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EFFECT OF KINEMATIC CHAIN TRAINING VERSUS PLYOMETRIC TRAINING ON THROWING PERFORMANCE AND SHOULDER MUSCLE STRENGTH IN COLLEGIATE SHOTPUT ATHLETES

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Abstract: **Background: The kinematic chain training and plyometric training are given to the subjects to find out the improvement in Throwing performance and shoulder muscle strength.**

Objective: The aim of the study is to find out the effect of Kinematic chain training versus Plyometric training on improving throwing performance and shoulder muscle strength in collegiate shotput athletes.

Methodology: Pre and post experimental study that includes 28 subjects. Subjects were divided into two groups. Group-A received Kinematic chain training and Group-B received Plyometric training. Training duration was 8 weeks. Shotput throw test and Medicine ball throw test were used as the outcome tool for assessing throwing performance and shoulder strength.

Results: This study showed that both groups have significant improvement ($p < 0.05$) but Group A statistically significant difference in pre and post-test scores. The unpaired 't' comparison of post-test values of Group A and Group B of Shotput throw test shows 't' value 3.4748 and Medicine ball throw test shows 4.3148 respectively.

Conclusion: This study concluded that Kinematic chain training is effective in improving throwing performance and shoulder muscle strength in collegiate shotput athletes.

Keywords: **Shotput athletes, Kinematic chain training, Plyometric training, Throwing performance, Shoulder muscle strength.**

I. INTRODUCTION

Shot put is one of the four throwing events in athletics, alongside the discus throw, hammer throw, and javelin. This event requires athletes to throw a heavy metal ball using one hand, aiming to achieve maximum distance. [1] The shot put has been a modern Olympic event for men since the Olympic revival in 1896, and the women's competition was introduced in

1948. [2] Shot put is a track and field event that necessitates substantial power generation. Muscular power is largely determined by muscular strength, the maximum velocity of movement, and the activation of the neuromuscular system. [3] Over the years, shot put athletes have engaged in experimenting with different throwing techniques, notably the glide, rotational, leg reverse, and shuffle methods, the glide technique was developed in the 1950s and remained a popular method for many years. This approach entails a linear movement from the rear to the front of the circle while the athlete faces away from the target area. Following this, competitors rotate their bodies toward the throwing sector, optimizing the shot put for maximum distance. In comparison, the rotational technique rose to prominence in the 1970s and continues to be a successful method today. [4] The rotational technique is conventionally divided into six distinct phases and entails roughly two rotations of the body prior to the release. During this process, an athlete exerts significant forces over brief intervals to propel the shot into the designated area. The generation of these substantial forces is influenced by both technical and physical elements, making it 2 essential to address both aspects to improve performance. Notably, the rotational shot-put technique, being a complex movement, demands a high degree of motor control. [5] Numerous modern shot-put competitors have embraced the rotational technique, which is believed to benefit those who can generate speed effectively after achieving the power position. In rotational shot put, power generation may depend more on the velocity of movement and the rate of force application rather than solely on muscle mass and strength. [6] The throwing events in track and field include the shot put, discus, javelin, and hammer throw. Success in these disciplines necessitates a refined movement technique and significant biological capability. Three primary biomechanical factors influence the distance thrown: the angle of release, the height of release, and the velocity of release. Among these, the velocity of release is the most critical biomechanical aspect for attaining optimal throwing performance. [7] The throwing events in track and field are marked by their explosive characteristics and complex technical demands, necessitating quick force output. The delivery phase and the final thrust are forceful movements, occurring within a brief duration of around 150 to 240 milliseconds. [8] Power and strength are fundamental components necessary for performing a wide range of athletic tasks. Therefore, the enhancement of these qualities is often a primary focus for athletes and their coaches. [9] A successful throwing motion requires both careful coordination and significant strength throughout the entire kinetic chain. It is vital for sports medicine specialists, including athletic trainers, physical therapists, and physicians, to possess a thorough understanding of throwing biomechanics to deliver optimal care to throwing athletes.[10] The kinetic link principle, often referred to as the kinetic chain, provides a vital framework for the analysis and understanding of human movement patterns. It supports the rationale for the use of exercise conditioning and rehabilitation programs that target the entire body, even when a particular joint or anatomical structure is compromised. In relation to the performance of upper extremity skills, the work carried out in this area is transmitted to the trunk and spine through a large musculoskeletal framework. This framework enables the exchange of forces, resulting in the creation of substantial energy. [11] Functional exercises and kinetic chain training have seen a rise in popularity in recent years, as they improve athletic performance through integrated workouts. These exercises emphasize coordinated muscle engagement to achieve optimal movement efficiency. Kinematic chain activation exercises improve movement patterns in throwing sports, fostering synchronicity and efficiency by activating multiple muscle groups at once. This aids in establishing proper sequencing, which allows for enhanced force and velocity in the throwing motion. Throwing demands the coordinated activation of muscles across the body, starting with the lower body for power and extending to the core for stability and efficient energy transfer. [12] Plyometric training is a specialized exercise regimen focused on developing rapid and forceful movements, as well as optimizing the nervous system's capabilities, with the goal of enhancing sports performance. It consists of exercises where muscles are loaded and then quickly contracted in succession, leveraging the strength, elasticity, and neural activation of the muscles and surrounding tissues to achieve objectives such as increased jump height, improved running speed, extended throwing distance, or enhanced striking power. [13] Plyometric training is designed to enhance explosive movement patterns in fast-twitch muscle fibers. The primary objective of plyometric is to first engage a muscle through a stretching or eccentric contraction, which is then immediately followed by a swift concentric contraction. This methodology complements the SAID principle, suggesting that plyometric training is the most effective method for addressing the specific requirements necessary to improve throwing velocity in overhead throwing activities. [14] A shotput test is typically designed to assess an athlete’s strength, technique, and overall performance in sports of shotput. It measures the maximum distance an athlete can throw a shot using a heavy metal ball, the height at which the shot is released, the angular velocity of the upper arm at the moment of release, the range of motion of the shoulder girdle throughout the delivery, and the average angular velocities of the trunk, shoulder girdle, and upper arm during the delivery exhibited significant correlations with both the classification and the measured distance. [15] The Seated Medicine Ball Throw (SMBT) is commonly referenced in academic literature as a method for measuring upper body explosiveness, owing to its practicality in real-world applications. This exercise is straightforward and can be easily learned, making it suitable for a wide range of individuals, including children, athletes, healthy adults, and older adults. [16]

II. METHODOLOGY

STUDY DESIGN:

The study design was a pre-test and post-test experimental study design.

STUDY SETTING:

The study was conducted in K.G College of Physiotherapy playground, Saravanampatti, Coimbatore. The study was done under the supervision of my guide.

STUDY DURATION:

The study was conducted over a period of six months and each subject received training for eight weeks.

STUDY POPULATION:

The study population was tracks athletes.

STUDY SAMPLING:

28 subjects were selected based on the inclusion and exclusion criteria. By random sampling method Subjects were divided into 2 groups, each group with 14 members.

CRITERIA FOR SELECTION:

Inclusion Criteria was Age - 18 to 25 years, Gender - both male and females are included, Athletes with minimum shotput throwing distance (with 6 kg shot put) – 6mts and above, Athletes who were not involved in any specific training program for the past 6 months, Good health status – free from any musculoskeletal injuries or conditions that may affect the throwing performance, those who were willing to participate were all considered for admittance. Exclusion Criteria was Athletes with cardiorespiratory disorders, orthopaedic and neurological impairments, Athletes with recent surgery or medical procedures and Athletes who are unwilling and uncooperative were excluded.

PROCEDURE:

A total of 28 active collegiate shotput athletes were selected according to the selection criteria. The purpose and nature of the study were explained to all participants and an informed consent was obtained from them. The subjects were allocated into 2 groups with 14 subjects in each group. Subjects in Group A received Kinematic chain training whereas subjects in Group B received Plyometric training. Throwing performance and Shoulder muscle strength was measured at the baseline and at end of training session.

Group A underwent kinematic chain training - Warm up duration - 10 minutes, Kinematic chain training- 40 minutes, Cool down duration - 10 minutes, All subjects underwent kinematic chain training for 60 minutes per session, 5 sessions per week for 8 weeks.

KINEMATIC CHAIN TRAINING

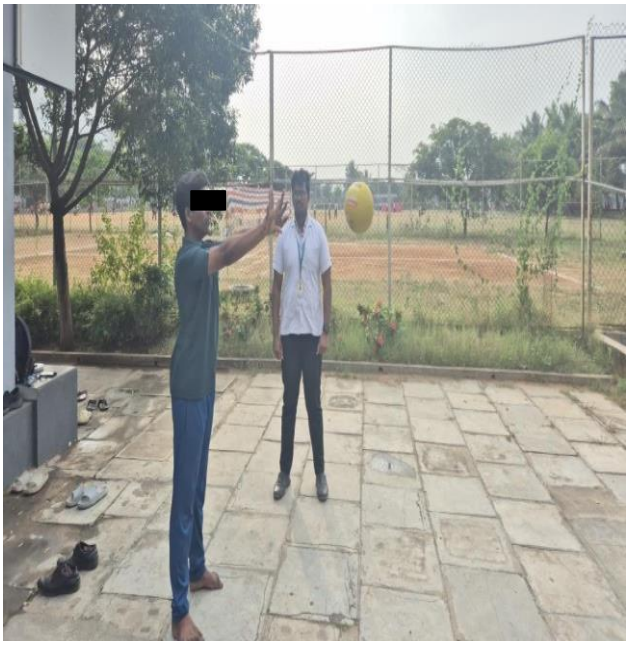
GOBLET SQUAT

OVERHEAD MEDICINE BALL SLAM

Group B underwent plyometric training - Warm up duration - 10 minutes, Plyometric training – 20 to 40 minutes, Cool down duration - 10 minutes, All subjects underwent plyometric training for 60 minutes per session, 5 sessions per week for 8 weeks.

PLYOMETRIC TRAINING

COUNTERMOVEMENT JUMP



CHEST PASSES

III. DATA ANALYSIS AND INTERPRETATION

Age group classification:

S.NO	AGE	NO OF PLAYERS
1	18-20	10
2	21-23	12
3	24-25	6
4	TOTAL	28

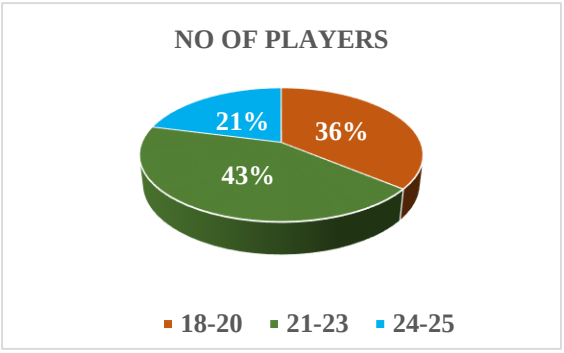


TABLE II SHOWS ANALYSIS OF SHOTPUT THROW TEST BETWEEN GROUP A AND GROUP B:

S.NO	POST TEST	NO OF PLAYERS	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	"t" VALUE
1.	Group A	14	10.6	1.26	0.25	3.4748
2.	Group B	14	9.34			

The table II shows the analysis of Shotput Throw Test in Group A and Group B. Using unpaired 't' test with 26 degrees of freedom and 0.05 as a level of significance, the calculated "t" value is 3.4748, which was greater than tabulated "t" value 2.056. The result shows that there was a marked difference between post-test values of both groups.

GRAPH –II SHOWS ANALYSIS OF SHOTPUT THROW TEST BETWEEN GROUP A AND GROUP B

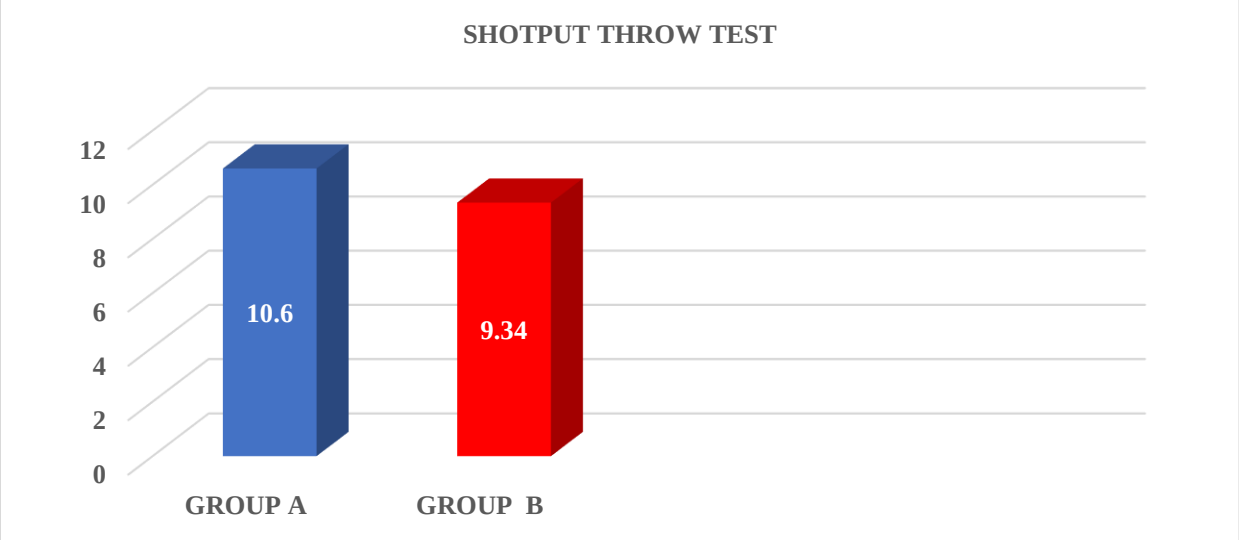
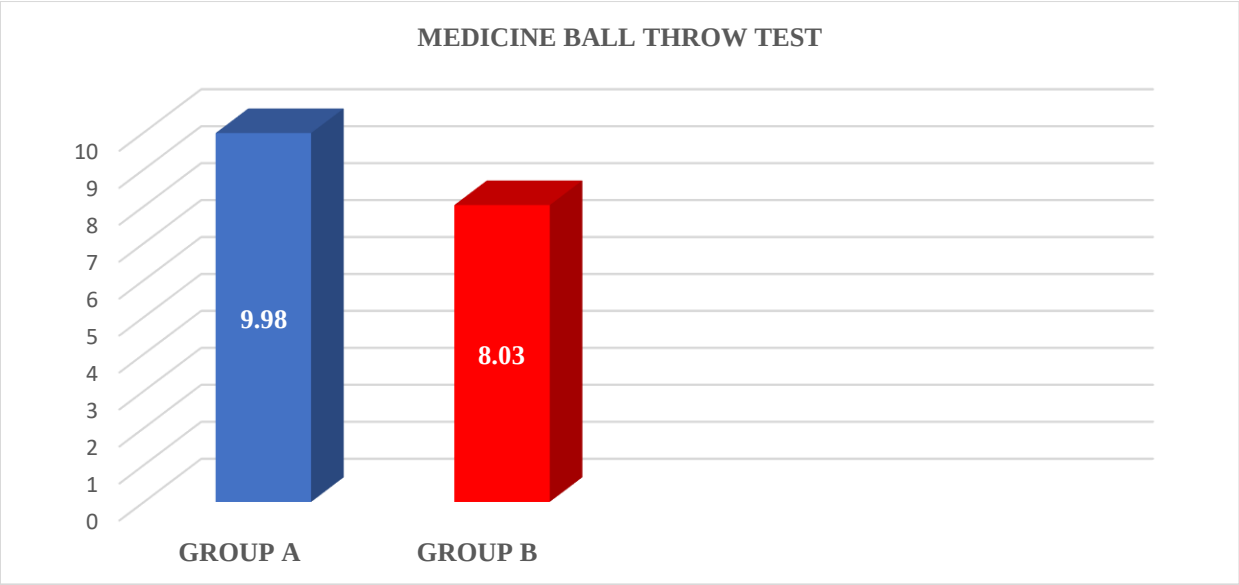


TABLE III SHOWS ANALYSIS OF MEDICINE BALL THROW TEST BETWEEN GROUP A & GROUP B:

S.NO	POST TEST	NO OF PLAYERS	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	"t" VALUE
1.	Group A	14	9.98			
2.	Group B	14	8.03	1.95	0.27	4.31148

The table VI shows the analysis of Medicine Ball Throw test in Group B. Using paired 't' test with 13 degrees of freedom and 0.05 as a level of significance, the calculated "t" value is 4.3148, which was greater than tabulated "t" value 2.160. The result shows that there was a marked difference between pre-test and post-test values.

GRAPH –II SHOWS ANALYSIS OF MEDICINE BALL THROW TEST BETWEEN GROUP A & GROUP B:



IV. DISSCUSSION

The shot put is a track and field event where athletes throw a heavy metal sphere using one hand, aiming to achieve maximum distance. Shot put athletes are required to have a combination of strength, speed, and technical proficiency to perform effectively. The application of biomechanics and appropriate training methods is crucial for optimal performance. To achieve maximum distances and exert the greatest force, the Shot put discipline highlights the importance of an athlete's

strength, momentum, and skill. The purpose of study was to analyze the effect of kinematic chain training versus plyometric training on throwing performance and shoulder muscle strength in collegiate Shot put athletes. This research presents an in-depth examination of the physical attributes and performance metrics of the participants delivering thorough insights into the mean, standard deviation, and statistical significance of multiple variables. This research carefully documented pre-intervention metrics related to throwing distance and shoulder muscle strength. These initial performance indicators were essential for evaluating the effectiveness of the intervention. By setting these benchmarks prior to the intervention, the study guaranteed that any improvements noted could be ascribed to the experimental procedure rather than to natural development or training conducted outside the defined study parameters. Collegiate shotput athletes who fulfilled the predetermined inclusive and exclusive criteria were selected and divided into two groups within each group. Subjects in Group A underwent kinematic chain training and Subjects in Group B underwent Plyometric training. Statistical analysis was done using student "t" test. Paired test conclude that there was a significant increase in throwing efficiency and shoulder muscle strength in collegiate shotput athletes. Unpaired test showed that there was a significant difference between the Kinematic chain training and Plyometric training collegiate shotput athletes on throwing efficiency and shoulder muscle strength. Kinematic chain training demonstrates a notable enhancement in throwing distance attributed to the activation of the kinematic chain. This approach may have been particularly effective in augmenting the muscle strength and coordination essential for activities related to throwing. Research conducted by Cools et al., (2021), suggests that tailored, sport- specific rehabilitation programs can significantly influence throwing performance. The kinetic chain serves as the foundation for sequenced and coordinated human movements, which are facilitated by the nervous system and myofascial highlighting the interdependence of various body parts. Myofascial chains, along with the dynamics of passive neural tissues, enable effective force transmission between the core and the limbs. The range of motion at a single joint is influenced by the overall positioning of the body, reflecting the operation of the kinetic chain through the myofascial muscle network. Repetitive movements associated with sports can result in the thickening and shortening of fascia surrounding overused muscles, while causing lengthening in other areas. The core acts as the central hub of the kinetic chains in most athletic activities, making it crucial for reducing injury risk and enhancing limb functionality. The complex sequence and coordination of muscle activation within the kinetic chain are vital for the efficient transfer of energy necessary to perform sport-specific skills or tasks. Kinematic chain training can strengthen the kinetic chain in the body which is important factor for generating power and improving the throwing technique of shotput athletes. The mean values for the Flexor and External Rotators were considerably elevated, suggesting that the experimental exercises positively impacted these specific movement patterns. This enhancement may be linked to the focused strengthening of the external rotator muscles and the posterior chain. The notable increase in Flexor strength among athletes is especially significant, as it influences throwing mechanics and shoulder stability. Researchers Wight et al., (2022), found that athletes suffering from shoulder injuries could experience significantly improved outcomes with tailored rehabilitation programs that emphasize external rotator strength. The study conducted by Mustapha et al., (2019), revealed notable statistical differences between the pre-test and post-test results for Plyometric training group, specifically concerning muscular strength and performance in the shotput technique. The researchers attributed these findings to the training program implemented, which was grounded in scientific principles and focused on high-quality physical exercises relevant to the sport, particularly emphasizing the incorporation of plyometric exercises. The analysis of the plyometric training program's effects on motor abilities associated with the shotput technique revealed similar outcomes in the technique itself. The advantages of the implemented plyometric training extended beyond the shotput technique, leading to enhancements in various motor abilities such as power, strength endurance, speed, and acceleration. Consequently, the advancement of the shotput technique was facilitated by the improvement of these related motor abilities, which resulted from the plyometric training program. Plyometric training evokes the elastic properties of the muscle fibers and connective tissue in a way allows the muscle to store energy during the deceleration phase and release the energy during the acceleration phase. Therefore, Plyometric training has been recommended for sports that rely on generation of high-power output. Researchers and practitioners assumed that these characteristics of plyometric training would facilitate significant gains in muscle strength and power and therefore optimizing throwing performance. Both groups had a better outcome because of training regimen, but the group trained with kinematic chain training is more effective than plyometric training on throwing performance because it focuses on optimizing the sequencing movement pattern and coordination of the entire body during the throw, ensuring that energy is efficiently transferred from the lower body to the arm. Therefore, it improves the joint mobility and stability, helping prevent injuries and ensuring proper technique. This approach is generally more effective for building overall shoulder strength, particularly in terms of joint integrity and long-term shoulder health.

Clinical implication: The implication of study is that kinematic chain training can be used to improve the Throwing performance and Shoulder muscle strength in collegiate shotput athletes.

V. CONCLUSION

There is a significant difference between the within group and between group in Throwing performance and Shoulder muscle strength following intervention. However, Kinematic chain training has shown significant improvement in throwing performance and shoulder muscle strength than Plyometric training. So, this study concludes that Kinematic chain training is more effective in improving throwing performance and shoulder muscle strength than Plyometric training in collegiate shotput athletes.

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