD DEVIATION		T value	P value
Bruce Treadmill Test	Pre-test	Post-test	Pre-test	Post-test	4.513777	0.00041
	48.14375	66.22125	14.55843	7.598587		

TABLE 3 concluded that there is **significant** effect of treatment B (DYNAMIC STRETCHING) in increasing the value of **BRUCE TREADMILL TEST**(t=4.51,p=0.00041<0.05).In addition, the mean value of Bruce Treadmill Test has increased from 48.14 to 66.22, which confirms that treatment B is significantly effective in increasing the value of Endurance.

TABLE:4(Effect of pre & post test value of 40YardSprintTest)

TEST	MEAN		STANDARD DEVIATION		T value	P value
40YardSprintTest	Pre-test	Post-test	Pre-test	Post-test	3.973307	0.0012
	16.875	14.5	5.64358	3.63318		



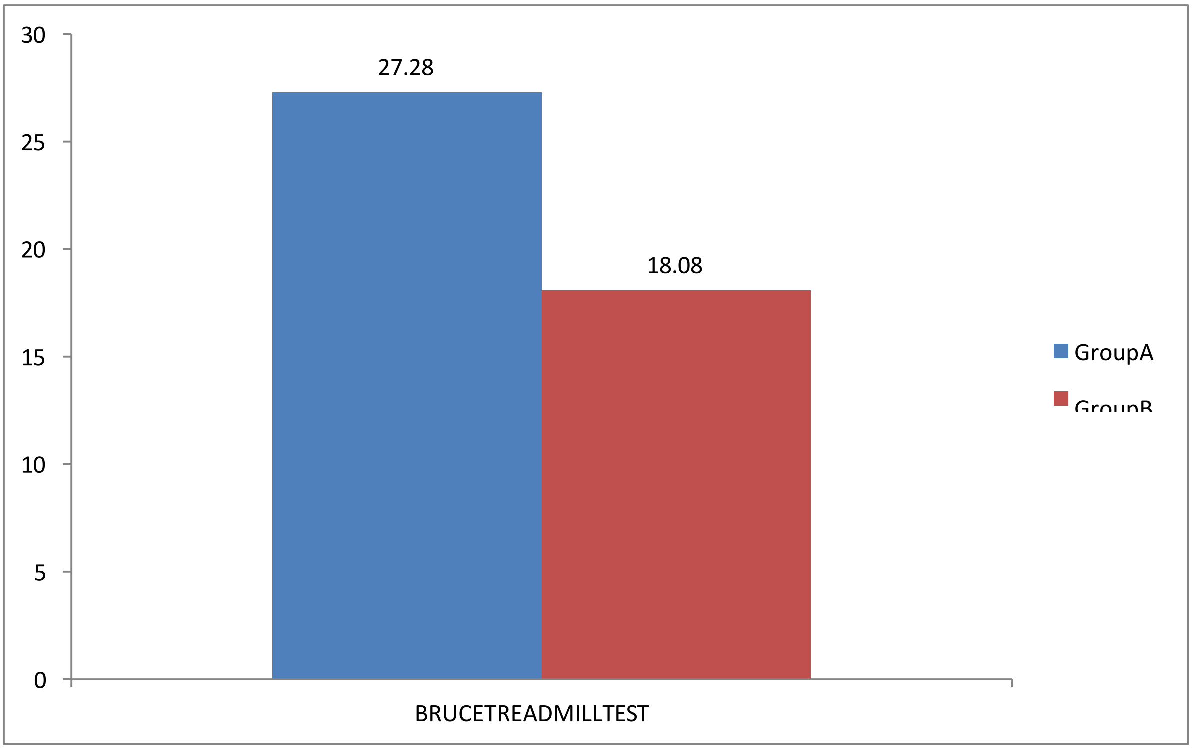
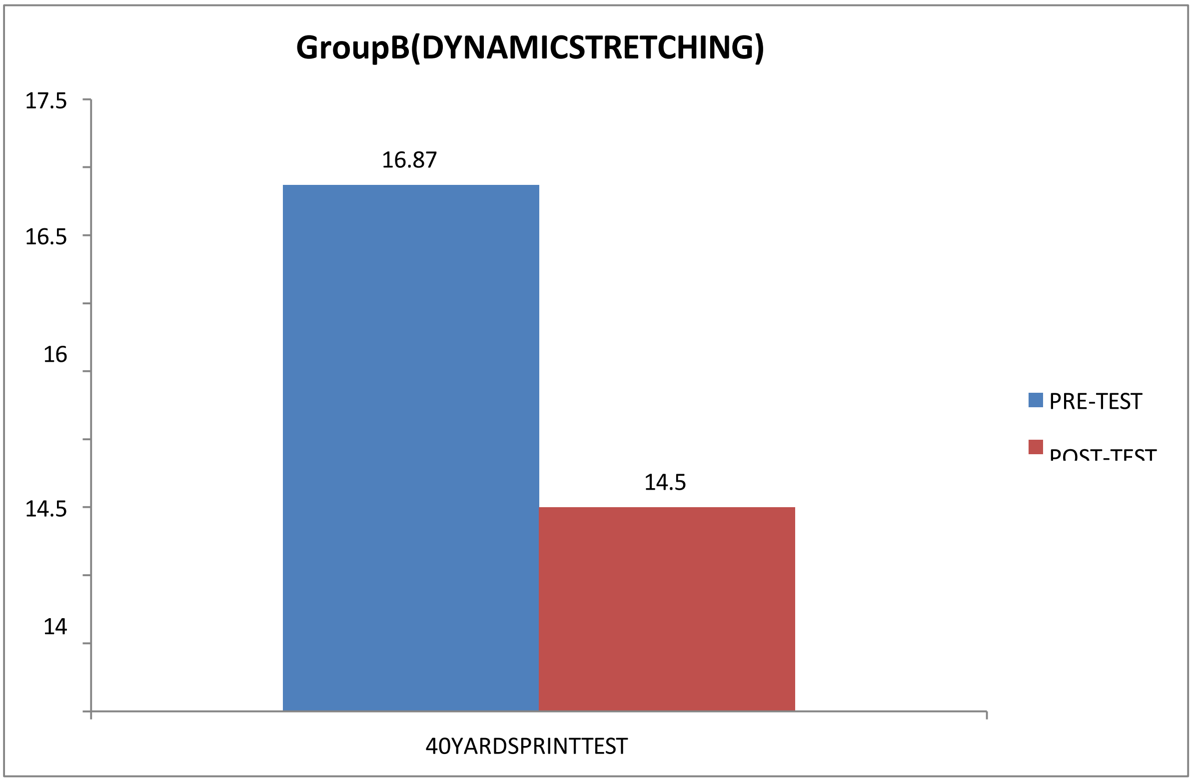


TABLE 4 concluded that there is **significant** effect of treatment B (DYNAMIC



STRETCHING) in decreasing the value of **40 YARD SPRINT TEST** ($t = 3.97$, $p = 0.00122<0.05$). In addition ,the mean value of 40 Yard Sprint Test has decreased from 16.87 to 14.5, which confirms that treatment B is significantly effective in increasing the value Speed.

INTER-GROUPANALYSIS

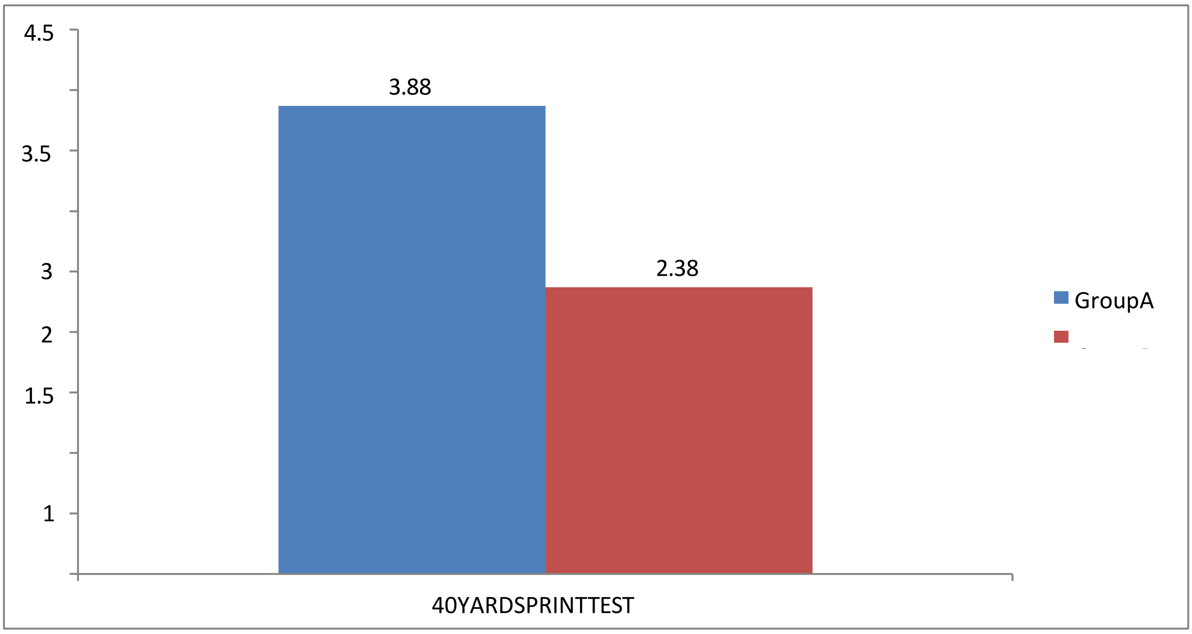
TABLE: 5 Comparing theeffects of Treatment A andB interms of change in the value ofBruce Treadmill Test.

TEST	MEAN		STANDARD DEVIATION		Tvalue	P value
BruceTreadmill Test	GroupA	GroupB	GroupA	GroupB	1.9027	0.033359
	27.2838	18.0775	10.86033	16.01984		

TABLE 5 concluded that there is **significant** difference between two treatments (A and B) in terms of average improvement in **BRUCE TREADMILL TEST**(t=1.9027,p=0.033359<0.05). In addition, the mean improvement in the value of Bruce Treadmill Test by Group A (27.28) is much greater than that of Group B (18.08). Hence concluded that **Group A treatment (MET) is significantly effective than Group B treatment (Dynamic Stretch)** in terms of mean improvement in the value Bruce Treadmill Test.

TABLE: 6 Comparing the effects of Treatment A and B in terms of change in the value of40 Yard Sprint Test.

TEST	MEAN		STANDARD DEVIATION		T value	P value
40YardSprintTest	Group A	Group B	Group A	Group B	1.50157	0.71831
	3.875	2.375	3.201562	2.390955		



concluded that there **no significant** difference between two treatments (A and B) in terms of average improvement in **40 YARD SPRINT TEST** (t = 1.50157, p = 0.71831>0.05). In addition, the mean improvement in the value of 40 Yard Sprint Test by Group A(3.88) Is not much Greater than that of Group B(2.38).Hence concluded that **Group A treatment (MET) and Group B treatment (Dynamic Stretch) are equally effective** in terms of mean improvement in the value 40 Yard Sprint Test

DISCUSSION

This study was conducted to evaluate and compare the effectiveness of Muscle Energy Technique (MET) and Dynamic Stretching (DS) on the calf muscle group in improving speed and physical endurance among healthy school-level sprint runners. The outcome measures focused on standardized tests such as the 40-Yard Sprint Test and the Bruce Treadmill Test, which are well-recognized indicators for sprint performance and endurance capacity, respectively.The findings revealed that both MET and DS resulted in significant improvements in sprint speed and endurance within their respective groups. However**,** intergroup analysis showed that MET had a significantly greater impact**,** particularly in enhancing performance on the Bruce Treadmill Test and 40-Yard Sprint Test. This suggests that while dynamic stretching prepares the muscle for immediate explosive movement and contributes positively to performance, Muscle Energy Technique may offer substantial and sustained physiological benefits**,** more likely due to its impact on muscle extensibility, neuromuscular activation, and biomechanical efficiency.Studies like those **by** Roshan Adkitte et al (2016) and Radhika Talapalli et al (2014) support this, concluding that MET significantly increases flexibility, especially in athletes, and may reduce injury risk during high-performance activities.Furthermore, Praveen Kumar et al (2015) and Kaniz Rabia et al (2019**)** found MET equally or more effective than other techniques like PNF or static stretching in improving flexibility and ROM, with positive implications for athletic performance and rehabilitation.Studies such as Jules Opplert et al (2018) **and** OlfaTurki et al **(2012)** demonstrate that DS can enhance muscle temperature, increase blood flow, and stimulate the nervous system, resulting in improved muscular performance and sprint speed.Brad S. Curry et al (2009) and Michelle N. Samuel et al (2008) noted DS is preferable over static stretching before high-power activities, as it prepares the muscles without reducing explosive strength.In terms of endurance**,** improved flexibility and joint mobility from MET may allow for more efficient oxygen utilization**,** reduced muscular fatigue, and better biomechanical alignmen**t**, as supported by studies like Stojanović et al (2023) and Daniel Mayorga-Vega et al (2013).As highlighted by Paula Teich et al (2023), children's physical development and fitness levels are influenced by chronological and biological age, as well as training exposure. Implementing proper warm-up and conditioning strategies, such as MET and DS, at the school level can aid in optimizing physical development and performance, especially for sprint runners in their early stages of training. This study concludes that both Muscle Energy Technique and Dynamic Stretching are effective in enhancing speed and endurance in school-level sprint runners. However, MET showed superior improvement, particularly in measures requiring sustained muscular effort and control. Incorporating MET into training regimens may provide young athletes with improved biomechanical efficiency, reduced injury risk, and bettersprintperformance.

LIMITATIONS

Study sample size is small**,** Samples were healthy individuals**,** Short follow up period.

FURTHER RECOMMENDATIONS:

Explore long-term effects of these interventions, Assess combined effects of MET and DS in warm-up routines, Investigate gender and age-specific responses to flexibility interventions, Include electromyography analysis to better understand neuromuscular adaptations, Study can be conducted on a large population, Study can be conducted with Long term follow up Other age groups can be involved, Distance runners can be involved and Other questionnaire can be included.

CONCLUSION

In this study, both Group A and Group B were shown to be equally effective in improving the enduranceandspeedwithsprintrunnersinschoollevel.ComparingMETandDynamicStretching, Group A (MET) provides better improvement in endurance and speed than Group B (Dynamic Stretching).

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