EFFECT OF UNIFORM PLYOMETRIC TRAINING PROGRAMME ON MOTOR FITNESS PARAMETERS OF TEEN-AGE ATHLETES

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BY

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TO

MY BELOVED

PARENTS,

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SON

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RESPECTED TEACHER

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FRIENDS

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LIST OF ABBREVIATION

SL.NO.	ABBREVIATION	FULL FORM
1.	S	Sprinter
2.	SR	4x10 mt. shuttle run
3.	PU	Pull up test
4.	SBJ	Standing Broad Jump
5.	RTT	Reaction Time Test
7.	M	Mean
8.	SD	Standard Deviation
9.	SEC	Second
10.	MT.	Meter
11.	Pre-T	Pre-Test
12.	Post-T	Post-Test
13.	Test-1	Post-Test-1
14.	Test-2	Post-Test-2
15.	Test-3	Post-Test-3
16.	df	Degree of freedom
17.	SS	Sum of square
18.	ANOVA	Analysis of Variance
19.	ANCOVA	Analysis of co-variance
20.	J	Jumper
21.	T	Thrower

CHAPTER-I

INTRODUCTION

CHAPTER-I

INTRODUCTION

1.1 GENERAL INTRODUCTION:

Success in many sports controlled heavily upon the athlete's explosive muscle power and muscular strength. The jumping, throwing, track and field sports and other games, the athlete must be able to utilized strength as quickly and forcefully as possible. This discussion comes in the form of speed-strength or power (Yeses, & Hatfield 1986). Power shows the amount of work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought (Paul, et. al., 2003).

Given the type of sport, athletes and sport competitors have different needs, priorities, and preferences in terms of motor fitness and mobility conditions. In other side, all sport courses hold individual needs in strength, power, flexibility, and speed, or a combination of them; which depends from one sport to other sports .Muscle power is an important parameter to success. In physical education, it defined to the highly force that a muscle generates in the shortest possible time in order to confront the resistance, it is same to muscular force or explosive muscle power.

Plyometric training related specific muscles in eccentric-concentric movement rhythm. Frequency of eccentric (stretching) and concentric (shortening) actions contribute highest power than of normal concentric action. Elastic energy within the muscle can provide more force. Increased power generation plays an important contribution in improvement of sprint running times, which needs high explosive muscle power. **Cavagna et al. (1971**) evaluated the amount of force transferred during sprint running, from first to last points (9.4 m/s) and make that the high power outside were obtained by 5 m/s mean time cause to inherited attached features of muscles and the appearance of elastic energy before concentric movement .Plyometric training involves explosive practices to active the first response and elastic proportion of the main muscles. It was primarily adjusted by Soviet Olympians in the 1950s, and then sporting worldwide. Sports utilized plyometric involve basketball, squash and

football as well as the different codes of football. The term “plyometric” was introduced by Fred wilt after follow soviet athlete’s preparation for their sports in track and field. He began discussed with trainer Michael Yessis to contribute plyometric.

Since its start in the early 1980s, two forms of plyometric have attached. In the current version, invented by Russian scientist Yuri Verkhoshanasky; it was identified as the shock method. In this, the athlete’s world drop down from a height and experience a “shocked” upon landing. This in turn world brings about a forced eccentric contraction which was then immediately switched to a concentric contraction as the athletes jumped upward. The landing and takeoff were executed in a extremely short in the range of 0.1-0.2 seconds. Explosive plyometric describes the approach originally created by Verkhoshansky. He experimented with many different exercise, but the depth jump appeared to the best for duplicating the forces in the landing and takeoff. The second version of plyometric, seen to a greater extend in the United States, involves any form of jump regardless of execution time. The term plyometric become popular with the publication of the book son the subjects.

The term “plyometric” refers to specific exercise which encompass a rapid stretching of muscle that is undergoing eccentric stress followed by a concentric, rapid contraction of that muscle for the purpose of developing a forceful movement over a short period of time **(Chu, 1983)**. For an exercise to be truly plyometric, it must be a movement preceded by an eccentric contraction. This result not only stimulating the proprioceptors sensitive to rapid stretch, but also in loading the serial elastic components (the tendon and cross bridges between muscle fibers) with a tendon force from which they can rebound(chu,1998). As an athlete’s lands on the ground during a plyometric training a plyometric exercise, a stretch occurs in the involved muscle fibres.Propioceptors with in the muscles tissue immediately sense this stretch and send a message to the spinal cord through an afferent or sensory neuron. The spinal sends an immediate massage back to the muscle fiber via an efferent or motor neuron, telling it to contract to keep it from overstretching. This is known the “stretch reflect” and it is one of the body’s built-in protection mechanisms for prevention of injuries to muscles fibers. Plyometric exercise can be used to train to body the emit this sensor the signal in a shorter time period which cause the effected muscles to react more quickly (Freeman and Freeman, 1984). Hochmuth (1974) also stated that, “a body movement, requiring an extremely high end velocity can best be achieved by starting it with a movement in the opposite direction. The breaking of the opposite movements creates positive acceleration power for the original

movements." Most human movement activities involves a counter movement during which the muscles involved are first stretched and then shortened to accelerate the limb. This action of the muscles is called a stretched shorting cycle (SSC) (komi, 1986) and involves some interesting neural and mechanical processes. The great deal of research has been directed towards the study of the stretching cycle (Boaco and Komi, 1979; et.al; 1982; Etteme, et.al. 1990; Golhofer and kyrolainen, 1991; Hakkinen, 1989; Komi, et.al., 1982; schmidtbleicher, 1988) because it has been observed that jump performance is potential by the pre-stretch experienced during a counter movement jump (Boaco and Komi, 1979).One study by Boaco, et. Al. (1982) found differences between squat jump and counter movement jump height of 18-20 percentage.

Plyometric training contributes the opportunity to train various movement type in a biomechanically write manner at a more effectively appropriate speed. This contributes functional strengthening of the muscle, tendon and ligaments specific to the demands of everyday exercises and sports. The ultimate aim of uniform plyometric training is to progress the reaction time of the muscle action activity (eccentric deceleration, isometric stabilization and concentric acceleration).

The speed of muscular extortion is barrier by neuromuscular co-ordination. This meant that the body will move high significantly and efficiency within a limitation of speed that the nervous system has been programmed to permit. Plyometric training develops both neuromuscular efficiency and a limit of speeds set by the central nervous system. Optimum performance of any exercise carry's on the speeds at which muscular forces can be transfered **(Esteem, et.al. 1990).**

1.2 PHASES OF UNIFORM PLYOMETRIC TRAINING EXERCISE:

There are 3 distinct stages involved in plyometric training including the eccentric contraction (the loading or declaration stages; the amortization, or transition phase and the concentric or unloading phase.

THE ECCENTRIC PART: The first part of a plyometric movement can be divided as the eccentric phase, but it have the also been named the declaration, loading, yielding, counter movement, or cocking phages. This stages increase muscle spindle activity by pre-stretching the muscle prior to needful. Potential energy is stored is to elastic parameters of the muscle

during this loading stages. A low eccentric phase prevents taking maximum advantage of the mitotic stretch reflect.

THE AMORTIZATION PART: This stage attach dynamic stabilization and is the time between the end of the eccentric contraction (the loading or declaration stages) and the starting of the concentric contraction(the uploading or force production stages) .The amortization part something referred to s the transition phase ,is also referred to as the electromechanical delay between the eccentric and concentric contraction continue which the muscle must switch from overcoming force to imparting force in the intended movement. An amortization stages result in less than maximum neuromuscular ability from a loss of electric potential energy. A rapid key from an eccentric contraction to a concentric contraction lead to a more powerful response.

THE CONCENTRIC PART: The concentric stage (or uploading phase) incidents quickly after the amortization part and attaches a concentric contraction, resulting in progress muscular ability following the eccentric stages of muscle contraction. This incident secondary to progressed addition and reutilization of elastic potential energy, muscle potential and provide of the mitotic stretch reflect. This discus comes in the form of speed-strength or power **(Yeses, & Hatfield 1986).**

1.3 PHYSIOLOGICAL PRINCIPLES OF PLYOMETRIC TRAINING:

Plyometric training used the elastic proprioceptive evidences of a muscle to generate optimum force provide by stimulating mechanoreceptor to facility an enhanced in muscle attachment in a minimal amount of time. Muscle spindles and Golgi tendon organ contribute proprioceptive based for plyometric exercise. The central nervous system then utilized this sensory data to influence muscle ton, motor execution and kinesthetic consciousness. Stimulation of this receptors can cause facilitation, inhibition and modulation of both agonist and antagonist muscle exercise. This enhances neuromuscular ability and effective strength.

THE ELASTICS PARAMETERS OF MUSCLE-

The idea of plyometric is depend on the three parameters model of muscle. Muscle is modeled with a contractile elements and two elastic parameters that are called according to their attachment to the contractile elements – one in line with (the series elastic elements) and one

in equal line (the parallel elastic elements). When a muscle contracts tension is not directly transmitted to the ends of the tension and the load is not exit, leading to movements. This would only occurred in the connection in the contractile elements and its insertion were rigid and inelastic. In cause, the contractile elements develops tension, stretching the line elastic parameters; the degree of stretch is dependent on the load to be transferred. After maximum tension has been transferred the tension at the end of the muscle is sufficient to overcome the load and the load is moved. When a load is applied to a joint (eccentric phase), the elastic elements stretch and store potential energy (amortization phase) prior to the contractile elements contracting (concentric phase).

An eccentric contraction immediately preceding a concentric contraction significantly increases the force generated concentrically as a result of the storage of the elastic potential. During the loading of the muscle, the load is transferred the series elastic components as stored as elastic potential energy. The elastic elements then contribute to the overall force production by converting the stored elastic potential energy to kinetic energy, which enhance the contraction. The muscles ability to use the stored elastic potential energy is affected by the variable of time, magnitude of stretch and velocity stretch. Increased forced generation during the concentric contraction is significant when the preceding eccentric contraction is of low range and is performed without lazy.

A simple example of the utilization of the energy stored in the elastic parameters is the based vertical or countermovement, jump. The primarily squat (the countermovement) is the eccentric stages that stretches the elastic parameters and stored elastic energy (amortization stages). When the jump is performed (the concentric stages), the stored energy is "+" to the tension provide leading to a maximum jump. The area of stored energy utilized is inversely proportional to the time spent in the amortization stages. When doing a vertical jump, then higher one waits at the last of the countermovement in the before performing the jump, the minimum the eventual jump height due to in ability to recover the elastic energy.

The development muscular ability the occurs with the pre-stretch in a muscles the result of the mixed effects of both the storage of elastic potential energy and the proprioceptive prophetic of the muscles fiber. The percentage of the every component provides is unknown at this time, but the degree of the muscular performance as first earlier is involves upon the time in transition from the eccentric to the concentric contraction, thereby development performance.

This can be accomplished through integrated training **Barry L. Johnson and Jack K. Nelson (1982)** Practical measurements for evaluation in Physical Education, Delhi: Surety Publications, p.215.

1.4 PROPOSED MECHANISM BY WHICH PLYOMETRIC TRAINING IMPROVED PERFORMANCE:

There are 3 actual mechanisms by which plyometric exercise enhancing performance enhanced muscle spindle exercise, decentization of the GTO and improved intramuscular neuromuscular abilities.

ENHANCED MUSCLE SPINDLE ACTIVITY

The speed of a muscular contraction is controlled by the neuromuscular system. The human movement system will only transferred within a set speed area regardless maximum strong a muscle is the quicker the eccentric loading, the higher the concentric force production. For example, the quadriceps are loaded more quickly when dropping from an in box versus a 0.25 m box.

DESENSITIZATION OF THE GOLGI TENDON ORGAN OF BODY PARTS

Desensitization the GTO enhanced the stimulation threshold for muscular inhibition. This promotes increased forced production with a greater load applied to the musco-skeletal system.

IMPROVED NEURO-MUSCULAR ABILITY

Plyometric exercise may provide better nuro-muscular of the contracting agonist and synergists, thus enabling that central nervous system to make high reflex. These neural adaptation leading to progressed neuromuscular ability in the absence of morphological adaptation, such as muscle hypertrophy. Exploiting the stretch reflex starting the GTO and improving the ability of the nervous system to reaction with high speed to the lean thing muscle minimizes the force provide by the concentric contraction.

In the end, plyometric training has long-ranging effect beyond power output. There is medium evidence that when plyometric training are helping into an integrated training program., there

are documented progressed in jumping ability, running economy, power output, and range of force improvement, but not strength. When used is an isolated training programmer, there is medium evidence that plyometric have short positive benefits on performance. There is no data that youth athletes, when properly contributed and following side, cannot utilized plyometric in a uniform training programmer or that plyometric should be counted solely for athletes. A common fallacy when concede ring plyometric training that is that plyometric are only use in training for jumping performance when there are random trails following significance reduction in injury rates **Adams, T. (1984)** an investigation of selected Plyometric Training exercises on muscular leg strength and power. Track and Field Quarterly Review, 84(4), 36-40.

1.5 BENEFITS OF PLYOMETRIC TRAINING:

The advantage of plyometric are the simple but elusive athletic needs of more speed, more stamina and more power, be it in running, jumping, throwing, swimming or another sport-specific movement. It's about the efficient use and manipulation of muscles to produce consistent peak performance, not about building bulkier muscles. These benefits come with practice, training and care. These exercises take competitive athletes who want a permanent, physical edge to the next level of competition by teaching their bodies to do what they want them to do. While sometimes used to build muscle back as part of rehabilitation or physical therapy, plyometric are still primarily for use by athletes who are in training and are already strong, fit and flexible. Flexibility prevents injury, while also ensuring that the plyometric are used to their peak efficiency. It also helps to be strong and currently engaged in a strength-building routine **(Boaco and Komi, 1979).**

1.6 STATEMENT OF THE PROBLEM:

The purpose of the study was to investigate the **"Effect of uniform plyometric training programme on motor fitness parameters of teen-age athletes."**

1.7 OBJECTIVES OF THE STUDY:

- To understand the effect of 3 months uniform plyometric training on speed, agility, power, shoulder strength, reaction time of Sprinters.

- To understand the effect of 3 months uniform plyometric training on speed, agility, power shoulder strength, reaction time of Jumpers.
- To understand the effect of 3 months uniform Plyometric training on speed, agility, power, shoulder strength, reaction time of Throwers.

1.8 DELIMITATION

- Population: 100 meters and 200 meters sprinters, long jumpers, triple jumpers and shot-putters, discus throwers of state level male and female teen-age athletes of West Bengal from each group was considered as subjects.
- Sampling: Purposive random sampling technique was considered for the purpose of selecting the subjects for the present study.
- Group: 10 sprinters, 10 jumpers, 10 throwers and 10 control group (3 sprinter, 3 jumper and 4 thrower) was considered as subjects for this study. In the meantime, first three groups are experimental groups.
- Age: 14-19 years.
- Area: The study was restricted to 40 students of school games in barasat athletic coaching center club, Barasat, (N) 24 parganas, West Bengal.
- Period: The training period was delimited to 12 weeks.

1.9 LIMITATION

- Climatic conditions were considered as limiting factors.
- Genetic and economic factors were considered as limiting factors.
- Psychological factors, food habits, resting period, life style etc. could not be controlled.
- Since the subjects were from the coaching center their past experiences in the field of athletics were not taken into consideration.
- The growth and developments of the subjects if any during the period of experimentation and its possible influence on the variables could not be controlled. However the controlled group was employed to nullity the effect of maturation.

1.10 HYPOTHESIS

It may be hypothesized that, there would be no significant differences in speed, agility, power, shoulder strength and reaction time for the effect of 3 months uniform plyometric training applied on teen-age sprinter, jumper and throwers.

1.11 SIGNIFICANCE OF THE STUDY

- The study may make significant contribution to enrich the existing knowledge of plyometric training.
- The study may throw some light on the effects of plyometric training on motor fitness parameters.
- The study may be useful in preparing some training programmed for Young men/women or even athletes for development of motor fitness parameters.
- The study may be of some worth for remedial, curative and rehabilitative programmed for patients suffering from various motor fitness problems

1.12 METHODOLOGY

SELECTION OF PARAMETERS

The selected parameters to be taken for this study are-

- Speed
- Agility
- Power
- Shoulder strength
- Reaction time

CRITERION MEASURE

- Speed was measured by 50 meter sprint and the result was recorded to the nearest1/100th seconds.
- Agility was measured by 4×10 meter shuttle run test and the results was recorder to the nearest1/100th seconds.

- Power was measured by Standing Broad Jump and the results was recorded in meter.
- Shoulder strength measured by pull up test for one minute and the number of legal pull up was considered as a result.
- Reaction time measured by Nelson Choice-Response Movement test and result was recorded in nearest 1/100 seconds.

1.13 STATISTICAL PROCEDURE

In order to find out the significant difference of speed, agility, power, shoulder strength, reaction time after 3 months of uniform plyometric training among teen-age athletes. Repeated measures Analysis of Variance (ANOVA) and repeated measures Analysis of Covariance (ANCOVA) were used at 0.05 levels of confidence and to identify the significance differences between the mean critical differences, Post-hoc test was used. Descriptive and comparative statistics were done for analysis of data by using SPSS (20).

1.14 OPERATIONAL DEFINATION OF THE TERMS:

Training

"Training defined as, a programme of exercise designed to improve skills and increase energy capacities, for an athlete, the preparation for a particular event" (Friedberg, 2001). Training defined as "Systematic process of repetitive progressive exercise of work involving the learning process and acclimatization" (Archean, 1985).

SPEED: Speed is kinematics, the speed of an object is the magnitude of the rate of change of its position with time. The average speed of an object interval of the time is the distance travelled the object divided by the duration of the interval; the instantaneous speed is the limit of the average speed as the duration of the time interval approaches zero.

Speed can be thought of as the rate at which an object cover distance. A fast moving objects has a high speed and covers a relative large distance in given amount of distance and in the same amount of speed has the dimension of distance divided by time.

AGILITY: Agility is an ability to change the body's position to efficiency and required the integration of isolation movement skills using a combination of balance, co-ordination, speed,

reflex, strength and endurance. Ability is the ability to change the direction of the body in an efficiency and effective manner and to achieve this require a combination of different fitness parameters.

In sports, agility to often define to term of an individual sport, due to it being an integration of many components each used differently. Sheppard and Young (2006) defined agility as a "rapid whole body movement with change of velocity or direction in response to a stimulus."

Agility is also an important attribute in many role of plying game, both video games such as Pokémon and table top games such as dragon. Agility may affect the character abilities to evade an enemy attack or lands their won or pickpocket and pick locks.

POWER: Power athletes are individuals who train with high resistance muscle loads, including such sports as weight lifting wrestling, body building among others. This form of exercise, term static or isometric exercise, which imposes a pressure load on the heart and cardiovascular system to static exercise involve small increases in blood pressure and maintaining of systematic vascular resistance, a pattern of hemodynamic response that is quite different from that present during dynamic exercise. As a result of these hemodynamic changes, chronic training as a power athletes leads to modest increase in maximal oxygen consumption largely because of the increase of skeletal muscle mass. Increases in left ventricular mass in power athletes generally is less than that associated with chronic repetitive dynamic exercise.

SHOULDER STRENGTH: The human shoulder is made of three bones, the clavicle, the scapula and the humorous as well as the associated muscles, ligaments and tendons. The articulation between the bones of the shoulder make up the shoulder joints. The shoulder joint, also known as the glenohumeral joint, is the major joint of the shoulder, but can more broadly include the acromioclavicular joint. In human anatomy, the shoulder joint compare the part of the body where the humerus attaches to the scapula and the head sites in glenoid cavity. The shoulder is the group of structure in the region of the joint.

The shoulder must be mobile enough for the wide range action of the arms and hands, but stable enough to allow for action such as lifting, pushing and pulling**.**

REACTION TIME: Mental chronometry is the scientific study of processing speed or reaction time on cognitive task to infer the content, duration and temporal sequencing of

mental operation. Reaction time is measured by the elapsed time between stimulus onset and an individual response on elementary cognitive task, which are relatively simple perceptual motor task typically administrative in a laboratory setting. Mental chronometry's one of the core methodological paradigm of human experimental, cognitive and differential psychology, but is also commonly analyzed psychophysiology, cognitive neuroscience and behavioral neuroscience to help lucid the biological mechanism underlying perception, attention and decision making in human and others specifics.

CHAPTER-II

REVIEW OF RELATED LITERATURE

CHAPTER-II

REVIEW OF RELATED LITERATURE

Literature on this aspect could not be traced; only the following could be collected. In a research study it is customary to collect relevant information and findings of leading researchers. This approach helps the researchers understand the status of his own research and reliability to the findings. For the purpose of this research the researcher collected the reviews from Jadavpur University Library and Visas-Bharati University Library. He also took help of electronic media and visited a number websites to collect related literature in retrospect. Such literatures are reviewed in the following paragraphs, as far as the researcher could collect.

Aashis et. al., (2015) investigated on the effect of plyometric training programme on the agility performance among male basketball players. To achieves the purpose of this study a group of thirty(30) male basketball players age ranged between 18-24 years, were selected from two basketball academics in japer region. The agility was measured by the help of T-test and Barrows Zigzag test. The paired t-test was use to assess the mean of pre & post-test differences. Level of $p \leq 0.05$ was considered significant.

Abbas (2009) conducted a study that was to evaluate the "Effect of plyometric training with three modes on leg muscle strength". 40 subjects were from untrained male University students within the age ranged from 18 to 27 years. The subjects were randomly selected and divided into three experimental and one control groups. The data was collected during the twelve weeks of training period and analysed using descriptive measures, ANCOVA and Scheffe post hoc analysis. It was found that plyometric exercises with depth rebound jumping improved the leg muscle strength.

Amrinder (2013) conducted a study that was to compare the "Effects of four week plyometric training on two different surface, sand and grass on muscle soreness and selected sport specific performance variable in national level hockey players". Subject were randomly divided into two group namely grass training group (N=20) and sand training group (N=20). The variables tested were strength, endurance, balance, agility and muscle soreness. After 4 weeks of training with three sessions per week similar improvements in strength,, endurance, balance and agility was found in both the surface but induces significant less muscle soreness.

Ashok, et al. (2012) conducted study that was to investigate "The effect of skill training and its combination of plyometric with skill training on jumping ability, anaerobic capacity and skill performance among volleyball players". For this sixty male volleyball player from various college in coimbatore District, Tamilnadu were selected as subject and divided into plyometric and skill training (20), skill training (20) and control (20). Jumping ability, anaerobic capacity and skill performance were tested during 12 weeks of training programme. The result reveal that the skill training with plyometric significantly improve jumping ability anaerobic capacity and skill performance among volleyball players.

Brown et al., (1986) conducted a study that was to find out the effects of plyometric training on vertical jump in male high school basketball players (n=26). Players were randomly assigned either to a training group or a control group. The training group performed 3 set of depth jumps 3 day/week for 12 weeks. The control group performed only the regular basketball training. The plyometric group improved in vertical jump with arm assistance significantly more than the control group. The two groups were not significantly different in vertical jump with out arm assistance. In the plyometric group 57 percent of the vertical jump gain was due to jumping skill improvement, and 43 percent was due to strength gain. There force plyometric training appears to enhance the coordination of the arms with strength development of the legs and provides a convenient in-session training method.

Campillo, et al. (2013) Conducted a study that was to examine "Plyometric training on different volume and training surfaces on neuromuscular performance". To achieve this purpose twenty nine subjects were divided into 4 groups namely, moderate volume group (n=9), moderate volume hard surface group (n=8), high volume group (n=7) and control group (n=5). Maximum strength, squat jump, countermovement jumps, 20 m sprint, agility, body weight and height were measured before and after 7 weeks. The results reveal that high training volume significantly increased the explosive performance. Further, plyometric training on hard surface and moderate training volume significantly improved the explosive performance, maximal strength and speed.

Chaouachi, et al. (2013) Conducted a study was to compare the "Effectiveness of plyometric and its combination with balance training on balance and power parameter in children". The subject were divided into three groups namely, plyometric training group (n=14), combined balance and plyometric training group (n=14) and control group (n=12). Strength, power,

speed, static and dynamic balance and agility were tested during eight weeks of training. The combined group showed better improvement in leg stiffness, speed, agility than the other groups.

De Villarreal et al. (2009) conducted a study that was to examine a meta-analysis of 56 studies with a total of 225 effect sizes (ESs) to analyse the role of various factors on the effects of plyometric on VJH performance. The inclusion criteria for the analysis were a) studies employing true experimental designs and valid and reliable measurements and c) studies including enough data to calculate ESs. Subjects with more experience in sport obtained greater enhancements in VJH performance ($p< 0.01$). Subjects in either good or bad physical condition benefit equally from plyometric work ($p<0.05$), although men tend to obtain better power results than women after plyometric training ($p<0.05$). with relation to the variables of performance, training volumes of more than 10 weeks and more than 20 sessions, using high –intensity programs (with more than 50 jumps per session) were the strategies that seemed to maximize the probability of obtaining significantly. Greater improvements in performance ($p<0.05$). To optimize jumping enhancement, the combination of different types of plyometric (squat jump+ countermovement jump + drop jump) is recommended rather than using only 1 form ($p<0.05$). However, no extra benefits were found to have gained from doing plyometric with added weight. The responses identified in this analysis are essential and should be considered by strength conditioning professionals with regard to the most appropriate does- response trends for optimizing plyometric-induced gains.

Diallo et al.,(2001) conducted a study that was to examine the effectiveness of plyometric training and maintenance training on physical performances in prepubescent soccer players. Twenty boys aged 12-13 years were divided in two groups (10 in each): jump group (JG) and control groups (CG). JG trained 3 days/week during 10 weeks and performed various plyometric exercises including jumping, hurdling and skipping. The subsequent reduced training period lasted 8 week. However, all subjects continued their soccer training. Maximal cycling power was calculated using a force velocity cycling test. Jumping power was assessed by using the following tests countermovement jump (CMJ), squat jump (SJ) drop jump (DJ), multiple 5 bounds (MB5) and repeated rebound jump for 15 second s (RRJ15). Running velocities included : 20, 30, and 40 m ()V20, V30, V 40 m). Body fat percentage (BF percent) and lean leg volume were estimated by anthropometry. Before training, except for BF percent, all baseline anthropometric characteristics were similar between JG and CG. After the training

programme, Pmax ($p<0.01$), CMJ(P,0.01), SJ($P<0.05$), MB5 ($P<0.01$), RRJ15 ($P< 0.01$) and V20 ($p<0.05$), performances increased in the JG. During this period no significant performance increase was obtained in the CG. After the 8 week of reduced training, except Pmax ($p<0.05$) for CG, many increase was observed in both groups. These results demonstrate that –term plyometric training programmes increase athletes performances in prepubescent boys. These improvements were maintained after a period of reduced training.

Dodd and Alvar (2005) conducted a study that was to examine the simultaneous combination of heavy resistance training and plyometric. The objective of this study was to test the effect of complex training vs. heavy resistance or plyometric interventions alone on various power-specific performance measures. 45 male division II junior college baseball players participated in 3 separate 4 week resistance training interventions. Subjects were randomly assigned to one of three groups. In a counter balanced rotation design, each group participated in complex, heavy resistance and plyometric training interventions. Each individual was tested in 20- yd, 40 –yd, 60-yd, vertical jump, standing broad jump, and T – agility measures pre and post 4- week training interventions. There was no statistical significant different ($p= 0.11$) between groups all performance measures. Review of each distinct training intervention revealed greater percent improvement in SP20 (0.55;-0.49; -0.12) SP40 (0.26;-0.72; -1331), SP60 (0.27; 0.15: -0.27), standing board jump (1.80; 0.67; 1.1).and T-agility (2.33;1.23; -0.04) with complex training interventions, respectively. Plyometric only training showed greater percent changes in vertical jump (1.90) than with complex (0.97) or heavy resistance training 90.360. the present results indicate that complex training can provide strength and conditioning professionals equal , if not slightly greater improvements in muscular power than traditional heavy resistance- and plyometric- only interventions in moderately trained athletics. Complex training can be another valuable method for short- term power and speed improvement in athletes in isolation or in conjunction with other power development methods.

Ebben, Simenz and Jensen (2008) conducted a study that was to investigate the motor unit activation of the quadriceps (Q), hamstring (H) and gastrocnemius (G) muscle groups during a variety of plyometric exercises to further understand the nature of these exercise. 23 athletes volunteered to perform randomly ordered plyometric exercise, thought to cover a continuum of intensity levels, including 2 foot ankle hops; 15cm cone hops; tuck, pike , and box jumps; one and two leg vertical jump and reach squat jump with approximately 30% of their 1 RM

squat load; and 30 and 61 cm depth jumps. Integrated electromyography data were analysed for each exercise using a one-way repeated- measures ANOVA. Results revealed significant main effects for the Q when all subjects are analysed, as for separate analysis of man, women, subjects with vertical jumps greater than 50 cm, and those with vertical jumps less than or equal to 50cm ($p<or = 0.05$). significant main effects were also found for the G muscle group in the analysis of all subjects, as well as for men and subjects with vertical jumps greater than 50cm ($p<or 0.05$). No significant main effects were found for the H muscle group. Pairwise comparisons revealed a variety of differences among plyometric exercises. In some cases, plyometric previously reported to be of high intensity, such as the depth jump, yielded relatively little motor unit recruitment compared with exercise typically thought to be of low intensity. Results can assist the practitioner in creating plyometric programs based on the nature of the motor unit recruitment.

Herrero et al. (2006) conducted a study that was to assess the effects of four-week training period of electromyostimulation (EMS). Plyometric training (P), or combined EMS and P training of the knee extensor muscle on 20 m sprint time (ST), jumping ability (squat jump) [SP] and countermovement jump [CJM] maximal isometric strength (MVC) and muscle cross- sectional area(CSA). 40 subjects were randomly assigned to one of the four treatment groups; electromyostimulation (EG), plyometric (PG), combined EMG and P (EPG) that took place 4 time per week, and a control group (CG). Subjects were tested before and after the training program, as well as once more after 2 wk. of duration. A significant improvement ($p< 0.05$) in ST was observed after training (2.4%) in EG while a significant increases in EPG ($P<0.05$) was observed (-2.3%) in EPG. Significant increases in EPG ($P<0.05$) were observed in SJ (7.5%) and CMJ (7.3%) after training, while no significant changes in both jump were observed after training and detraining for EG. A significant increase ($p<0.05$) in MVC was observed after training (9.1%) and after determining (8.1%) in EG. A significant increase ($p<0.05$) in MVC was observed after training (16.3%) in EPG. A significant increase ($p<0.01$) in CSA was observed after training in EG (9.0%) and in EPG (7.1%).EMS combined with plyometric training increased the jumping height and sprint run in physically active men. In addition, EMS combined with plyometric training leads to increase maximal strength and to some hypertrophy of trained muscles. However, EMS training alone did not results in any improvement in jumping explosive power development or even interfered run.

Impellizzeri et al., (2008) conducted a study that was to compare the effects of plyometric training on sand vs a grass surface on muscle soreness, vertical jump height and sprinting ability. Parallel two group, randomised, longitudinal (pre-test, post-test) study. After random allocation 18 soccer players completed 4 weeks of plyometric training on grass and 19 players on sand. Before and after plyometric training, 10m and 20m sprint, squat jump (SJ) countermovement jump (CMJ), and eccentric utilization ratio (CMJ/SJ) were determined. Muscle soreness was measured using a Likert scale. Results: no training surface x time interactions were frond for sprint time ($p<0.870$) where as a trend was found for SJ ($p= 0.08$) with both groups showing similar improvements ($p<0.001$). on the other hand, the grass group improved their CMJ($p=0.033$) and CMJ/SJ($p=0.005$) significantly ($p<0.001$) more than players in the sand group. In contrast in the sand group experienced less muscle sorwness than those in the grass group ($p<0.001$). Conclusions: plyometric training on sand improved both jumping and sprinting ability and induced less muscle soreness. A grass surface seems to be superior in enhancing CMJ performance while the sand surface showed a greater improvement in SJ. Therefore, plyometric training on different surface may be associated with different training- effects on some neuromuscular factors related to the efficiency of the stretch- shortening cycle.

Kotzamanidis (2006) conducted a study that was to investigate the effect of plyometric training on running velocity (RV) and squat jump (SJ) in prepubescent boys. Fifteen boys(11.1+/- 0.5years) followed a 10 –week plyometric program (JUMP group). Another group of 15 boys (10.9 +/- 0.7 years)followed only the physical education program in primary school and was used as the control (CONT group). Running diatance(0-10m, 10-20m, 20-30m), were selected as testing variables to evaluate the training program. The total number of jumps was initially 60 per session which was gradually increased over a period of 10 weeks to 100 per session. Results revealed significant differences between CONT and JUMP groups in RV and SJ. In JUMP group the velocity for the running distances 0-30, 10-20, and 20-30 m increased ($p<0.05$), but not for the distance 0-10m ($p<0.05$). Additionally, the SJ performance of the JUMP group increased significantly, as well ($p<0.05$). there was no change in either RV or SJ for the CONT group , these results indicate that plyometric exercises can improve SJ and RV in prepubertal boys. More specifically, this program selectively influenced the maximum velocity phase, but not the acceleration phase.

Kotzamanidis et.al.,(2006) conducted on the effect of plyometric training on running velocity and squat jumping prepubescent boys. Fifteen boys of 1.1 years followed a 10 week plyometric program. Another group of 15 boys of 10.9 years followed only the physical education program in primary school and was used as the control group. Running distance (0-10 m., 10-20 m., and 0-30 m.) were selected as testing variables to evaluate the training program. These results indicate that plyometric training can improve squat jump and running velocity in prepubertal boys. More specifically, this program selectively influence the maximum velocity phase, but not the acceleration phase.

Kramer, Marrow and Leger(1993) conducted a study that was to compare standard and standard plus plyometric programs on sport-specific and non sport specific tests. 24 female rowers completed the weight training or the weight training plus plyometric exercise 3 times per week and rowing ergometer training four times per week, 1 hr per session for 9wks. Analysis of Variance tests were used to compare S(n=11; 5 novice and 6 experienced rowers) and S+P(N=13;7 NOVICE and 6 EXPERIENCED ROWERS) program on the following sport specific tests: 1) time to row 2,500 m and 2) distance rowed in 90 s; and on the following non sport –specific tests: 1) leg press,1RM, 2) leg press endurance , 3) bench pull, 4)bench pull endurance, 5) vertical jump, 6)isokinetic knee extensor peak and average power during concentric and eccentric muscle action and 10) angle of occurrence of peak torque during concentric muscle action. These results do not discount the value of plyometric exercises, but indicate that the jump exercises used offered no advantages to intercollegiate oarswomen.

Lees and Fahim(1994) conducted a study that was to investigate the effects of drop height in the performance of plyometric training. Thirty male subjects were asked to perform drop jumps from heights of 0.12, 0.24, 0.36, 0.46, 0.58, and 0.68m, as well as counter-movement jumps and squat jumps. They performed their jumps on a kistler force platform, and the resultant force trace was integrated to calculate negative displacement of the total body centre of gravity (CG) net height rise of the CG, maximum vertical force, and maximal vertical velocity. The results showed that the best performance in all measured parameters was for the drop height of 0.12m. This finding differed from results of similar studies reported in the literature by others (Asmussen and Bonde-Petersen 1974, Bosco and Komi 1978). This finding was interpreted in terms of a skill and co-ordination element in the performance of

plyometric movements, in contrast to a natural biomechanical response to imposed load and the state of muscle training and competency.

Lubbers et al. (2003) conducted a study that was to examine the effect of 2 plyometric training programs, equalized for training volume, followed by a 4 wk. recovery period of no plyometric training on anaerobic power and vertical jump performance. Physically active, college-aged men were randomly assigned to either a 4 week (n=19, weight =73.4+/-7.5 kg) or a 7 wk.(n= 19, weight = 80.1 +/-12.5 kg) program. Vertical jump height, vertical jump power, and anaerobic power via the margaria staircase test were measured pre-training (PRE) immediately post-training (POST), and week post-training (POST-4). Vertical jump height increased PRE to post -4 in week (67.8+/-7.9 cm) to POST (65.4+/-7.8 cm).Vertical jump height increased from PRE to POST-4 in 4-week (67.8+/-7.9 to 69.7+/-7.6 cm) and 7 week (64.6+/-6.2 to 67.2+/-7.6) training programs. Vertical jump power decreased in the 4-week group from pre (8,660+/-546.5 W) to POST (8,541+/-557.4W) with no change in the 7-week group vertical jump power increased PRE to POST - 4 in 4-week (8,660.0+/-546.5 W to 8,793.6+/-541.4 W) and 7-week (8,702.8 +/- 527.4 W to 8931.5 +/-537.6 W) training programs. Anaerobic power improved in the 7-week group from PRE (1,1201.9 +/- 174.7 W) to POST (1,192+/-189.1 W) to POST (1,192.2+/-189.1 W) but not the 4-week group. Anaerobic power significantly improved PRE to POST in both groups. There were no significant differences between the 2 training groups. Four –week and 7-week plyometric programs are equally effective for improving vertical jump height, vertical jump power and anaerobic power when followed by a 4-week recovery period. However, a 4-week program may not be as effective as a7-week program if the recovery period is not employed.

Lubbers et.al.,(2003) conducted on the effect of plyometric training and the recovery on vertical jump performance and anaerobic power. This study examined the effect of 2 plyometric training program, equalized for training volume, followed by 4 week recovery period of no plyometric training on anaerobic power and vertical jump performance. Vertical jump power increased PRE to POST 4 in 4 week (8,660.0-6456.5 W to 8793.6-6541.6 W) and 7 week (8702.8-6527.4W to 8931.5-6537.6W) training program. Anaerobic power significantly improves PRE to POST 4-in both groups.

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Maffiuletti et al. (2002) conducted a study that was to investigate the influence of a 4-wk combined electromyostimulation (EMS) and plyometric training program on the vertical jump performance of 10 volleyball players. Training session were carried out three times weekly with each sessions consisted of three main parts: EMS of the knee extensor muscles (48 contractions) EMS of the planter flexor muscles (30 contraction) and 50 plyometric jumps. Subjects were tested before (week 0), during (week 2) and after the training program (week 4), as well as once more after 2 wk. of normal volleyball training (week 6). Different vertical jumps were carried out, as well as maximal voluntary contraction (MVC) of the knee extensor and plantar flexor muscles. At week 2, MVC significantly increased (+20% knee extensor, +13% plantar flexors) as compared to baseline (<0.05). After the 4-wk training program, different vertical jumps considered were also significantly higher compared to pertaining (<0.001), and relative gains were comprised between 8-10% (spike-counter movement jump) and 21% (squat jump). The significant increases in maximal strength and explosive power produced by the present training program were subsequently maintained after an additional 2 wk. of volleyball training. EMS combined with plyometric training has proven useful for the improvement of vertical jump ability in volleyball players. This combined training modality produced rapid increases (approximately 2 wk.) of the knee extensor and plantar flexors maximal strength. These adaptions were then followed by an improvement in general and specific jumping ability, likely to affect performance on the court. In conclusion, when EMS resistance training is proposed for vertical jump development, specific work out (e.g., plyometric) must complement EMS sessions to obtain beneficial effects.

Markovic (2007) conducted a study that was to determine the precise effect of plyometric training (PT) on vertical jump height in healthy individuals. Meta-analysis of randomised and non-randomised controlled trails that evaluated the effect of PT on four typical vertical jump height tests were carried out: squat jump (SJ); countermovement jump (CMJ); countermovement jump with the arm swing (CJMA) and drop jump (DJ). Studies were identified by computerised and manual searchers of the literature. Data on changes in jump

height for the plyometric and control groups were extracted and statistically pooled in a meta-analysis, separately for each type of jump. A total of 26 studies yielding 13 data points for SJ,19 data points for points for CJM, 14 data points for CJMA and 7 data points for DJ met the initial inclusion criteria. The pooled estimate of the effect of PT on Vertical jump height was 4.7 % (95% CI 1.8 TO 7.6%), 8.7% (95% CI to 10.4%), 7.5% (95% CI 4.2 to 10.8%) and 4.7% (95% CI 0.8 to 8.6%) for the SJ, CJM, CMJA and DJ, respectively. When expressed in standardised units (ie, effect sizes), the effort of PT on vertical jump height was 0.44 (95% CI 0.15 to o.72), 0.88 (95% CI 0.64 to 1.11), 0.74 (95% CI 0.47 to 1.02) and 0.62 (95% CI 0.18 to 1.05) for the SJ, CMJ, and DJ, respectively. PT provides a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (SJ and DJ), over 7.5% (CMJA) TO 8.7% (CMJ).These results justify the application of PT for the purpose of development of vertical jump performance in healthy individuals.

Masamoto et al. (2003) conducted a study that was to examine the acute effects of plyometric exercise on I repletion maximum (RM) squat performance in trained male athletes. 12 men (mean age +/- SD : 20.5+/-1.4 years) volunteered to participate in 3 testing sessions separated by at least 6 days of rest. During each testing session the IRM was assessed on back squat exercise. Before all 3 trials subjects warmed up on a stationary cycle for 5 minutes and performed static stretching. Subjects then performed 5 submaximal sets of 1-8 repetitions before attempting a 1RM lift. Subjects rested for at least 4 minutes between 1RM trials. During the first testing session (TI) subjects performed a series of sets with increasing load until their 1 RM was determined. During the second and third testing sessions subjects performed in counterbalanced order either 3 double-leg tuck jumps(TJ) or 2 depth jumps (DJ) 30 seconds before each 1RM attempt. The average 1RM lifts after T1 and testing sessions with TJ or DJ were 139.6+/- 29.3 kg, 140.5+/-25.6kg, and 144.5+/-30.2kg, respectively (T1<DJ; $p<0.05$). These data suggest that DJ performed before 1RM testing may enhance squat performance in trained in trained male athletes.

Mcguigan et.ai.,(2009) investigated on the effect of an 8 weeks plyometric training program on children who were overweight or obese. Forty-eight children (26 girls and 22 boys; mean age of 9.7 years.) participated in an 8 weeks undulating per iodized plyometric training for 3 days in a week. Measures of body composition via dual-energy X-ray absorptiometry, anthropometry, strength and power were made before and after the training invention. The

result shows that there are significant changes in body composition and strength and power measures, as well as being well tolerated by participants.

Miller, et al. (2006) Conducted a study that was to compare on agility among athletes owing to plyometric training. The subjects were divided into plyometric and control groups. The subjects were tested on agility using T agility and Illinois agility test, collected and analysed using ANCOVA. The results of this study reveal that plyometric training significantly improved agility.

Myer et al. (2006) conducted a study that was to find out the biomechanical effects of plyometric and balance training. A protocol that includes balance training without plyometric training will decrease control plan hip, knee and ankle motions during landing and plyometric training will not affect coronal pane measures. The corollary hypothesis was that plyometric and balance training effects on knee flexion are dependent on the movement task tested. 18 high school female athletes participated in 18 training sessions during a week period. The plyometric group (n=8) performed maximum-effort jumping and cutting exercises and the balance group (n=10) used dynamic stabilization/ balance exercises training. Lower extremity kinematics were measured during the drop vertical jump and the medical drop landing before and after training using 3D motion analysis technique. During the drop vertical jump, both plyometric and balance training reduce initial contact (p=.002), maximum knee abduction angle (p=.038). plyometric training increased initial contact knee flexion(p=.002) and maximal knee abduction angle (p=.038). plyometric training increased initial contact knee flexion (p=.038) during the drop vertical jump, whereas the balance training increased maximum knee flexion (p=.005) during the medial drop landing. The conclusions do indicate that both plyometric and balance training can reduce lower extremity lower extremity valgus measures. Plyometric training affects sagittal plane kinematics primarily during a drop vertical jump, whereas balance training affects sagittal plane kinematics during single-legged drop landing.

Nageswaran & Ravichandra (2014) conducted a study that was to assess the "Effects of weight training, plyometric training and complex training on speed performance." Thirty school boys from SDAT, Thanjavar unit, Tamilnadu, India were selected as subjects with the age group16 to 19 years and divided in to weight training (10), plyometric training (10) and complex training (10). Speed was assessed by 50 meters run and acceleration was assessed fly

run after eight weeks of training of training period the collected data were analysed using‘t’ test and analysis of co-variance. The weight training, plyometric training and complex training produced significant improvement in speed performance.

Ozbar et.al.,(2014) determined on the effect of 8 week plyometric training on leg power, jump and sprint performance in female soccer players. No significance difference was found between the groups at pre-test variable($p>0.05$).Significant improvement were found in the post-test of both groups($p<0.05$),except for the 20 m. sprint test in the control groups($p>0.05$).The results indicate that safe, effective and alternative plyometric training can be useful to strength and conditioning coaches, especially during competition season where less time is available for training.

Pienaar and Coetzee (2013) conducted a study that was to determine “To assess the r ugby conditioning program and its combination with plyometric training on selected physical, motor performance and anthropometric measurements”. The player were selected from the under 19 rugby teams of the North West University, South Africa. The selected players were divided into experimental group (n=19) and control group (n=16) .Anthropometric measurement were taken on 26 sited and a battery test for measuring the physical and motor performance test were conducted. The data was processed by dependent t-test and result showed that the experimental group had significant improvement in wrist breadth, speed, agility and power than the control group.

Rahimi (2004) conducted a study that was to examine the effects of a plyometric exercise on 1 repetition maximum (1RM) squat performance after short (15,30second) and long (60 second) rest interval following plyometric training in trained male athletes. The subjects were 15 trained men (age=22+-1.4 years, mass 80.61+- 3.20 kg) who had previous experience in strength training and experience performing plyometric exercise. All subjects performed 4 testing session and separated by at lest 1 day of rest. Before all testing sessions subjects participated in a warming –up program and it kept constant through all testing sessions. During the first testing session, 1RM was assessed in backsqat and during the depth jump sessions subjects performed in counterbalanced order a set of 2 depth jump (DJ) 15,30 or 60 second before each 1RM attempts. One way repeated analysis of variance with Bonferroni post-hocs demonstrate significant different differences between 1RM in baseline measurement and DJ session ($p<0.05$). Also , 1RM in back squat significant improved after

15 second and 30 second post a set of 2 depth jump. There by macking the results support for the use of plyometric exercise 15 to 30 second before 1RM test to improve maximum strength performance.

Rajesh (2012) conducted a study that was to find out the "Effect of plyometric exercise on speed among football players". To achieve this 40 male players from various colleges of Osmania University, Hyderabad were selected. The subjects were made into experimental and control group. Speed was assessed by 30 meter run. After six weeks of training the plyometric exercise showed improvement on speed than the other group.

Ratamess et al. (2007) conducted a study that was to find out the effect of 10weeks of resistance and combined plyometric / sprint training with the Meridian Elyte athletic shoe on muscular performance in women. 14 resistance-trained women were randomly assigned to one of the 2 training groups : (a) an athletics shoe IN =6 (AS) group or (b) the meridian Elyte (a <8) (MS) group. Training was performed for 10 weeks and consisted of resistance training for 2 days per week of plyometric training. Linear periodized resistance training consisted of 5 exercises per workout for 3 set of 3-12 repetition maximum (RM). Plyometric training consisted of 5-7 exercise per work out for 3-6 sets with gradually increasing volume followed by a 2 week taper phase. Assessments for IRM squat and bench press, vertical jump, broad jump, sprint speed, and body composition were performed before and following the 10 week training period. These results indicated that similar improvements in peak sprint speed and jumping ability were observed following 10 weeks of training with either shoe. However heigh intensity sprint endurance at 60 m increased to a greater extent during training with the Meridian Elyte athletic shoe.

Roopchand & Lue (2010) Conducted a study that was to investigate the "Effect of plyometric training on jump and agility". 18 subjects were selected from Jamaican national netball players and tested using the vertical & broad jump test and Illinois agility run. The duration of training was 3 weeks. The data were analysed using Kolmogorov smirnov test and paired samples t-test. Result reveals that due to the effect of plyometric training significant outcome was found on jump and agility.

Rubley, et al. (2011) Conducted a study that was to asses "effect of plyometric training vertical jump and kicking distance among adolescent soccer players". For this sixteen adolescent female soccer players were selected and divided into control group (6) and

plyometric training group (10). The control group practised only their regular soccer training and the experimental group practised soccer training along with the plyometric exercise. The duration of training period was 14 weeks. The data were analysed using 2x3 ANOVA with repeated measures. The plyometric training group had significantly improve on kicking distance and vertical jump height after 14 weeks.

Schulte Edelmann et al.(2005) conducted a study that was to find out the effectiveness of a 6 week plyometric training period on power production of the posterior shoulder and elbow musculature. 28 normal college aged voluntree were divided into control and plyometric training groups. Both groups were pre- and post tested using shoulder and elbow isokinetic test and the Closed Kinetic chain Upper extremity stability test. The plyometric training group (n=13) showed significant improvement in the power generated in the elbow extensor muscles; however, no other significant changes were observed within this group. The control group (n=15) showed no significant changes in power output over the course of this study. It was concluded that plyometric training of the upper extremity enhances power of the elbow extensor muscles.

Spurrs, Murphy and Watsford (2003) conducted a study that was to examine whether changes in running performance resulting from plyometric training were related to alteration in lower leg musculotendinous stiffness (MTS). Seventeen male runners were pre and post-tested for lower leg MTS, maximum isometric force, rate of force development, 5-bound distance test (5BT), counter movement jump (CMJ) height RE, VO_2max late lactate threshold [The (la)] and 3-km time. Subjects were randomly split into an experimental (E) group which completed 6 weeks of plyometric training in conjunction with their normal running training and a control (C) group which trained as normal. Following the training period, the E group significantly improved 3-km performance (2.7%) and RE at each of the tested velocities while no changes in vo_2max were recorded. CMJ height, 5BT, and MTS also increased significantly. No significant changes were observed in any measured for the C group. The results clearly demonstrated that a 6-week plyometric programme led to improvements in 3 – km running performance. It is postulated that the increase in MTS resulted in improved RE, as improved RE led to changes in 3- km running performance, as there were no corresponding alterations in Vo_2max .

Stemm & Jacobson (2007) conducted a study that was to find out the "Effect of land and aquatic based plyometric training on vertical jump performance". A convenience sample of 21 college men were selected randomly and assigned into aquatic plyometric group and control group. The aquatic group performed the exercise in water at the height of knee level, the land group performed exercise in the land for 6 weeks and the control group did not participated in any training. The collected data were analysed using 2x3 ANOVA with repeated measure. It was concluded that aquatic and land plyometric training had produced similar effects on vertical jump.

Thomas, et al. (2009) Conducted a study that was to compare the "Effects of two plyometric trainings on power and agility". To achieve this purpose, twelve males from semi-professional football club's academy were randomly selected and subjected to plyometric training for 6 weeks. Pre-test and post-test were conducted to the subjects belong to depth jump and counter movement jump group. Finally it was concluded that depth jump and counter movement jump plyometric improved power and agility.

Theodoros et.al., (2000) conducted on the effect of two plyometric training programs of different intensity on vertical jump performance in high school athletes. Eighteen healthy adolescent male subject were randomly allotted to per iodized plyometric intensity ,constant moderate plyometric intensity and a control group, for a 6week plyometric training programe.Although there were significant difference ($p>0.05$) between CONS and INCR for any of the performance variable, there was a trend for greater improvement for the INCR group.

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Thomas, French and Hayes (2009) conducted a study that was to compare the effects of two plyometric training techniques on power and agility in youth soccer players. 12 males from a semi-professional football club's academy (age=17.3+/-0.4 years, stature=177.9+/-5.1 cm,

mass=68.7+/-5.6 kg) were randomly assigned to 6 weeks of depth jump (DJ) or countermovement jump (CMJ) training twice weekly. Participants in the DJ group performed drop jumps with instruction to minimize ground-contact time while maximizing height. Participants in the CMJ group performed jumps from a standing start position with instruction to gain maximum jump height. Post-training, both groups experienced improvements in vertical height ($p<0.05$) and no change in sprint performance ($p<0.05$). There were no differences between the treatment groups ($p<0.05$). The study concludes that both DJ and CMJ plyometric are worthwhile training activities for improving power and agility in both in soccer players.

Toumi et al., (2004) conducted a study that was to compare the effect of plyometric training performed with rapid or slow stretch contraction on jump performance and muscle properties. 30 males between the ages of 19 and 22 volunteered for the week experiment. Subjects were divided into the following three groups: training group 1 (TG1), training group 2 (TG2), and control group (CG). Each of the two experimental groups underwent a unique training regimen. For the first group (TG1 N=12): from a standing position the subject flexed his knees to a 90 degrees angle with velocity standardized and controlled at 0.4m/s and immediately performed a leg extension as quickly as possible. For the second group (TG2, N=12): from a standing position, the subject flexed his to a 90 degrees angle with velocity standardized at 0.2m/s and then performed a leg extension as quickly as possible. Each exercise consisted of six sets of ten repetitions with a barbell on the shoulders at 70% of the maximal isometric force (1 RM). The 70% load was modified at two week intervals by evaluating a new 1 RM. Exercise were performed four times a week over the eight-period. The third group *(CG, n=6), served as the control group. Maximal isometric force (MVC), maximal concentric force, squat jump (SJ) and counter movement jump (CJM) exercise were performed before and after the training program. Subjects were filmed (100Hz) and each jump was divided into three phases: eccentric phase (ECC), transition phase (TR) and concentric phase (CON). Surface EMG was used to determine the changes in the electromyography (EMG) activity before and after the training program. There was an increase in leg extension force, velocity and electrical activity for SJ and CMJ for the two training groups ($p< 0.05$). However, TG1 showed a significant decrease in TR compared to the TG2 ($p< 0.05$). The results of this study show that when plyometric training is performed with rapid stretch contraction the CMLJ jump height increases and the TR decreases.

Turner, Owings and Schwane (2003) conducted a study that was to determine whether a 6-week regimen of plyometric training would improve running economy. 18 regular but not highly trained distance runner (age=29+/-7[mean+/-SD] year) were randomly assigned to experimental and control groups. All subjects continued regular running training for 6 week experimental subjects also did plyometric training. Dependent variables measured before and after the 6 week period were economy of running on level on a level treadmill at 3velocities Vo_2max, and indirect indication of ability of muscles of lower limbs to store and returnelestic energy. The last were measurements during jumping tests on an inclined sled: maximal jump height with and without countermovement and efficiencies of series of 40 submaximal countermovement and static jumps. The plyometric training improved economy ($p<0.05$). Averaged values (m.ml [-1].kg [-1]) for the 3 running speeds were : (a)experimental subjects - 5.14 +/-0.39 pre-training, 5.26+/-0.39 post-training. The vo_2max did not change with training. Plyometric training did not result in changes in jump height or efficiency variables that would have indicated improved ability to store and return elastic energy. Thus it was concluded that 6 weeks of plyometric training improves running economy in regular but not highly trained distance runners; the mechanism must still be determined.

Vaczi, et al. (2013) Conducted a study that was to find out "The effects of plyometric training on power, agility and knee extensor strength." The subject were male soccer player form a third league team and assigned into an experimental and control groups. Depth vertical jump height, agility and maximal voluntary isometric torque in knee extensors were evaluated before and after six week of experiment. Result revel that the plyometric training had remarkable improvements in lower extremity power and maximal knee extensor strength and agility.

Vissing, et al. (2008) Conducted a study that was to evaluate on muscle strength, power and morphology due to conventional strength training versus plyometric training. The young untrained men were divided into conventional resistance training (8) and plyometric training (7). Pre -tests and post tests were taken during 12 weeks of training. 1 RM incline leg press, 3 RM knee extension, 1RM knee flexion, countermovement jump and ballistic inclined leg press were assessed. Plyometric training increased maximum countermovement jump height with high power and ballistic leg press than the conventional resistance training.

Wilson, Murphy and Giorgi(1996) conducted a study that was to determine performed in an effort to again greater insights into the adaptation invoked by plyometric and weight training. 41 previously trained males were randomly allocated in either a control, plyometric or weight training group. The experimental groups were trained for 8 weeks, performing either heavy lifts or dynamic plyometric exercises. The following test items were performed prior to and after the completion of the training period: (a) vertical jump, (b) a series of is inertial concentric and eccentric tests, (c) push –up test, and (d) maximal bench press and squat lifts. The results do indicate that plyometric training significantly enhanced the rate of eccentric lower body force production. The weight-training group primarily enhanced concentric function.

Yeeriswamy & Saikumar (2013) conducted a study that was to assess the "Effect of plyometric training on selected skill performance variable of junior college level football players". For this, 40 junior football players from Kurnool district, Andhra Pradesh, India were selected as subject and divided into plyometric training (20) and control group (20). The training period was kicking for distance right and left foot, ball control and dribbling. It was concluded that the significant improvement was found on plyometric training in skill performance variable.

CHAPTER-III

METHODOLOGY

CHAPTER-III

METHODOLOGY

This chapter leads with the methodology followed in the select of the subjects or students, selection of parameters, selection of different tests, reliability of the data , prepare pilot study, ,organization to the subjects, training programed, collection of data, test administration, experimental design, statistical procedure and justification for statistical techniques used for analysis of the data.

3.1 SELECTION OF THE SUBJECTS

The asses of the pre-test were to find out effects of uniform plyometric training on motor fitness of teen-age athletes.

For the study, 40 athletes were randomly selected as subjects. The age of the subjects ranged between 14 to 19 years state levels athletes. The selected subjects were divided into three experimental groups and one control groups with ten subjects in (10) each groups. Different experimental group (sprinter, jumper and throwers) trained by uniform plyometric training protocol for the twelve weeks but the control group didn't receive plyometric training protocol.

All the subjects were instructed about the nature of the study and their consent was obtained to help till the last of the experiment and testing time. Experimental group and control group also practices in daily normal exercise. Qualified coaches examined the subject's physical fitness for the study. They were free to everything their consent in case they felling any problem during the period of their presentation, but there were no exequise. All subjects were fit for the study because everyone had achieved at state level school games competition.

3.2 SELECTION OF VARIABLES

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, track and field events and other activities, the athlete must be able to use strength as quickly and forcefully as possible. Power represents the amount of

work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought.

Given the type of sport, athletes and sport champions have different needs, importance, and preferences in terms of motor fitness and mobility condition. In other hands, all sport participation hold individual requirements in strength, power, flexibility, and speed, or a mixed of them; which depend from one sport to another one. Muscle power is an important parameter to success. In physical education, it refers to the highly force that a muscle generates in the shortest possible time in order to confront the resistance, it is equal to muscular force or explosive power.

Plyometric training attached mentioned muscles in eccentric-concentric movement cycles. Frequency of eccentric (stretching) and concentric (shortening) actions produces maximum power than of simple concentric action. Elastic energy within the muscle can provide high force. Enhanced power generation role an important participation in development sprint running times, which needs maximum explosive power. **Cavagna et al. (1971)** introduced the number of force transferred during sprint running, from first to last points (9.4 m/s) and found that the high power out puts were obtained by 5 m/s mean time due to inherited attachment character of muscles and the role of elastic energy before concentric movement .

The research scholar reviewed the available scientific literature pertaining to the problem from books, journals, magazines, websites, and research papers which revealed the importance of plyometric training. Taking into consideration of feasibility, criteria and availability of the instruments the following variables and the tests were selected for this study.

3.2.1 DEPENDENT VARIABLES

Selected motor fitness parameters:

a. Speed

b. Agility

c. Power

d. Shoulder strength

e. Reaction time

3.2.2 INDEPENDENT VARIABLES

I) Group-i: Experimental group (Sprinter).

II) Group-ii: Experimental group (Jumper).

III) Group-iii: Experimental group (Thrower).

IV) Group-iv: Control group (Sprinter, jumper and thrower).

3.3 EXPERIMENTAL DESIGN

The study was formulated as a true random group design, consisting of a pre-test and post-test. Forty state level athletes from Barasat athletic club, North 24 Parganas district, West Bengal, India were selected as subjects at random and their ages ranged from 14-19 years. The subjects (n=40) were randomly selected to three equal groups of ten subjects of each groups. Pre-test was conducted for all the subjects on selected motor fitness parameters. The initial test score formed as pre-test score of the subjects. The group was assigned as experimental group-I (sprinter), experimental group-II (jumper), experimental group-III (thrower) and control group-IV (sprinter, jumper and thrower). Experimental group-I (sprinter), experimental group-II (jumper) and experimental group-III (thrower) was exposed to plyometric training and control group-IV (sprinter, jumper and thrower) was not exposed to plyometric training other than their regular daily activities. The duration of the experimental period was 12 weeks. After the experimental treatment, all the forty subjects were tested on their different parameters. This final test scores formed as different post-test (posttest-1, posttest-2 and posttest-3) scores of the subjects. The pre-test and different post test scores were subjected to statistical analysis using Repeated measures Analysis of Co-variance (ANCOVA) and Repeated measures Analysis of Variance (ANOVA) to find out the significance among the mean differences, whenever the 'F' ratio for adjusted test was found to be significant, Tukey's Post- hoc test was used. In all cases 0.05 level of significance was fixed to test hypothesis.

3.4 PILOT STUDY

A pilot study organized to assess the primary capacity of the subjects in according to fix the load**.** For this purpose ten subjects were selected randomly and underwent training protocol

under follow of the experts and the researcher. Basis on the response of the subjects in the pilot study the training schedule were made, however the individual differences were also considered while constructing the training programme. The basic principles of the training were also observed.

3.5 CRITERION MEASURES AND SELECTION OF TESTS

The present study was undertaken primarily to find out the effect of uniform plyometric training on motor fitness parameters of teen-age athletes.

The following test were administered to measures the selected motor fitness parameters for athletes. The tests were administered to the subjects before and after the training programme.

Table -I

Test Selection

SL.NO.	PARAMETERS	TESTS	UNITS
1.	Speed	50 meter sprint	Seconds
2.	Agility	4x10 meter shuttle run	Seconds
3.	Power	Standing broad jump	Meter
4.	Shoulder strength	Pull up test	Number
5.	Reaction time	Nelson Choice Response Movement Reaction test	Seconds

3.6 RELIABILITY OF DATA

The reliability of data was introduced by using test-retest methods. To aim this purpose, ten subjects were randomly selected and the test was administered twice after a day's gap of duration. Care was taken to keep all testing conditions uniformly during testing and re-testing. The scores recorded for the ten subjects during the test and retests were analyzed by correlation using intra class checking for the different parameters. The co-efficient of correlation presented in Table-II give bellow.

Table-II

Reliability Co-Efficient of Correlation of Test-Retest Scores

SL. NO.	PARAMETERS	CO-EFFICIENT OF CORRELATON
1.	Speed	0.88*
2.	Agility	0.87*
3.	Power	0.91*
4.	Shoulder strength	0.92*
5.	Reaction test	0.90*

*significant was judged at 0.05 level of significance.

3.7 RELIABILITY OF INSTRUMENTS

The instrument such as stop watch, measuring tape, football cones, weighing machine, Stadiometer, tool box were reliable and exact sufficient to measures the particulars successively.

3.8 TESTERS RELIABILITY

To ensure the testers reliability of the tests the investigator had a number of practice sessions in the teaching procedure and well versed in the technique of conducting the test. Tester reliability of test was formed by test-retest methods. For this purpose ten subjects were selected at random on the chosen parameters, which were recorded twice under identify conditions on various occasions by the different tester.

3.9 SUBJECTS RELIABILITY

In according to get uniform results from the same subjects, they were used under same conditions for the similar test by the same investigator. The test-retest procedure were used to find out the subjects reliability.

3.10 ORIENTATION OF THE SUBJECTS

The investigation held a discussion with the subjects prior to the administration of tests. The purpose, the significance of this study and the needs of the testing method were demonstrated to them in trolley, so that there was no confusion in their mind, regarding the efforts required

of them. All the subjects' partially came front to help in the testing methods and the training to put in their highest efforts in the interest of the scientific investigation and in order to improve their own performance. The subjects were very enthusiastic and helpful throughout the thesis.

3.11 ADMINISTRATION OF THE TEST ITEMS:

3.11.1 50 METER SPRINT (SPEED):

Purpose

To measure the speed of the subjects.

Equipment

Stopwatch, whistle, score sheet, pen and line powder.

Procedure

Clear instruction was given to the subjects about the procedure of running 50 meter sprint. The subjects were called to stand at the starting line. The starters blow the whistle. On hearing the whistle sound, the subjects ran as fast as possible up to the finishing line (**Barrow & McGee, 1979).**

PHOTOGRAPH-I

Scoring

The score was the elapsed to the largest one tenth of a second between the starting and the instant the subjects crosses the finishing line.

3.11.2 4 X 10 METER SHUTTLE RUN (AGILITY):

Purpose

To measure the agility of the subjects.

Equipment

Two lines parallel to each other are placed on the floor 10 meter apart. Since the subjects must over run both of these lines, it is necessary to have several meter more of floor space at either end. Two blocks of wood, 2 by 2 by 4 meter, a stopwatch, score sheet and helpers were needed.

Procedure

The subjects stand at one of the line with the two blocks at the other line. One the signal to start, takes one, and returns to the starting line, and placed the block behind that line. The subjects then return to the second block, which is carried across the starting line one way back. At the signal "Go", run at fast as you can to the next line and pick up a block. Subjects should return the block over the second line where place it on the floor. Return for the second block, and this time subjects may run across the starting line as fast as subjects can without placing the blocks on the floor.

PHOTOGRAPH-II

Scoring

The score was the elapsed time recorded in second and tenth of seconds between the starting and the instant the subjects crosses the finish line **(Baumgartner, et.al.2003).**

3.11.3 STANDING BROAD JUMP (POWER):

Purpose

To measure power of the subjects.

Equipment

Measuring tape, a mat, space on the floor and score sheets.

Procedure

PHOTOGRAPH-III

The subjects stand behind a take-off line with his feet several inches apart. Before jumping, the subjects dip at the knees and swinging the arms backward. The subjects jump forward by simultaneously extending the knees and swinging the arms forward. Measurement is from the closest heel mark to take off line. Indoor administration is best accomplished by placing a tape measure on the floor at right angle to the take-off line and permitting the students jumps alone the line. Measurement can then be made by sighting across the tape to the point of the jump. The subjects must take-off both feet simultaneously, jump as far forward as possible, and land on both feet. Try not to fall backward after the landing. Subjects can jump further by crouching before the jump and swinging the arms **(Marrow, et al. 2005).**

Scoring

The score is the distance between the take-off line and the nearest point where any part of the subject's body touching the floor. It is measuring in meter to the nearest centimeters **(Marrow, et al. 2005).**

3.11.4 PULL UP TEST (SHOULDER STRENGTH):

Purpose

To measure shoulder strength of the subjects.

Equipment

A metal bar approximately 1.5 inches in diameter is placed at a convenient height.

Procedure

The bar was adjusted to such height that the subjects can hanged free of the floor. The subjects grasped the bar with his palms facing away from the body (overhead grasp).The subjects should then raise subjects body until was over the bar and then lower it again to the starting position with the arms fully extended. The subjects not lift knees or assist the subject's pull-up by kicking. Subjects must return to the hang position with the arms fully straight.

PHOTOGRAPH-IV

Scoring

One point is scored each time the subjects completes a pull-up. Part score do not count **(AAHPERED Manual, 1979).**

3.11.5 NELSON CHOICE-RESPONSE-MOVEMENT TEST (REACTION TIME TEST):

Purpose

To measure the reaction time of the subjects.

Equipment

Stopwatch, measuring tape, and marking equipment's, marking, score sheet and helpers.

Procedure

PHOTOGRAPH-V

The subjects face the subjects while crouching in an on the guard position at a stop exactly between the two side line. The subjects hold the stop watch in his upraised hand. The subjects then abruptly waves his arms to either the left or right and simultaneously start the watch. The subject's responds to the hand signal and attempt the run as quickly as possible, in the indicated direction, to the boundary line. The watch was stopped when the subjects crossed the correct line. If the subjects should start to move in the wrong direction, the watch continues to run until the subjects reverse direction and reaches the correct side line. Ten trails are given, five to each side, but in a random sequence.

Scoring

The time of each trail was read to the nearest tenth of second. The average score is then recorded. **(Marrow, et al.2005)**

3.12 TRAINING PROGRAMME

During training duration the experimental groups underwent their surrounding uniform plyometric training programme in addition to their daily regular activities as per the schedule. Experimental group namely experimental group-I(Sprinter),experimental group-II(Jumper) and experimental group-III(Thrower) underwent their respective experimental training on three alternative days per week for twelve weeks. The experimental training programmers were designed basis on the recourses collected from books, periodical, e-materials and discussion with the experts. The duration of experimental training were planned for 60 minutes. The subjects reported for experimental training between 3.00 pm and 4.00 pm. All the subjects involved in this study were carefully monitored throughout the training programme and 90 percent attendance, were there for the participants.

Table-III

General Structure of Training Programs

GROUPS WITH TRAINING PARTICULARS	TRAINING
Experimental Group-I(sprinter)	Regular activities & plyometric training
Experimental Group-II(jumper)	Regular activities & plyometric training
Experimental Group-III(thrower)	Regular activities & plyometric training
Control Group-IV	Regular activities
Training duration in daily	Sixty minutes
Training session per week	Three days
Total duration of training	Twelve weeks

Table-IV

Shedule of Plyometric Training Programme

Training week	Training volume(foot contact)	Plyometric Drill		Set*Reps	Training Intensity	Rest between sets
Week-1	20	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 2*5 2*5 2*5 2*5	Low Low Low Low Low	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*10 3*10	Low Low	
Week-2	20	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 2*10 2*10 2*10 2*10	Low Low Low Low Low	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass Hand both hand	Hand	3*10 3*10	Low Low	
Week-3	30	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 2*10 2*10 2*10 2*10	Low Low Low Low Low	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*10 3*10	Low Low	

Training week	Training volume(foot contact)	Plyometric Drill		Set*Reps	Training Intensity	Rest between sets
Week-4	30	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 2*10 2*10 2*10 2*10	Low Low Low Medium Medium	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*10 3*10	Medium Medium	
Week-5	30	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 2*10 2*10 2*10 2*10	Medium Medium Medium Medium Medium	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	4*10 4*10	Medium Medium	
Week-6	30	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*15 3*15 3*15 3*15 3*15	Medium Medium Medium Medium Medium	2-3 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	4*10 4*10	Medium Medium	
Week-7	40	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*15 3*15 3*15 3*15 3*15	Medium Medium Medium Medium Medium	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*12 3*12	Medium Medium	
Week-8	40	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	4*10 4*10 4*10 4*10 4*10	Medium Medium Medium Medium Medium	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*12 3*12	Medium Medium	

Training week	Training volume(foot contact)	Plyometric Drill		Set*Reps	Training Intensity	Rest between sets
Week-9	40	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	2*5 2*5 2*5 2*5 2*5	High High High High High	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*10 3*10	High High	
Week-10	50	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	2*10 2*10 2*10 2*10 2*10	High High High High High	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	3*10 3*10	High High	
Week-11	50	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 3*10 3*10 3*10 3*10	High High High High High	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	4*8 4*8	High High	
Week-12	50	•Line hops •Squat jumps •Box jumps •Hurdles hops •Depth jumps	Leg	3*10 3*10 3*10 3*10 3*10	High High High High High	3-4 Minutes
		•Plyometric push up •Medicine ball chest pass both hand	Hand	4*8 4*8	High High	

3.13 PLYOMETRIC TRAINING

3.13.1 LINE HOPS:

Line hops is normally used by coaches and athletes to improve muscle power, speed and agility. Line hops exercise is excellence for beginners since they are simple and required limited equipment's. In fact all that is needed is a boundary line (made from paint, chalk or tape) on a gym floor, a sports field or another nonslip resilient surface. Athletes can vary the difficulty of line hops exercise by altering combination of upper and lower body movements and changing the complexity of footwork. The athletes stands parallel with the line and then hops back and forth over it with the feet together for a specified time period or number of repetitions. After the athlete land for each hops, he should immediately push off again and hops to the other side of the line. No extra hops or bounces should occur **(Yuba.et.al.2001).**

3.13.2 SQUAT JUMPS

Squat jump are high-intensity plyometric exercise that are excellent for building explosive power, conditioning the muscles and joints of the lower body and increasing the height of your vertical jump. Because of their difficulty, jump squats should be performed correctly to prevent injury and get the most out of the exercise. Before performing squat jump, you should familiarize yourself with basic takeoff and landing position, correct jumping technique and mechanics of creating and absorbing force **(y. Negra.et.al. 2017).**

3.13.3 BOX JUMPS

The key is to start with a low box to get accustomed to movement – select something between 12-24 inches in height, depending on your personal level of confidence and strength. The exercise itself, in theory, is simple. The whole goal is to simple stand facing the box, then in smooth motion, jump from the floor to the top off the box, landing both feet at the same time. That's it. But, as with most things, the devil is in the details. It's important to master proper from as you learn the exercise, even if the short jump feels simple because it will enable you to perform the exercise safely and effectively as you progress in box jump height **(Andrew, D.P.S, 1999).**

3.13.4 HURDLE HOPS

The hurdle hops is a simple but powerful plyometric movement that combines the raw power of depth jump with increased demand on rhythm and power. To perform the exercise, line up 2 to12 or more hurdles anywhere from 4 to 6 feet apart. Athletes with rebound jump over them in sequence, "bunching" on the landing with the minimal contact time. An example of hurdle hops intense enough to overload an athlete's it do that. To the challenging and stretch athletes to the limit of the ability, these jump must be progressed over time rather than just being there in a programme, as they often are **(Costello, F.1984).**

3.13.5 DEPTH JUMPS

Depth jump are an excellence exercise to help improve reactive or eccentric strength, one of the great thing about them is that often they provide immediately and noticeable gain in jump height. The down side is that these short term results often lead to them being abused as a training tool **(Kitset, et, al.1987**).

3.13.6 PLYOMETRIC PUSH UP

Start in a plank position on your knees, kneeling forward slightly to get in a high plank position. Bend your arms to lower yourself into a push up. Immediately push back up explosively, taking your hand off the floor. Plyometric push up most commonly used exercise commonly used exercise among fitness buffs and elite level athletes. As a closed chain exercise that target the chest and upper body pushing strength and endurance, and can be done with no equipment. There are plenty of regressions, progression and variations to pick form, making pushups useful for athletes of all types. Form body weight push up to loaded isometric push-ups, there is also various ways to load and challenges the movement **(De. Villarreal, et, al, 2008).**

3.13.7 MEDICINE BALL CHEST PASSES BOTH HANDS

Stand up straight, facing a wall or a partner. Make sure there is approximately 5 feet of space between the subjects. Holding a medicine ball with hands bring it up to subjects chest level. Focusing the tensions in subject's chest, explosively toss the ball straight and forward against the wall or have subjects partner catch it. Catch the ball as its bounces back and repeat the

movement in rapid succession. Medicine ball chest passes a gym work out exercise that targets abs and chest and also involves biceps and shoulders and triceps. Refer to the illustration above for how to perform this exercise correctly. Hanging leg rises to bar , windshield wiper and burped or squat thrust are related exercise that target the same muscles group as medicine ball chest pass **(Hewett,et,al,1996).**

3.14. COLLECTION OF DATA

The parameters used in the study were assessed from all the subjects before they have to treat with the supporting treatments. It was assumed as pre-test. After finish of treatment they were tested again as it was in the pre-test on all variables and assumed as post-test.

3.15. STATISTICAL TECHNIQUES AND ITS JUSTIFICATION

The following statistical techniques were acclimatization to treat the collected data in connection with proved hypothesis and objectives of this study.

To find out the differences between pre-test and different post-test of every groups. Repeated measure ANOVA and ANCOVA were used because the subjects were selected random, but the groups were not equal in relation to the factors to be examined. Hence the differences between means of the four groups in the pre-test had to be taken into account during the analysis of the post-test differences between the means. This was achieved by the application of analysis of co-variance, where the final means for differences in the initial means were tested significant.

Whenever the post-test mean were found significant, the Tukey Post-hoc test was employed to find out the mean differences. To test the obtained results on different parameters, level of significance 0.05 level was fixed and considered as adequate for the study.

CHAPTER-IV

RESULT AND DISCUSSION

CHAPTER-IV

RESULT AND DISCUSSION

Overview: The chapter deals with the analysis of data collected from the sample study. The four groups namely, three experimental and one control group observation were analyzed in term of different motor fitness parameters such as speed, agility, power, shoulder strength, reaction time response to uniform plyometric training at relation to pre-test and post-test. The statistics which help to describe a data distribution measure of mean and standard deviation were calculated for summarizing the data. Paired sample has been used for finding significant pre-test to post-test mean differences in each group of each parameters. Repeated measure ANOVA and repeated measure ANCOVA were used to find out significant mean difference in pre-test and post-test of different groups with respect to each parameters. Repeated measures ANOVA and repeated measures ANCOVA was used to find out significance adjusted post-test mean difference of four groups with respect to each parameter, the Tukey post-hoc test was used. The repeated measure ANOVA and repeated measure ANCOVA needed to be significant at 0.05 levels**.** The mean compare utilized Tukey comparisons basis on an alpha of 0.05. Tukey comparisons were utilized to test the variants in the sufficient marginal means for each and every combination of within-subject effects. Different abbreviation has been used for result and discussion of the study, such as M-means, SD-standard deviation,S-sprinter,J-jumper,T-thrower,C-control,T1-Test1,T2-Test2,T3-Test3,SR-shuttle run, SBJ-standing broad jump, PU-pull up, RTT-Reaction Time Test. Detail about result and discussion of each parameters has given below-

4.1 REPEATED MEASURES ANOVA FOR SPRINTER (50M SPRINT)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented Table: 4.1.1

Table No. 4.1.1

Mean and SD Table for Within-Subject Variables of Speed (Sprinter)

Variable	MEAN(SEC)	SD
Pre-Test	6.54	0.37
Test-1	6.51	0.37
Test-2	6.46	0.32
Test-3	6.40	0.31

Note. n = 10.

Table 4.1.1 showed the Mean and SD of the 50m sprint performance of the Sprinters in Pre Test, Test-1, Test-2 and Test-3.

Figure-1

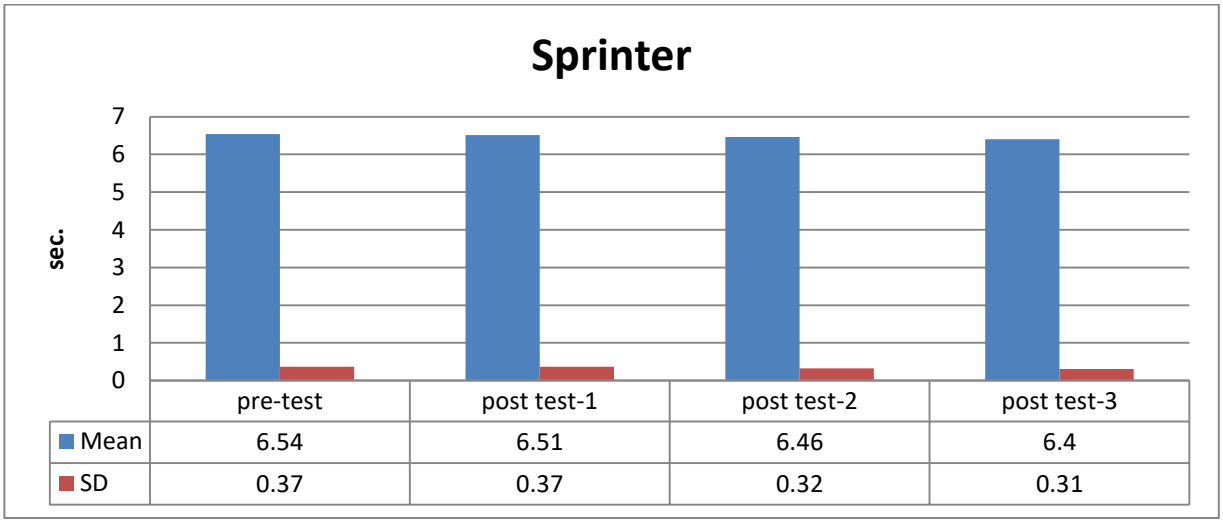

Figure 1: Graphical Representation of Mean and SD of speed (sprinter)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was organized to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 50m sprint(sprinters) performance was concerned.

Table No. 4.1.2

Repeated Measures ANOVA Results of Speed (Sprinter)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.11	0.04	8.60	< .001	0.49
Residuals	27	0.12	0.00			

The main effect for the within-subjects factor was significant F (3, 27) = 8.60, p = .009, indicating there were significant differences between the values of Pre Test, Test-1, Test-2, and Test-3. Table 4.1.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.1.2.

Post-hoc. The mean contrasts utilized Tukey's comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.1.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-test	Test-1	0.04	0.01	9	3.34	.036
Pre-test	Test-2	0.09	0.03	9	3.29	.039
Pre-test	Test-3	0.14	0.04	9	3.23	.043
Test-1	Test-2	0.05	0.02	9	2.33	.163
Test-1	Test-3	0.10	0.04	9	2.75	.088
Test-2	Test-3	0.05	0.02	9	2.18	.201

Note. Tukey's Comparisons were used to test the differences in estimated marginal means.
**Significance was judged at 0.05 level of significance.

Within Effects. Post -test-1 performance of speed was significantly greater than Pre-test, t (9) = 3.34, p = .036, Test-2 performance was significantly greater than Pre-test, t (9) = 3.29, *p* = .039, and Pre-test was marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Test-3 significantly greater than Pre-test, t (9) = 3.23, p = .0 43. Table-4.1.3 presented the test performances were significantly improved by the

treatment of uniform plyometric. But there was so difference between different post-tests so far as 50m sprint performance was concerned.

Present study showed that Pre-test performance of Sprinters in 50m sprint was lower than their performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-2 score so far as sprinting performance was concerted after the treatment. The differences were found more or less significant in all cases.

This result of the present study is very much relevant to the study conducted by **Nag Eswaran & Ravi Chandra (2014).** They concluded that the weight training, plyometric training and complex training produced significant improvement in speed performance. In their study speed was assessed by 50 meters run and acceleration was assessed fly run after eight weeks of training of training period the collected data were analyzed using's' test and analysis of co-variance.

The results of the study conducted by **Campillo, et al. (2013)** state that high training volume significantly increased the explosive performance. Further they concluded that, plyometric training on hard surface and moderate training volume significantly improved the speed which is authenticating our study.

In the present study it was found that Pre-test time is significantly greater than other Post -test means after the application of Plyometric training bout of different duration. This result is very much validated by the study of **López Ochoa, S. et. Al (2015) that** suggested that the plyometric training used on the students with a sedentary life, with a duration of 8 sessions organized in 4 weeks, can have positive effects, increasing the performance capability of the speed and acceleration in a distance of 30 meters, focusing on improving the Maximum Strength, Explosive Strength, Power and the stretch-shortening cycle of the muscle. More or less all previous study showed same results in case of the control group performance after treatment so far as improvement of sprinting performance is concerned.

The present study clearly showed that the different post- test performances are significantly improved than pre-test performance by the treatment of plyometric training. In this context, less time indicates betterment of the performance of speed (sprinter). In different post-test, gradually decreased of speed time means the performance of speed (sprinter) enhanced.

That's why it was clear that the plyometric training is very effective improvement for the teen-age athletes (sprinter) performance.

4.2. REPEATED MEASURES ANOVA FOR JUMPER (50M SPRINT)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.2.1.

Table No. 4.2.1

Means and SD Table for Within-Subject Variables of Speed (Jumper)

Variable	MEAN(SEC)	SD
Pre-Test	6.49	0.53
Test-1	6.47	0.51
Test-2	6.47	0.48
Test-3	6.40	0.40

Note. n = 10.

Table 4.2.1 showed the Mean and SD of the 50mt. sprint performance of the jumpers in Pre Test, Test-1, Test-2 and Test-3.

Figure-2

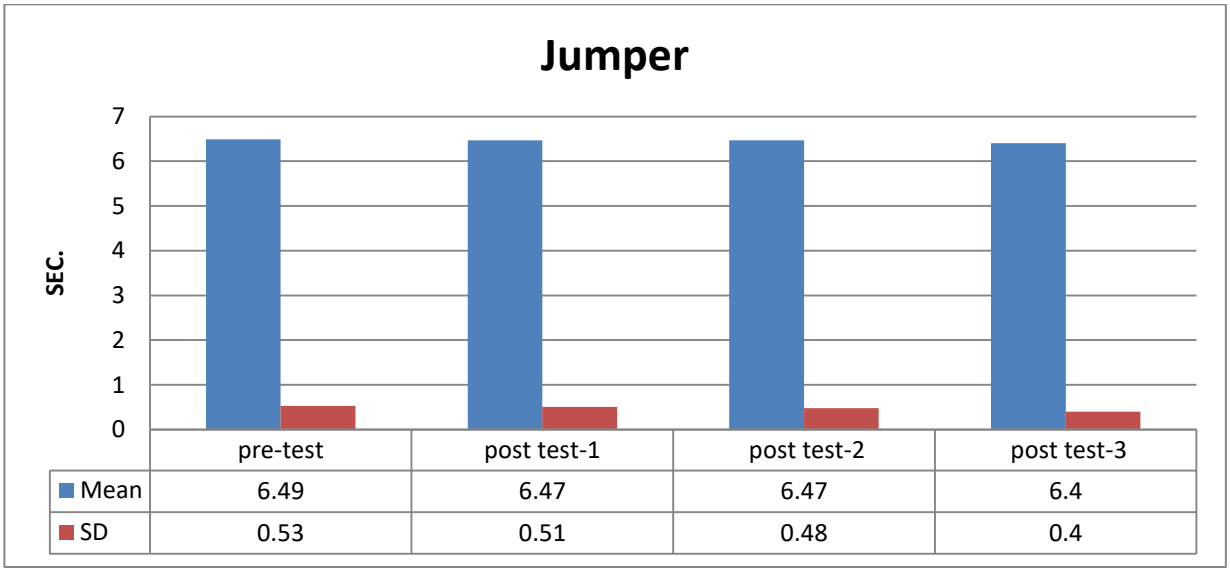

Figure 2: Graphical Representation of Mean and SD of speed (Jumper)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 50m sprint(jumpers) performance was concerned.

Table No. 4.2.2

Repeated Measures ANOVA Results of Speed (Jumpers)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.05	0.02	13.77	.022	0.30
Residuals	27	0.11	0.00			

The main effect for the within-subjects factor was significant F (3, 27) = 13.77, p = .022, indicating the values of Pre-Test, Test-1, Test-2, and Test-3 were all gradually increase of performance. Table 4.2.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.2.2 and Figure 2.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.2.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	p
Pre-Test	Test-1	0.02	0.01	9	2.08	.230
Pre-Test	Test-2	0.02	0.02	9	1.09	.706
Pre-Test	Test-3	0.09	0.04	9	2.08	.229
Test-1	Test-2	-0.00	0.01	9	-0.07	1.000
Test-1	Test-3	0.07	0.04	9	1.82	.324
Test-2	Test-3	0.07	0.03	9	2.28	.175

Note. Tukey Comparisons were used to test the differences in estimated marginal mean. **Significance was judged at 0.05 levels of significance.

Within Effects. Most significant differences were found between Pre-Test, Test-1, Test-2, and Test-3. Table 4.2.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of plyometric. But there was so difference between different post-tests so far as 50m sprint performance was concerned.

Present study showed that Pre-test performance of Jumpers in 50m sprint was lower than their post- test performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-2 score so far as sprinting performance was concerted after the treatment. The differences were found significant in all cases.

The study showed improves in sprinting performance of Jumpers after uniform Plyometric treatment of different duration. It also showed that 12 weeks of uniform Plyometric training of this type was significantly improve the sprinting speed of the jumpers. The result is authenticated by the result of the study conducted by **Bogdan's, G.C. et. al. (2019**), which was concluded that despite the considerable improvement of speed and power, the 8-week training period may be considered too short to induce significant differences in some forms of jumping performance. Therefore, further studies considering longer training interventions are needed to examine longer-term Plyometric training in similar populations.

The present study clearly showed that the different post- test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of speed (jumpers). In different post-test, gradually decreased of speed time means the performance of speed (jumpers) enhanced. That's why it was clear that the plyometric training is very effective improvement for the teen-age athletes (jumpers) performance.

4.3. REPEATED MEASURES ANOVA FOR THROWER (50M SPRINT)

The mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented Table: 4.3.1.

Table No. 4.3.1

Means and SD Table for Within-Subject Variables of Speed (Thrower)

Variable	MEAN(SEC)	SD
Pre-Test	6.97	0.44
Test-1	6.92	0.37
Test-2	6.77	0.37
Test-3	6.67	0.35

Note. n = 10.

Table 4.3.1 showed the Mean and SD of the 50m sprint performance of the thrower in Pre Test, Test-1, Test-2 and Test-3.

Figure 3

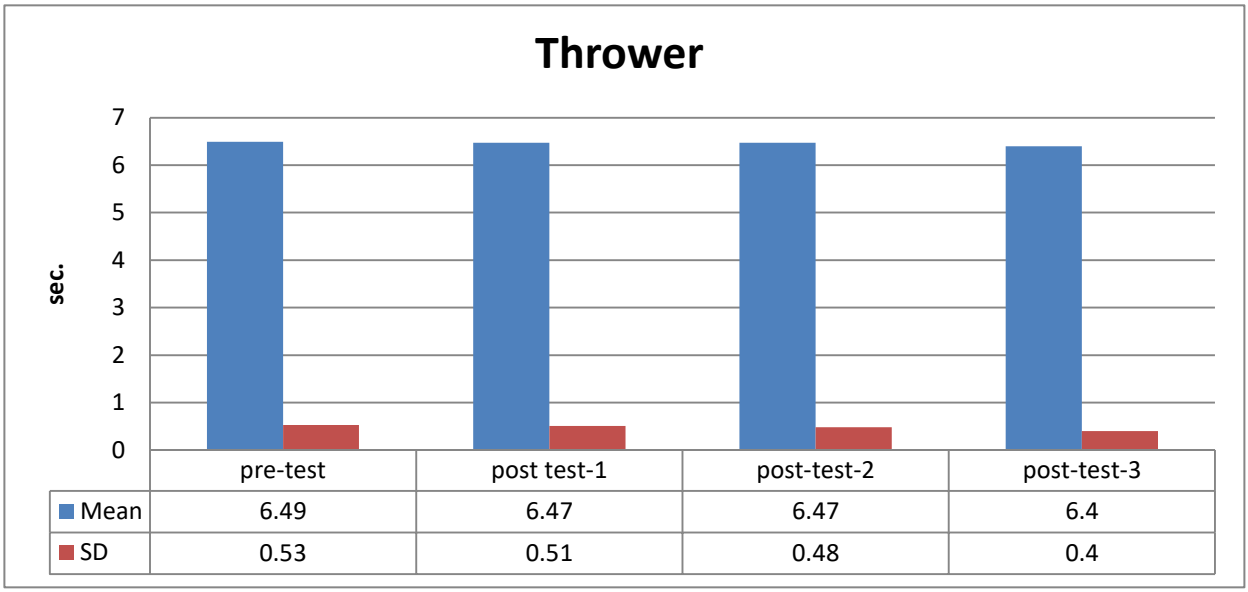

Figure 3: Graphical Representation of Mean and SD of speed (Thrower)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 50m sprint(throwers) performance was concerned.

Table No. 4.3.2

Repeated Measures ANOVA Results of speed (thrower)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.54	0.18	9.80	< .001	0.69
Residuals	27	0.25	0.01			

The main effect for the within-subjects factor was significant F (3, 27) = 9.80, p < .001, indicating there were significant differences between the values of Pre-Test, Test-1, Test-2, and Test-3. Table 4.3.1 presented the ANOVA results. The means of the within-subjects factor were presented in Table 4.3.2 and Figure 3.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects

Table No. 4.3.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	p
Pre-Test	TEST-1	0.05	0.02	9	2.15	.208
Pre-Test	TEST-2	0.20	0.05	9	3.79	.018
Pre-Test	Test-3	0.29	0.05	9	5.53	.002
Test-1	Test-2	0.15	0.05	9	3.21	.043
Test-1	Test-3	0.24	0.05	9	5.17	.003
Test-2	Test-3	0.10	0.02	9	3.93	.015

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. Post-Test-2 performance was significantly greater than Pre-Test, t(9) = 3.79, p = .018, Test-3 performance was significantly greater than Pre-Test, t(9) = 5.53, p = .002, Test-2 was significantly greater than Test-1, t(9) = 3.21, p = .043, Test-3 was significantly

greater than Test-1, t(9) = 5.17, p = .003, and Test-3 was significantly greater than Test-2, t(9) = 3.93, p = .015. Table-4.3.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was evident that the Post-test performances are significantly improved by the treatment of polymeric. But there was so difference between different post- tests so far as 50m sprint performance was concerned. The study showed that mean sprinting performance of the throwers was significantly improved through at least 12 weeks of uniform Plyometric training.

Present study showed that Pre-test performance of Throwers in 50m sprint was lower than their post -test performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-2 score so far as sprinting performance was concerted after the treatment. The differences were found more or less significant in all cases.

The well-known training methods such as resistance training and plyometric training, strength and conditioning professionals may well incorporate sprint training into an overall conditioning program of athletes striving to achieve a high level of explosive leg power and dynamic athletic performance. The result of the study is validated by the study of **Kotzamanidis, C. (2006)** where results indicated that plyometric exercises could improve Squat Jump and Running Velocity in prepubertal boys and more specifically, this program selectively influenced the maximum velocity phase, but not the acceleration phase.

The improvement in speed performance after plyometric training has been attributed to an improvement in ground contact time and muscle tendon stiffness **(Mero et al., 1991; Meylan &Malatesta, 2009; Rimmer & Sleivert, 2000).** In present study we found that after 8 weeks as well as 12 weeks of Plyometric training the jumpers speed performance was improved significantly, which was relevant to other studies. But there was significant improvements of throwers of speed performance after 12 weeks of such training.

The present study clearly showed that the different post-test performances are significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of speed (thrower). In different post-test, gradually decreased of speed time means the performance of speed (thrower) enhanced. That’s why it is clear that the plyometric training was very effective in the improvement of the teen-age athletes (thrower) performance.

4.4. REPEATED MEASURES ANCOVA FOR Test-3(50 Mt. Sprint):

A repeated measures Analysis of Covariance (ANCOVA) with one within-subjects factor was conducted to determine whether significant differences exist among T3-S, T3-J, T3-T, and T3-C after controlling for Pre-Test-S, Pre-Test-J, Pre-Test-T, and Pre-Test-C.

Table No. 4.4.1

Repeated Measures ANCOVA Results for pre-test and post-test-3(Speed)

Source	df	SS	MS	F	p	η_p^2
Between-Subjects						
Pre-Test-S	1	0.25	0.25	52.24	< .001	0.91
Pre-Test-J	1	0.68	0.68	143.94	< .001	0.97
Pre-Test-T	1	0.19	0.19	39.90	.001	0.89
Pre-Test-C	1	1.64	1.64	345.82	< .001	0.99
Residuals	5	0.02	0.00			
Within-Subjects						
Within Factor	3	0.01	0.00	2.43	.105	0.33
Pre-Test-S:Within.Factor	3	0.65	0.22	156.43	< .001	0.97
Pre-Test-J:Within.Factor	3	1.59	0.53	380.71	< .001	0.99
Pre-Test-T:Within.Factor	3	0.56	0.19	134.33	< .001	0.96
Pre-Test-C:Within.Factor	3	4.99	1.66	1191.82	< .001	1.00
Residuals	15	0.02	0.00			

The covariate, Pre-Test-S, was significantly related to T3-S, T3-J, T3-T, and T3-C, $F(1, 5) = 52.24$, $p < .001$. The covariate, Pre-Test-J, was significantly related to T3-S, T3-J, T3-T, and T3-C, $F(1, 5) = 143.94$, $p < .001$. The covariate, Pre-Test-T, was significantly related to T3-S, T3-J, T3-T, and T3-C, $F(1, 5) = 39.90$, $p = .001$. The covariate, Pre-Test-C, was significantly related to T3-S, T3-J, T3-T, and T3-C, $F(1, 5) = 345.82$, $p < .001$. The main effect for the within-subjects factor was significant $F(3, 15) = 2.43$, $p = .105$, indicating the values of T3-S, T3-J, T3-T, and T3-C were all similar. Table.4.4.1 presented the ANCOVA results.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.4.2

A Comparison of Post Test-3(Speed) for Sprinter, Jumper and Throwerss Group

Contrast		Difference	SE	df	t	p
T3-S	T3-J	0.04	0.01	5	3.02	.100
T3-S	T3-T	0.41	0.02	5	22.71	< .001
T3-S	T3-C	0.77	0.02	5	45.32	< .001
T3-J	T3_T	0.45	0.01	5	31.70	< .001
T3-J	T3_C	0.81	0.01	5	57.39	< .001
T3-T	T3-C	0.36	0.02	5	16.32	< .001

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 levels of significance.

Within Effects. T3-S was significantly less than T3-T, $t(5) = 22.71$, $p < .001$, T3-S was significantly greater than T3-C, $t(5) = 45.32$, $p < .001$, T3-J was significantly less than T3-T, $t(5) = -31.70$, $p < .001$, T3-J was significantly greater than T3-C, $t(5) = 57.39$, $p < .001$, and T3-T was significantly greater than T3-C, $t(5) = 16.32$, $p < .001$. Table.4.4.2 presented the marginal means contrasts for the Repeated Measures ANCOVA. From Post-hoc test it was concluded that the Post-test performances were significantly improved by the treatment of plyometric.

Table No. 4.4.3

Analysis of Covariance (ANCOVA) for three Experimental Groups and the Control Group with Regard to Speed as Measured by 50 Meter Run (Sec) Test.

Group	**Pre-test means**	**Post-test 3 means**	**Difference between means**	**Standard error of difference**	**t-ratio**
Sprinter group (experimental)	6.54	6.40	0.14	0.016	8.75
Jumper group (experimental)	6.49	6.40	0.09	0.014	6.43
Thrower group (experimental)	6.97	6.67	0.30	0.011	27.28
Control group	6.83	6.81	0.20	0.021	0.952

*significance was judged at 0.05 level of significance. t=2.09

It is was clear from this table that all the three experimental group (sprinter, jumper and thrower) had exhibited significant improvement in the variable speed as measured by 50 meter dash test after period of 12-weeks plyometric training as obtained ratio 8.75(sprinter), 6.43(jumper) and 27.28(thrower) respectively were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence except control group (0.952).

Also it was observed from the table that the experimental group of thrower(27.28) had shown much more significant differences between pre-test and final post-test than the experimental group of sprinter(8.75) and jumper(6.43).

Sprinters performance in Sprinting was found greater, after treatment of 12 weeks, than the performances of Jumpers, and found lower than the performances of Throwers as well as than the Control also. At the same time Jumpers mean performance in Sprinting was also lower than the performance of Throwers and Control also. The mean performance in Sprinting of the Throwers also found lower than the mean performance of the Control. The difference was found more or less significance.

Rajesh (2012) conducted a study that was to find out the "Effect of plyometric exercise on speed among football players". To achieve this 40 male players from various colleges of Osmania University, Hyderabad were selected. The subjects were made into experimental and control group. Speed was assessed by 30 meter run. After six weeks of training the plyometric exercise showed improvement on speed than the other group. The present study is very much relevant to the above study.

Kotzamanidis (2006) conducted a study that was to investigate the effect of plyometric training on running velocity (RV) and squat jump (SJ) in prepubescent boys. The study showed that the SJ performance of the JUMP group increased significantly, as well ($p<0.05$). According to **Kotzamanidis (2006) t**here was no change in either RV or SJ for the control group, these results indicated that plyometric exercises could improve SJ and RV in young boys. The conclusion was that the above program selectively influenced the maximum velocity phase, but not the acceleration phase. The result of our study is very much relevant to the above study.

Present study showed significant differences in Test-3 scores i.e. post test scores after 12 weeks of uniform plyometric treatment. All the groups showed significant improvement in sprint performance, which was greater than the control group. There were significant

difference between performances of all groups after the adjustment of Pre Test scores of 4 groups. That's why it was clear that the plyometric training is very effective in the improvement of sprinting performance of the teen age athletes.

4.5 REPEATED MEASURES ANOVA FOR SPRINTER (STANDING BROAD JUMP)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 standing broad jump performance variable have been presented in Table: 4. 5.1.

Table No. 4.5.1

Means Table for Within-Subject Variables of Standing Broad jump (Sprinter)

Variable	MEAN(METER)	SD
Pre-Test-S-SBJ	2.53	0.31
T1-S-SBJ	2.55	0.30
T2-S-SBJ	2.59	0.28
T3-S-SBJ	2.62	0.26

Note. n = 10.

Table 4.5.1 showed the Mean and SD of the standing broad jump performance of the sprinters in Pre Test, Test-1, Test-2 and Test-3.

Figure 5

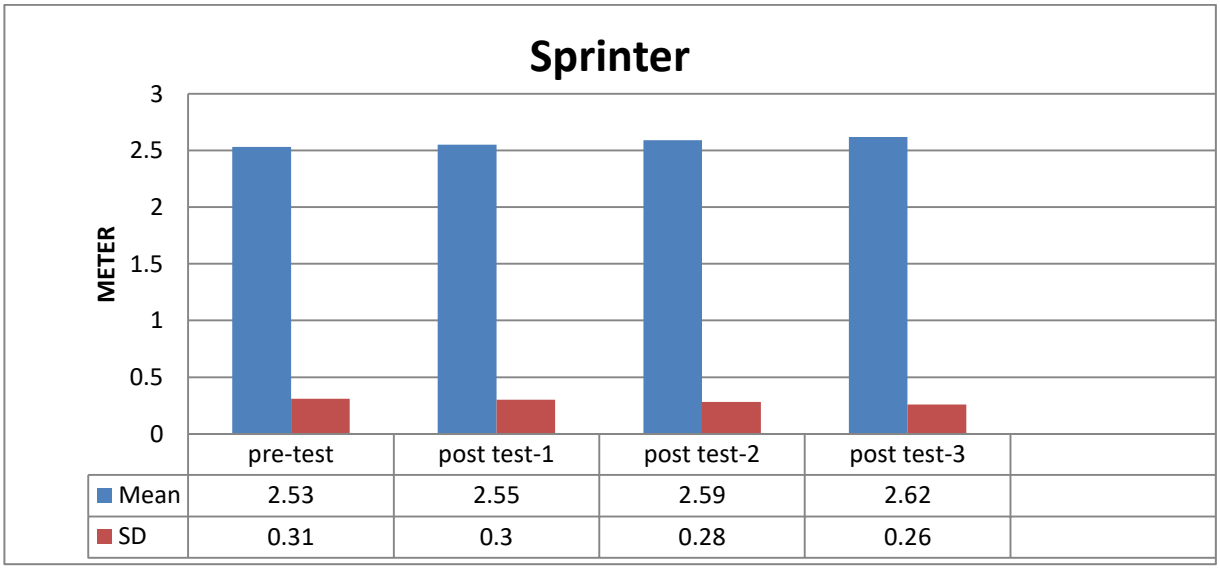

Figure 4: Graphical Representation of Mean and SD of Standing Broad Jump (Sprinter)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test, Test-1, Test-2, and Test-3 so far as standing broad jump (sprinter) performance is concerned.

Table No. 4.5.2

Repeated Measures ANOVA Results of Standing Broad Jump (Sprinter)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.05	0.02	7.75	< .014	0.46
Residuals	27	0.05	0.00			

The main effect for the within-subjects factor was significant F (3, 27) = 7.75, p = .014, indicating there were significant differences between the values of Pre-Test-S-SBJ, T1-S-SBJ, T2-S-SBJ, and T3-S-SBJ. Table no-4.5.1 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.5.2 and Figure-5.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.5.3

The Marginal Means Compare for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-Test-S-SBJ	T1-S-SBJ	-0.02	0.01	9	3.15	.048
Pre-Test-S-SBJ	T2-S-SBJ	0.06	0.02	9	2.90	.070
Pre-Test-S-SBJ	T3-S-SBJ	0.09	0.03	9	3.05	.055
T1-S-SBJ	T2-S-SBJ	0.04	0.02	9	2.33	.162
T1-S-SBJ	T3-S-SBJ	0.06	0.02	9	2.61	.108
T2-S-SBJ	T3-S-SBJ	-0.03	0.01	9	2.05	.241

Note. Tukey Comparisons were used to test the differences in estimated marginal means.

∗∗Significance was judged at 0.05 levels of significance.

Within Effects. Pairwise comparisons were examined between each combination of variables. The results of the multiple comparisons indicated significant differences, based on an alpha value of 0.05, between Pre-Test-S-SBJ and T3-S-SBJ. Table no- 4.5.3 presented the results of the pair wise comparisons. From Post-hoc test it was evident that the Post-test performances were significantly improved by the treatment of uniform plyometric training. But there was so difference between different post-tests so far as standing broad jump of sprinter performance was concerned.

Present study showed that Pre-test performance of Sprinters in SBJ was lower than their performances in Test-1, Test-2 and Test-3 performance respectively. Mean Test-2 and Test-3 scores were found greater than the Test-1 and Test-3 score was found greater than the Test-1 and Test-2 scores so far as SBJ performance was concerted after the treatment. The differences were found more or less significant in all cases.

This was indicated by the studies of **de Villarreal, E.S.S., et al. (2009), Saez de Villarreal, E., et al. (1993), Adams, K., et al. (1992), Holcomb, W., et al. (1996 b), Stojanović, and Kostić, (2002),** that the plyometric training in the short term is effective to the development of muscle power and contributes to the achievement of physical education and sports activities using explosive muscle contractions. In our study Plyometric treatment significantly improved the SBJ performance of the sprinters after 4 weeks. But this improvement was not significant after 8 and 12 weeks of treatment. **Kubo et al.** speculated that the change in muscle properties (active cross-bridge) was induced by plyometric training. However, **Foure et al.** Reported that plyometric training induced a significant decrease in the stiffness of the active portion of the series elastic component (cross-bridges or myofibrils), but also reported an increase in passive muscle properties (connective tissue or sarcolemma). The present study was very much relevant to the above study.

The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, distance increased indicates betterment of the performance of standing broad jump (sprinters). In different post-test, gradually increased of distance means the performance of standing broad jump (sprinters) enhanced. That's why it was clear that the plyometric training is very effective for the improvement of teen-age athletes (sprinter) performance in standing broad jump.

4.6. REPEATED MEASURES ANOVA FOR JUMPERS (STANDING BROAD JUMP)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.6.1.

Table No. 4.6.1

Means Table for Within-Subject Variables of Standing Broad Jump (Jumper)

Variable	*M*	*SD*
Pre-Test-J-SBJ	2.75	0.19
T1-J-SBJ	2.75	0.18
T2-J-SBJ	2.77	0.18
T3-J-SBJ	2.79	0.16

Note. n = 10.

Table 4.6.1 showed the Mean and SD of the standing broad jump performance of the jumpers in Pre-Test, Test-1, Test-2, and Test-3.

Figure 6

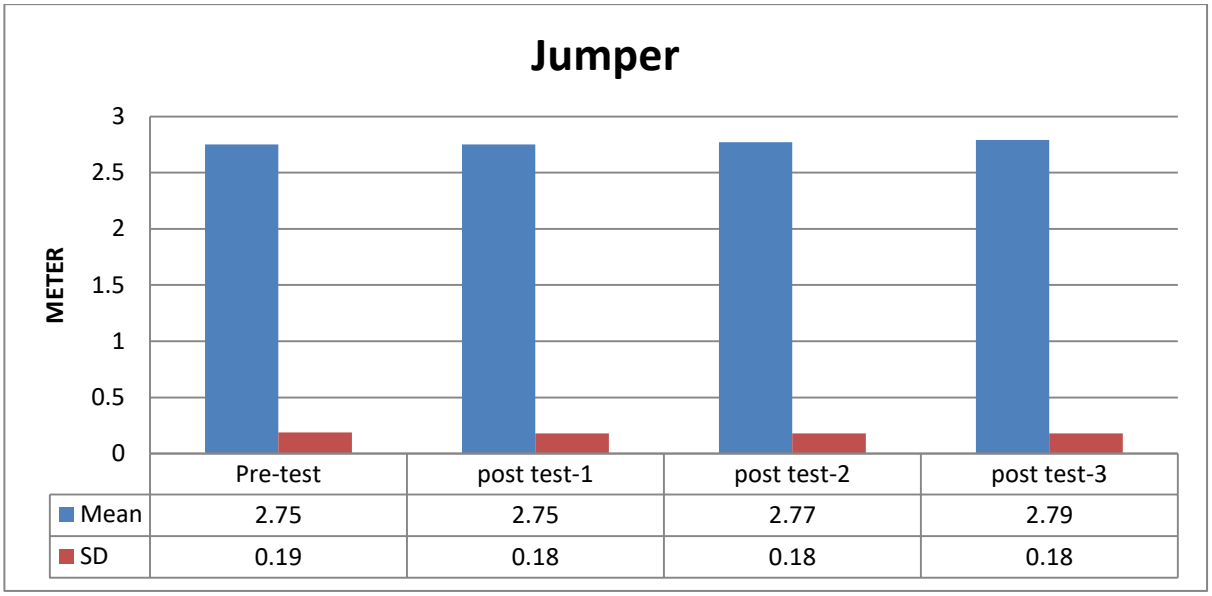

Figure 6: Graphical Representation of Mean and SD of Standing Broad Jump (Jumper)

A Repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre- Test, Test-1, Test-2, and Test-3 so far as standing broad jump (jumper) performance was concerned.

Table No. 6.2

Repeated Measures ANOVA Results of Standing Broad jump (Jumper)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.01	0.00	7.66	< .001	0.46
Residuals	27	0.02	0.00			

The results were examined based on an alpha of 0.05. . The main effect for the within-subjects factor was significant F (3, 27) = 7.66, p = .008, indicating there were significant differences between the values of Pre-Test-J-SBJ, T1-J-SBJ, T2-J-SBJ, and T3-J-SBJ. Table-4.6.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table-4.6.2 and Figure- 6.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.6.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-Test-J-SBJ	T1-J-SBJ	0.01	0.01	9	0.83	.838
Pre-Test-J-SBJ	T2-J-SBJ	0.02	0.01	9	1.77	.348
Pre-Test-J-SBJ	T3-J-SBJ	0.05	0.01	9	3.20	.045
T1-J-SBJ	T2-J-SBJ	0.02	0.01	9	1.78	.342
T1-J-SBJ	T3-J-SBJ	0.04	0.01	9	3.54	.027
T2-J-SBJ	T3-J-SBJ	0.02	0.01	9	3.34	.036

Note. Tukey Comparisons were used to test the differences in estimated marginal means.

**Significance was judged at 0.05 level of significance.

Within Effects. Pre-Test-J-SBJ was significantly less than T3-J-SBJ, t (9) = 3.20, p = .045, T1-J-SBJ was significantly less than T3-J-SBJ, t (9) = 3.54, p = .027, and T2-J-SBJ was significantly less than T3-J-SBJ, t(9) = 3.34, p = .036. Table-4.6.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of uniform plyometric. But there was so difference between different post-tests so far as standing broad jump performance was concerned.

Present study showed that mean Pre-test performance of Jumpers in SBJ was lower than their mean performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found greater than the Test-1 and Test-3 score was found greater than the Test-1 and Test-2 score so far as SBJ performance was concerted after the treatment. The differences were found more or less significant in many cases.

Training with plyometric has been extensively used for augmenting jumping performance in healthy individuals. This kind of exercise improves different type of jumps like squat jump (SJ), counter movement jump (CMJ), depth jump (DJ), long jump (LJ) (Kubo et al., 2007; Saunders et al., 2006). In some cases observed lack of adaptations that may be related to the nature of the selected exercises for plyometric training (Sale, 1992).In our study we measure standing long jump. From the literature for horizontal jumping performance it's observable that plyometric increase performance in both athletes **(Paavolainen et al., 1999; Spurrs et al., 2003)** and non-athletes **(Markovic et al., 2007).** Few studies examined this issue to children and the most of them found enhancement of jumping ability **(Diallo et al., 2001; Lehance et al., 2006; Michailidis et al., 2013)**. Our findings are to accordance with those of Diallo et al. (2001), Kotzamanidis (2006) and Lehance et al. (2006). They found that the performance at some kinds of jump (squat jump, standing long jump and at counter movement jump) improved significantly.

Ashok, et al. (2012) conducted a study that was to investigate "The effect of skill training and its combination of plyometric with skill training on jumping ability, anaerobic capacity and skill performance among volleyball players". For this sixty male volleyball player from various college in coimbatore District, Tamilnadu were selected as subject and divided into plyometric and skill training (20), skill training (20) and control (20). Jumping ability, anaerobic capacity and skill performance were tested during 12 weeks of training programme.

The result reveal that the skill training with plyometric significantly improves jumping ability anaerobic capacity and skill performance among volleyball players.

In the present study the jumpers showed significant improvement in their SBJ performance after 4, 8 and 12 weeks of plyometric treatment.

The present study it was evident that after 12 weeks of uniform plyometric training treatment the SBJ performance of jumpers was improved significantly, but no significant improvement was found after 1 and 4 weeks of treatment by plyometric resume.

In present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of plyometric training. In this context, distance increased indicates betterment of the performance of standing broad jump (jumpers). In different post-test, gradually increased of distance means the performance of standing broad jump (jumpers) enhanced. That's why it was clear that the uniform plyometric training is very effective for the improvement of teen-age athletes (jumpers) performance.

4.7. REPEATED MEASURES ANOVA FOR THROWERS (STANDING BROAD JUMP)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.7.1.

Table No. 4.7.1

Mean and SD Table for Within-Subject Variables of Standing Broad Jump (Thrower)

Variable	MEAN(SEC)	SD
Pre-Test-SBJ	2.11	0.14
T1-T-SBJ	2.17	0.13
T2-T-SBJ	2.28	0.15
T3-T-SBJ	2.40	0.17

Note. n = 10.

Table- 4.7.1 showed the Mean and SD of the standing broad jump performance of the jumpers in Pre-Test, Test-1, Test-2, and Test-3.

Figure 7

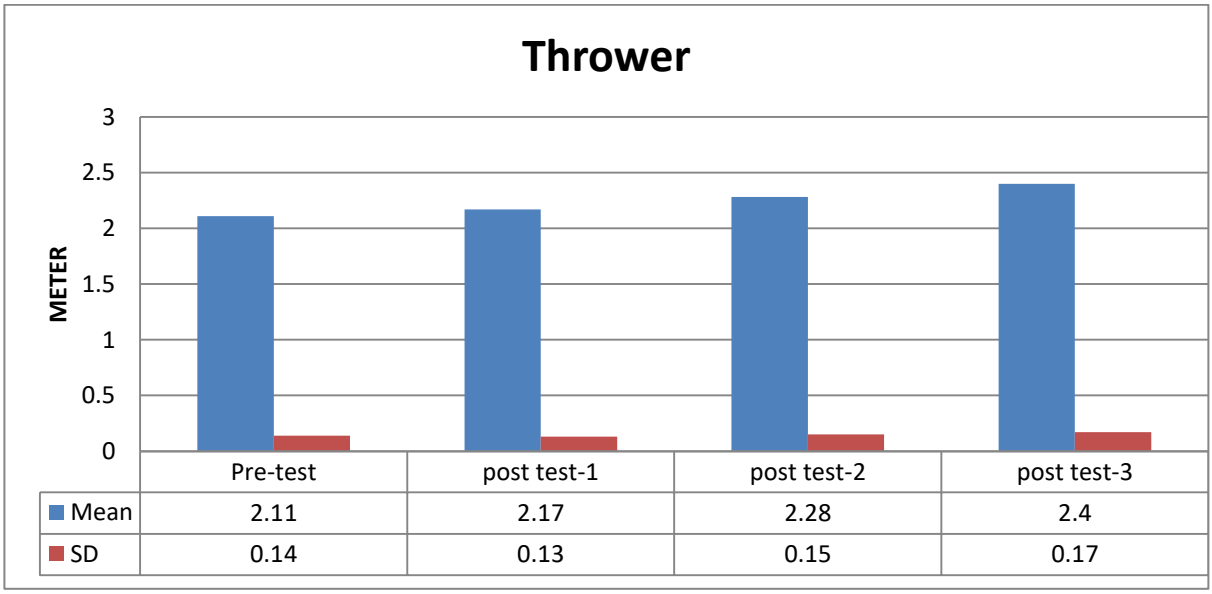

Figure 7: Graphical Representation of Mean and SD of Standing Broad Jump (Thrower)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as standing broad jump(thrower) performance was concerned.

Table No: 4.7.2

Repeated Measures ANOVA Results of standing Broad jump (Thrower)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.46	0.15	45.16	< .001	0.83
Residuals	27	0.09	0.00			

The main effect for the within-subjects factor was significant F (3, 27) = 45.16, p < .001, indicating there were significant differences between the values of Pre-Test-SBJ, T1-TSBJ, T2-T-SBJ, and T3-T-SBJ. Table-4.7.1 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.7.2 and Figure 7.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.7.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-Test-SBJ	T1-T-SBJ	0.05	0.01	9	8.20	< .001
Pre-Test-SBJ	T2-T-SBJ	0.16	0.03	9	6.06	< .001
Pre-Test-SBJ	T3-T-SBJ	0.28	0.03	9	0.31	< .001
T1-T-SBJ	T2-T-SBJ	0.11	0.03	9	3.60	.024
T1-T-SBJ	T3-T-SBJ	0.23	0.03	9	7.49	< .001
T2-T-SBJ	T3_T_SBJ	0.12	0.03	9	4.19	.010

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 level of significance.

Within Effects. Pre-Test-SBJ was significantly less than T1-T-SBJ, $t(9) = 8.20$, $p < .001$, Pre-Test--SBJ was significantly less than T2-T-SBJ, $t(9) = 6.06$, $p < .001$, Pre-Test-SBJ was significantly less than T3-T-SBJ, $t(9) = 10.31$, $p < .001$, T1-T-SBJ was significantly less than T2-T-SBJ, $t(9) = 3.60$, $p = .024$, T1-T-SBJ was significantly less than T3-T-SBJ, $t(9) = 7.49$, $p < .001$, and T2-T-SBJ was significantly less than T3-T-SBJ, $t(9) = 4.19$, $p = .010$. Table-4.6.3 presented the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was evident that the Post-test performances are significantly improved by the treatment of uniform plyometric. But there was so difference between different post-tests so far as standing broad jump (thrower) performance was concerned.

Present study showed that mean Pre-test performance of Throwers in SBJ was lower than their mean performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found greater than the Test-1 and Test-3 score was found greater than the Test-1 and Test-2 score so far as SBJ performance was concerted after the treatment. The differences were found more or less significant in many cases.

In a study regarding Plyometric treatment on Volleyball players Gjinovci, B. et al. (2017) suggested that irrespective of the positive effects of skill-based training on jumping and throwing variables, the plyometric-training was evidently more effective conditioning method than skill-based conditioning. Several physiological factors explained these findings. Plyometric exercises result in: (i) stimulation and activation not of an increased number of motor unit, and (ii) in higher neural firing frequency, which both lead to higher generation of force (McLaughlin, 2001; Pienaar and Coetzee, 2013). All conditioning capacities studied by Gjinovci, B. et al. (2017) were directly dependent on rate of force generation. They concluded that the improvements in sprinting, jumping and throwing capacities were logical consequence of such adaptation. In our study we found similar results regarding SBJ performance of the Throwers. The throwers showed greater improvement in standing broad jump or leg explosive strength after plyometric treatment of 4, 8 and 12 weeks in our study. The pre-test fitness of the throwers in leg explosive could not be considered by the researcher.

In present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, distance increased indicates betterment of the performance of standing broad jump (throwers). In different post-test, gradually increased of distance means the performance of standing broad jump (throwers) enhanced. That's why it was clear that the plyometric training is very effective for the significant improvement of teen-age athletes (throwers) performance.

4.8. REPEATED MEASURES ANCOVA FOR TEST-3 (STANDING BROAD JUMP):

A repeated measures Analysis of Covariance (ANCOVA) with one within-subjects factor was conducted to determine whether significant differences exist among T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ after controlling for Pre-S-SBJ, Pre-J-SBJ, Pre-T-SBJ, and Pre-C-SBJ.

Table No. 4.8.1

Repeated Measures ANCOVA Results for pre-test and post-test-3 (Standing Broad jump*)*

Source	df	SS	MS	F	p	η_p^2
Between-Subjects						
Pre-S-SBJ	1	0.11	0.11	219.97	< .001	0.98
Pre-J-SBJ	1	0.06	0.06	119.23	< .001	0.96
Pre-T-SBJ	1	0.03	0.03	56.13	< .001	0.92
Pre-C-SBJ	1	0.15	0.15	293.49	< .001	0.98
Residuals	5	0.00	0.00			
Within-Subjects						
Within Factor	3	0.00	0.00	0.21	.890	0.04
Pr-S-SBJ:Within.Factor	3	0.42	0.14	333.43	< .001	0.99
Pre-J-SBJ:Within.Factor	3	0.15	0.05	116.35	< .001	0.96
Pre-T-SBJ:Within.Factor	3	0.09	0.03	74.90	< .001	0.94
Pre-C-SBJ:Within.Factor	3	0.51	0.17	409.91	< .001	0.99
Residuals	15	0.01	0.00			

The results were examined based on an alpha of 0.05. The covariate, Pre-Test-S-SBJ, was significantly related to T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ, $F(1, 5) = 219.97$, $p < .001$. The covariate, Pre-Test-J-SBJ, was significantly related to T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ, $F(1, 5) = 119.23$, $p < .001$. The covariate, Pre-Test-T-SBJ, was significantly related to T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ, $F(1, 5) = 56.13$, $p < .001$. The covariate, Pre-Test-C-SBJ, was significantly related to T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ, $F(1, 5) = 293.49$, $p < .001$. The main effect for the within-subjects factor was not significant $F(3, 15) = 0.21$, $p = .890$, indicating the values of T3-S-SBJ, T3-J-SBJ, T3-T-SBJ, and T3-C-SBJ were all similar. Table-4.8.1 presented the ANCOVA results.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.8.2

A Comparision of Post Test-3(SBJ) for Sprinter, Jumper and Throwers Group

Contrast		Difference	SE	df	t	P
T3-S-SBJ	T3-J-SBJ	-0.20	0.01	5	-19.27	< .001
T3-S-SBJ	T3-T-SBJ	0.38	0.01	5	41.58	< .001
T3-S-SBJ	T3-C-SBJ	0.09	0.01	5	11.23	< .001
T3-J-SBJ	T3-T-SBJ	0.58	0.01	5	75.17	< .001
T3-J-SBJ	T3-C-SBJ	0.29	0.01	5	34.09	< .001
T3-T-SBJ	T3-C-SBJ	-0.29	0.01	5	-28.60	< .001

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 level of significance.

Within Effects. T3-S-SBJ was significantly less than T3-J-SBJ, t(5) = -19.27, p < .001, T3-S-SBJ was significantly greater than T3-T-SBJ, t(5) = 41.58, p < .001, T_S was significantly greater than T3-C-SBJ, t(5) = 11.23, p < .001, T3-J-SBJ was significantly greater than T3-T-SBJ, t(5) = 75.17, p < .001, T3-J-SBJ was significantly greater than T3-C-SBJ, t(5) = 34.09, p < .001, and T3-T-SBJ was significantly less than T3-C-SBJ, t(5) = -28.60, p < .001. Table-4.8.2 presented the marginal means contrasts for the Repeated Measures ANCOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of uniform plyometric.

Table No. 4.8.3

Analysis of Covariance (ANCOVA) for Three Experimental Groups and the Control Group with Regard to Power as Measured by Standing Broad Jump (Mt.) Test.

Group	Pre-test means	Post-test 3 means	Difference between means	Standard error of difference	t-ratio
Sprinter group (experimental)	2.53	2.62	0.09	0.024	3.75
Jumper group (experimental)	2.75	2.79	0.04	0.014	2.86
Thrower group (experimental)	2.11	2.40	0.29	0.028	10.36
Control group	2.41	2.42	0.01	0.036	0.28

*Significant was judged at 0.05 level of significance. t=2.09

It was clear evident from this table that all the three experimental groups (sprinters, jumpers and throwers) had exhibited significant improvement in the variable power as measured by standing broad jump test after period of 12-weeks plyometric training as obtained ratio 3.75 (sprinter), 2.86 (jumper) and 10.36 (thrower) respectively, were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence except control group (0.28).

Also it was observed from the table that the experimental groups of thrower (10.36) had shown much more significant differences between pre-test and final post-test than the experimental group of sprinter (3.75) and jumper (2.86).

The present study showed significant differences in Test-3 scores i.e. post test scores of SBJ after 12 weeks of treatment. All the groups showed significant improvement in sprint performance, which was greater than the control group. There appeared significant difference between performances of all groups after the adjustment of Pre Test scores of 4 groups.

Sprinters mean performance in SBJ was found lower, after treatment of 12 weeks, than the performances of Jumpers, and greater than the performances of Throwers as well as than the Control group also. At the same time Jumpers mean performance in SBJ was also found greater than the performance of Throwers and Control also. The mean performance in SBJ of the Throwers also found lower than the Control group. The difference was found more or less significant.

Brown et al., (1986) conducted a study that was to find out the effects of plyometric training on vertical jump in male high school basketball players (n=26). They concluded that the plyometric group improved in vertical jump with arm assistance significantly more than the control group and in the plyometric group 57 percent of the vertical jump gain was due to jumping skill improvement, and 43 percent was due to strength gain. They also concluded that the force plyometric training appears to enhance the coordination of the arms with strength development of the legs and provides a convenient in-session training method. In present study all the performance enhancement is very much related to the above study.

In present study demonstrated that Jumpers showed higher performance enhancement after the treatment. The mean performance of control group was always lower. Present study showed significant differences in Test-3 scores i.e. post test scores after 12 weeks of uniform

plyometric treatment. All the groups showed significant improvement in sprint performance, which was greater than the control group. There were significant difference between performances of all groups after the adjustment of Pre Test scores of 4 groups. That's why it was clear that the uniform plyometric training is very effective in the improvement of standing broad jump performance of the teen-age athletes.

4.9. REPEATED MEASURES ANOVA FOR SPRINTER (4X10 MT. SHUTTLE RUN)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.9.1.

Table No. 4.9.1

Mean and SD Table for Within-Subject Variables of Agility (sprinter)

Variable	MEAN(SEC)	SD
Pre-Test-S-SR	9.67	0.49
T1-S-SR	9.64	0.48
T2-S-SR	9.55	0.37
T3-S-SR	9.46	0.35

Note. n = 10.

Table- 4.9.1 showed the Mean and SD of the 4x10 meter shuttle run performance of the sprinters in Pre-Test, Test-1, Test-2, and Test-3.

Figure 9

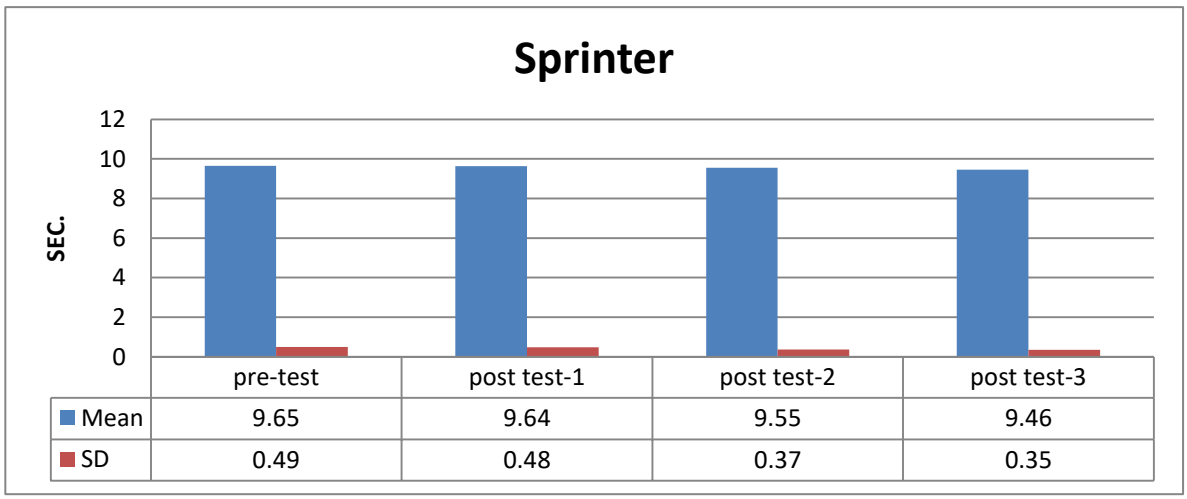

Figure 9: Graphical representation of Mean and SD of 4x10 meter Shuttle Run (sprinter)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 4x10 mt. shuttle run(sprinter) performance was concerned.

Table No. 4.9.2

Repeated Measures ANOVA Results of 4x10 meter Shuttle Run (Sprinter)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.28	0.09	5.91	.003	0.40
Residuals	27	0.42	0.02			

The main effect for the within-subjects factor was significant F (3, 27) = 5.91, p = .034, indicating there were significant differences between the values of Pre-Test-S-SR, T1-S-SR, T2-S-SR, and T3-S-SR. The means of the within-subjects factor are presented in Table-4.9.2 and Figure 9.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.9.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-Test-S-SR	T1-S-SR	0.03	0.01	9	2.12	.003
Pre-Test-S-SR	T2-S-SR	0.12	0.07	9	1.89	.298
Pre-Test-S-SR	T3-S-SR	0.21	0.07	9	2.99	.061
T1-S-SR	T2-S-SR	0.10	0.06	9	1.46	.495
T1-S-SR	T3-S-SR	0.18	0.07	9	2.63	.105
T2-S-SR	T3-S-SR	0.09	0.02	9	2.58	.006

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 levels of significance.

Within Effects. Test1-S-SR was significantly greater than Pre Test-S-SR, $t(9) = 5.12$, $p = .003$ and T3-S-SR was significantly greater than T2-S-SR, $t(9) = 4.58$, $p = .006$. Table no.-4.9.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of plyometric. But there was so difference between different post-tests so far as 4x10 mt. shuttle run (sprinter) performance was concerned.

Present study showed that Pre-test performance of Sprinters in SR was lower than their performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-1 and Test-2 score so far as SR performance was concerted after the treatment. The differences were found more or less significant in many cases.

Miller, et al. (2006) Conducted a study that was to compare on agility among athletes owing to plyometric training. The subjects were divided into plyometric and control groups. The subjects were tested on agility using T agility and Illinois agility test, collected and analyzed using ANCOVA. The results of this study reveal that plyometric training significantly improved agility.

In that study it was shown that pre teat mean greater than three post test means but all the differences were not significant so far as agility performance was concerned. **Tendulkar, S. S. et al. (2018)** concluded a study relating to effect of plyometric training on agility of Footballers and they concluded that plyometric training is helpful in improving agility in football players. At the same time they recommended the training methods for the football players for improving speed and skilled performances. In present study is very much relevant to the above studies.

The present study clearly showed that the different post test performances were significantly improved than pre-test performance by the treatment of plyometric training. In this context, less time indicates betterment of the performance of agility (sprinter). In different post-test, gradually decreased of speed time means the performance of agility (sprinter) enhanced. That’s why it was clear that the plyometric training is very effective improvement for the teen-age athletes (sprinter) performance.

4.10. REPEATED MEASURES ANOVA FOR JUMPER (4X10 MT. SHUTTLE RUN)

The mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.10.1.

Table No. 4.10.1

Mean and SD Table for Within-Subject Variables of Agility (Jumper)

Variable	MEAN(SEC)	SD
Pre -Test-J-SR	9.52	0.41
T1-J-SR	9.50	0.41
T2-J-SR	9.48	0.40
T3-J-SR	9.41	0.40

Note. n = 10.

Table- 10.1 showed the Mean and SD of the standing broad jump performance of the jumpers in Pre-Test, Test-1, Test-2, and Test-3.

Figure 10

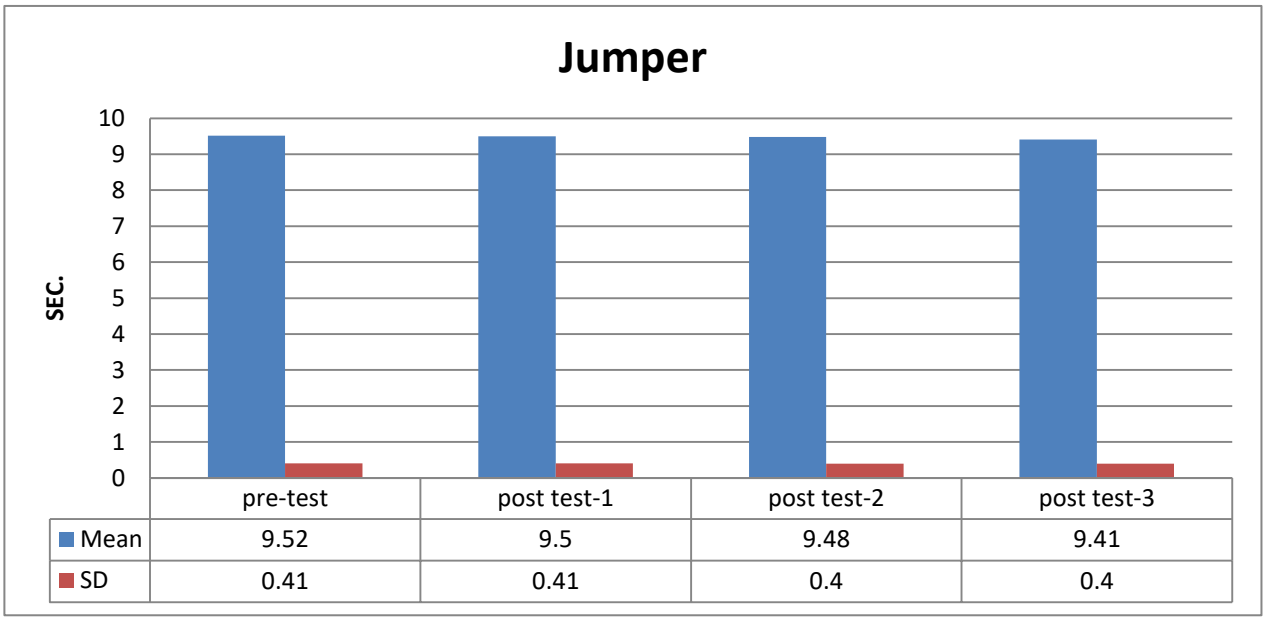

Figure 10: Graphical Representation of Mean and SD of 4x10 meter Shuttle Run (Jumper)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 4x10 mt. shuttle run(jumper) performance was concerned.

Table No.4.10.2

Repeated Measures ANOVA Results of 4x10 meter Shuttle Run (Jumper)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.07	0.02	13.05	< .001	0.59
Residuals	27	0.05	0.00			

The main effect for the within-subjects factor was significant F (3, 27) = 13.05, p = .001, indicating there were significant differences between the values of Pre-Test-J-SR, T1-J-SR, T2-J-SR, and T3-J-SR. Table4.10.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table-4.10.2 and Figure 10.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. – 4.10.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	p
Pre-Test-J-SR	T1_J_SR	0.03	0.01	9	3.56	.026
Pre-Test-J-SR	T2-J-SR	0.05	0.01	9	3.29	.039
Pre-Test-J-SR	T3-J-SR	0.12	0.03	9	4.51	.007
T1-J-SR	T2-J-SR	0.02	0.01	9	2.16	.205
T1-J-SR	T3-J-SR	0.09	0.03	9	3.53	.027
T2-J-SR	T3-J-SR	0.07	0.02	9	2.81	.080

Note. Tukey Comparisons were used to test the differences in estimated marginal means.

**Significance was judged at 0.05 levels of significance.

Within Effects. Pre-Test-J-SR was significantly lower than T1-J-SR, t(9) = 3.56, p = .026, Pre-Test-J-SR was significantly lower than T2-J-SR, t(9) = 3.29, p = .039, Pre-Test-J-SR was significantly lower than T3-J-SR, t(9) = 4.51, p = .007, and T3-J-SR was significantly greater than T1-J-SR, t(9) = 3.53, p = .027. Table-4.10.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of plyometric. But there was so difference between different post tests so far as 4x10 mt. shuttle run (jumper) performance was concerned.

Present study showed that Pre test performance of Jumpers in SR was lower than their performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-1 and Test-2 score so far as SR performance was concerted after the treatment. The differences were found more or less significant in many cases. .

Rameshkannan, S. and Chittibabu, B. (2014) conducted a research aimed to investigate the effect of 8-weeks of plyometric onagility of male handball players. In that study 0.60 sec (4.91%) improvement was noticed in plyometric training group on agility. That findings were in accordance with Miller et al., (2006); Robinson and Owens, (2004); Young, McDowell, Scarlett, (2001); Alricsson, Harms-Ringdahl and Werner, (2001); Ebben, (2002); Bal, Kaur, Singh, (2011); Asadi and Arazi, (2012); Shallaby, (2010); Lim, Wee, Chan and Ler, (2012). They concluded that Plyometric training showed well improved performance in agility tests either because of better motor recruitment or neural adaptations. At the same time our findings on agility performance of the subjects is very much relevant to the above studies. But at the same time the result of our study showed additional improvement in case of Jumpers after treatment in comparison to the sprinters so far as agility performance was concerned.

The present study clearly showed that the different post test performances were significantly improved than pre-test performance by the treatment of plyometric training. In this context, less time indicates betterment of the performance of agility (jumper). In different post-test, gradually decreased of time means the performance of agility (jumper) enhanced. That's why it was clear that the uniform plyometric training is very effective improvement for the teen-age athletes (jumper) performance.

4.11. REPEATED MEASURES ANOVA FOR THROWER (4X10 MT. SHUTTLE RUN)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.11.1.

Table No. 4.11.1

Means Table for Within-Subject Variables of Agility (Thrower)

Variable	MEAN(SEC)	SD
Pre-Test-T-SR	10.35	0.70
T1-T-SR	10.22	0.51
T2-T-SR	10.06	0.50
T3-T-SR	9.98	0.50

Note. n = 10.

Table-4.11.1 showed the Mean and SD of the 4x10 mt shuttle run performance of the thrower in Pre-Test, Test-1, Test-2, and Test-3.

Figure 11

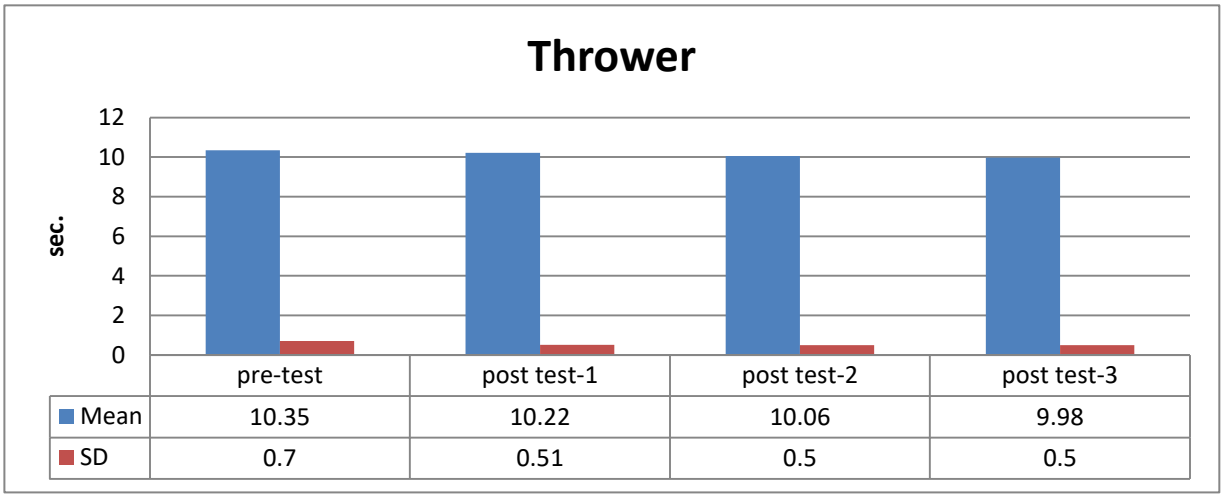

Figure 11: Graphical Representation of Mean and SD of 4x10 meter Shuttle Run (Thrower)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as 4x10 mt. shuttle run(thrower) performance was concerned.

Table No. 4.11.2

Repeated Measures ANOVA Results of 4x10 Shuttle Run (Thrower)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	0.83	0.28	9.95	< .001	0.53
Residuals	27	0.75	0.03			

The main effect for the within-subjects factor was significant F (3, 27) = 9.95, p = .008, indicating there were significant differences between the values of Pre-Test-T-SR, T1-T-SR, T2-T-SR, and T3-T-SR. Table 4.11.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.11.2 and Figure 11.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.11.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	*SE*	*df*	*t*	*p*
Pre-Test-T-SR	T1-T-SR	0.13	0.09	9	1.45	.504
Pre-Test-T-SR	T2-T-SR	0.29	0.10	9	2.75	.088
Pre-Test-T-SR	T3_T_SR	0.38	0.11	9	3.44	.031
T1-T-SR	T2-T-SR	0.16	0.03	9	4.82	.004
T1-T-SR	T3-T-SR	0.24	0.03	9	7.33	< .001
T2-T-SR	T3-T-SR	0.09	0.01	9	6.05	< .001

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 levels of significance.

Within Effects. Pre-Test-T-SR was significantly lower than T3-T-SR, t(9) = 3.44, p = .031, T2-T-SR was significantly greater than T1-T-SR, t(9) = 4.82, p = .004, T3-T-SR was significantly greater than T1-T-SR, t(9) = 7.33, p < .001, and T3-T-SR was significantly

greater than T2-T-SR, $t(9) = 6.05$, $p < .001$. Table-4.11.3 presented the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was evident that the Post-test performances were significantly improved by the treatment of plyometric. But there was so difference between different post tests so far as 4x10 mt. shuttle runs (thrower) performance was concerned.

Present study showed that Pre test performance of Throwers in SR was lower than their performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found lower than the Test-1 and Test-3 score was found lower than the Test-1 and Test-2 score so far as SR performance was concerted after the treatment. The differences were found more or less significant in many cases.

John Shaji, J. and Isha, S.(2009) conducted the study which demonstrated that dynamic stretching and plyometrics when used in conjunction with one another provided both statistically significant and practically relevant improvement in vertical jump height and agility over a period of 4 weeks in male collegiate basketball players. As we try to relate our study with that study on Basketball players who used their hand and shoulder power to achieve the distance of the ball, our findings are very much authenticated by this study.

Shamshuddin, M. H. B. et al. (2020) concluded that six weeks of plyometric training would improve the agility of recreational football players. They also concluded that the increase in sprint time among recreational footballers after six weeks of plyometric training was most likely due to improvement of the drive control and stretch-shortening capacity or musculo-skeletal rigidity because of improved leg explosive strength and Plyometric training improved the performance of the sprint, especially from 10 m to 40 m. In present study is very much relevant to the above study so far as agility performance of the throwers is concerned.

The present study clearly showed that the different post test performances were significantly improved than pre-test performance by the treatment of plyometric training. In this context, less time indicates betterment of the performance of agility (thrower). In different post-test, gradually decreased of time means the performance of agility (thrower) enhanced. That's why it was clear that the uniform plyometric training is very effective improvement for the teen-age athletes (thrower) performance.

4.12. REPEATED MEASURES ANCOVA FOR TEST-3(4X10 MT. SHUTTLE RUN):

A repeated measures Analysis of Covariance (ANCOVA) with one within-subjects factor was conducted to determine whether significant differences exist among T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR after controlling for Pre-S-SR, Pre-J-SR, Pre-T-SR, and Pre-C-SR.

Table No. 4.12.1

Repeated Measures ANCOVA Results for Pre Test and Post Test-3(4x10 mt. Shuttle Run)

Source	df	SS	MS	F	p	η_p^2
Between-Subjects						
Pre-S-SR	1	150.65	150.65	23.93	.005	0.83
Pre-J-SR	1	67.61	67.61	10.74	.022	0.68
Pre-T-SR	1	6.56	6.56	1.04	.354	0.17
Pre-C-SR	1	23.69	23.69	3.76	.110	0.43
Residuals	5	31.47	6.29			
Within-Subjects						
Within Factor	3	26.04	8.68	0.94	.444	0.16
Pre-S-SR:Within.Factor	3	67.08	22.36	2.43	.106	0.33
Pre-J-SR:Within.Factor	3	37.03	12.34	1.34	.298	0.21
Pre-T-SR:Within.Factor	3	5.37	1.79	0.19	.898	0.04
Pre-C-SR:Within.Factor	3	186.27	62.09	6.75	.004	0.57
Residuals	15	138.04	9.20			

The results were examined based on an alpha of 0.05. The covariate, Pre-S-SR, was significantly related to T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR, $F(1, 5) = 23.93$, $p = .005$. The covariate, Pre-J-SR, was significantly related to T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR, $F(1, 5) = 10.74$, $p = .022$. The covariate, Pre-T-SR, was significantly related to T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR, $F(1, 5) = 1.04$, $p = .354$. The covariate, Pre-C-SR, was not significantly related to T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR, $F (1, 5) = 3.76$, $p = .110$. The main effect for the within-subjects factor was significant $F (3, 15) = 0.94$, $p = .444$, indicating the values of T3-S-SR, T3-J-SR, T3-T-SR, and T3-C-SR were all similar. Table 4.12.1 presented the ANCOVA results.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.12.2

A Comparision of Post Test-3(4x10mt. Shuttle Run) for Sprinter, Jumper and Throwers Group

Contrast		Difference	SE	df	t	p
T3-S-SR	T3-J-SR	-2.30	0.95	5	-2.42	.191
T3-S-SR	T3-T-SR	4.10	1.98	5	2.07	.279
T3-S-SR	T3-C-SR	5.30	1.18	5	4.50	.023
T3-J-SR	T3-T-SR	1.80	1.53	5	1.17	.666
T3-J-SR	T3-C-SR	3.00	0.92	5	3.25	.078
T3-T-SR	T3-C-SR	1.20	1.27	5	0.94	.784

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 levels of significance.

Within Effects. T3-S-SR was significantly greater than T3-C-SR, t (5) = 4.50, p = .023. Table 4.12.2 presents the marginal means contrasts for the Repeated Measures ANCOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of polymeric. But there was so difference between different posttests so far as 4x10 mt. shuttle run test performance was concerned.

Table No. 12.3

Analysis of covariance (ANCOVA) for Three Experimental Groups and the Control group with Regard to Agility as Measured by 4x10 meter Shuttle Run (sec) Test.

Group	Pre-test means	Post-test 3 means	Difference between means	Standard error of difference	t-ratio
Sprinter group (experimental)	9.56	9.46	0.19	0.032	5.94
Jumper group (experimental)	9.52	9.41	0.11	0.012	9.17
Thrower group (experimental)	10.35	9.98	0.37	0.065	5.65
Control group	9.67	9.65	0.02	0.022	0.91

*significant was judged at 0.05 level of significance. t=2.09

It is proved from this table that all the three experimental group (sprinter, jumper and thrower) had exhibited significant improvement in the variable agility as measured by 4x10 meter shuttle run test after period of 12-weeks plyometric training as obtained ratio 5.94(sprinter), 9.17(jumper) and 5.69(thrower) respectively were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence except control group (0.91).

Also it also observed from the table that the experimental group of jumper(9.17) had shown much more significant differences between pre-test and final post-test than the experimental group of sprinter(5.94) and thrower(5.69).

Present study showed significant difference between Shuttle Run performance of sprinters and control group. The differences were not significant in all cases. Sprinters mean performance in SR was found lower, after treatment of 12 weeks, than the performances of Jumpers, Throwers as well as than the Control also. At the same time Jumpers mean performance in SR was also found greater than the performance of Throwers and Control also. The mean performance in SR of the Throwers also found greater than the Control. The difference was found more or less significant.

Chaouachi, et al. (2013) Conducted a study was to compare the "Effectiveness of plyometric and its combination with balance training on balance and power parameter in children". The subject were divided into three groups namely, plyometric training group (n=14), combined balance and plyometric training group (n=14) and control group (n=12). Strength, power, speed, static and dynamic balance and agility were tested during eight weeks of training. The combined group showed better improvement in leg stiffness, speed, agility than the other groups.

Pienaar and Coetzee(2013) conducted another study that was to determine "To assess the rugby conditioning program and its combination with plyometric training on selected physical, motor performance and anthropometric measurements". The player were selected from the under 19 rugby teams of the North West University, South Africa. The selected players were divided into experimental group (n=19) and control group (n=16). Anthropometric measurement were taken on 26 sited and a battery test for measuring the physical and motor performance test were conducted. The data was processed by dependent t-test and result showed that the experimental group had significant improvement in wrist breadth, speed, agility and power than the control group.

Present study showed significant differences in Post-Test-3 scores i.e. post test scores after 12 weeks of uniform plyometric treatment. All the groups showed significant improvement in agility performance, which was greater than the control group. There were significant difference between performances of all groups after the adjustment of Pre Test scores of 4 groups. That's why it was cleared that the uniform plyometric training is very effective significant improvement for the teen-age athlete's performance.

4.13. REPEATED MEASURES ANOVA FOR SPRINTER (PULL UP TEST)

The mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.13.1.

Table No. 4.13.1

Means Table for Within-Subject Variables of Shoulder Strength (Sprinter)

Variable	MEAN(NUMBER)	SD
Pre-Test-S-PU	20.20	4.39
T1-S-PU	21.90	4.72
T2-S-PU	21.50	4.97
T3-S-PU	20.40	3.37

Note. n = 10.

Table- 4.13.1 showed the Mean and SD of pull up test performance of the sprinter in Pre-Test, Test-1, Test-2, and Test-3.

Figure13

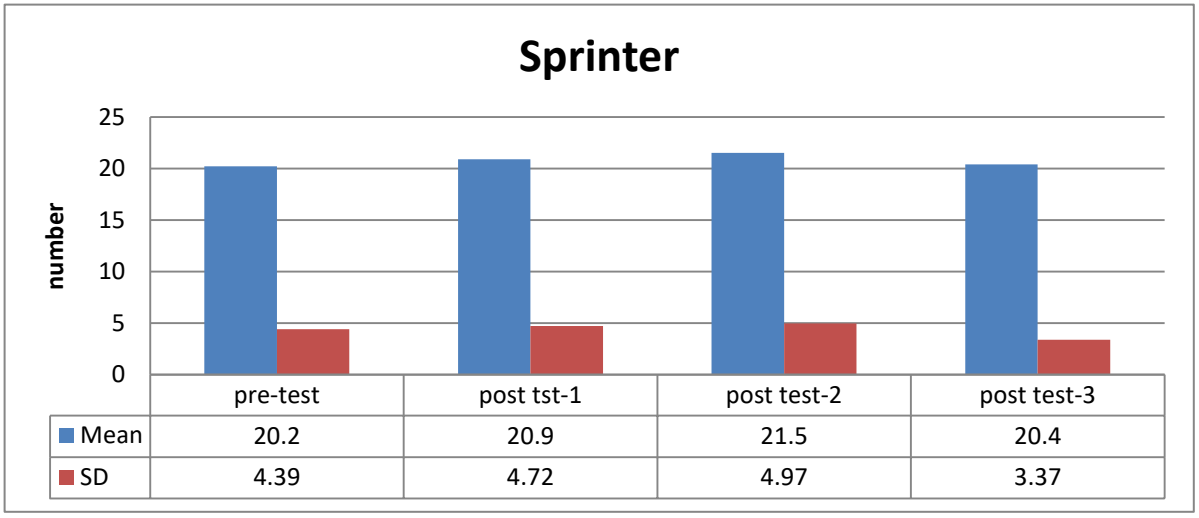

Figure 13: Graphical Representation of Mean and SD of Pull up Test (Sprinter)

A repeated measures analysis of variance (ANOVA) with one within-subjects factor was conducted to determine whether not significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as pull up test(sprinter) performance was concerned.

Table No. 4.13.2

Repeated Measures ANOVA Results of Pull up Test (Sprinter*)*

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	20.60	6.87	1.20	1.327	0.12
Residuals	27	153.90	5.70			

The results were examined based on an alpha of 0.05. The main effect for the within-subjects factor was not significant F (3, 27) = 1.20, p =1.327, indicating the values of Pre-Test-S-PU, T1-S-PU, T2-S-PU, and T3-S-PU were all similar. Table-4.13.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.13.2 and Figure 13.

In present study sprinters showed no improvement in performance after 4, 8 and 12 weeks of treatment so far as Pull-ups activity was concerned.

4.14. REPEATED MEASURES ANOVA FOR JUMPER (PULL UP TEST)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.14.1.

Table No. 4.14.1

Means Table for Within-Subject Variables of Pull up Test (Jumper)

Variable	MEAN(NUMBER)	SD
Pre-Test-J-PU	21.50	3.10
T1-J-PU	23.00	3.23
T2-J-PU	25.40	2.95
T3-J-PU	24.30	3.74

Note. n = 10.

Table- 4.14.1 showed the Mean and SD of the pull up test performance of the jumpers in Pre-Test, Test-1, Test-2, and Test-3.

Figure 14

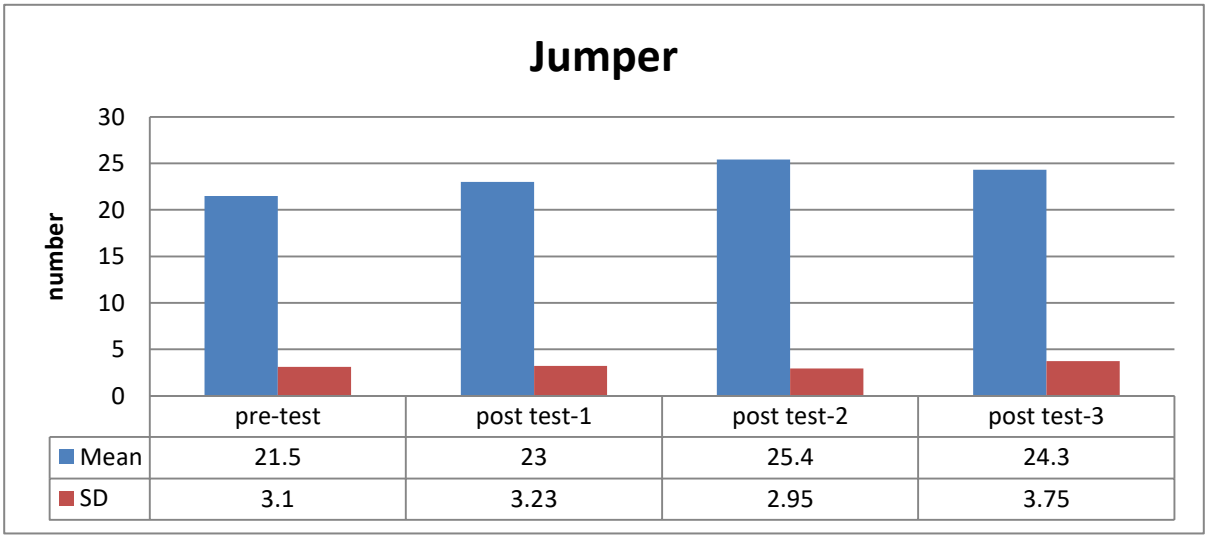

Figure 14: Graphical Representation of Mean and SD of Pull up Test (Jumper)

A repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as pull up test(jumper) performance was concerned.

Table No. 4.14.2

Repeated Measures ANOVA Results of Pull up Test (Jumper)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	84.90	28.30	5.34	.005	0.37
Residuals	27	143.10	5.30			

The main effect for the within-subjects factor was significant F (3, 27) = 5.34, p = .033, indicating there were significant differences between the values of Pre-Test-J-PU, T1-J-PU, T2-J-PU, and T3-J-PU. Table 4.14.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 4.14.2 and Figure 14.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.14.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-Test-J-PU	T1-J-PU	1.50	0.27	9	5.58	.002
Pre-Test-J-PU	T2_J_PU	3.90	0.55	9	7.13	< .001
Pre-Test-J-PU	T3-J-PU	2.80	1.25	9	2.23	.186
T1-J-PU	T2-J-PU	2.40	0.62	9	3.88	.016
T1-J-PU	T3-J-PU	1.30	1.30	9	1.00	.753
T2-J-PU	T3-J-PU	1.10	1.53	9	0.72	.887

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. Pre-Test-J-PU was significantly less than T1-J-PU, t (9) = 5.58, p = .002, Pre-Test-J-PU was significantly less than T2-J-PU, t (9) = 7.13, p < .001, and T1-J-PU was significantly less than T2-J-PU, t (9) = 3.88, p = .016. Table 4.14.3 presented the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was evident that the Post-test performances are significantly improved by the treatment of polymeric. But there was so difference between different post-tests so far as pull up test (jumper) performance was concerned.

Training with plyometric has been extensively used for augmenting jumping performance in healthy individuals. In some cases observed lack of adaptations that may be related to the nature of the selected exercises for plyometric training (Sale, 1992).In present study we measure number of pull up. From the literature for horizontal jumping performance it's observable that plyometric increase performance in both athletes **(Paavolainen et al., 1999; Spurrs et al., 2003)** and non-athletes **(Markovic et al., 2007).** Few studies examined this issue to children and the most of them found enhancement of jumping ability **(Diallo et al., 2001; Lehance et al., 2006; Michailidis et al., 2013)**. Our findings are to accordance with those of Diallo et al. (2001), Kotzamanidis (2006) and Lehance et al. (2006). They found that the performance at some kinds of jump (squat jump, standing long jump and at counter movement jump) improved significantly.

Ashok, et al. (2012) conducted a study that was to investigate "The effect of skill training and its combination of plyometric with skill training on jumping ability, anaerobic capacity and skill performance among volleyball players". For this sixty male volleyball player from various college in coimbatore District, Tamilnadu were selected as subject and divided into plyometric and skill training (20), skill training (20) and control (20). Jumping ability, anaerobic capacity and skill performance were tested during 12 weeks of training programme. The result reveal that the skill training with plyometric significantly improves jumping ability anaerobic capacity and skill performance among volleyball players. In the present study the jumpers showed significant improvement in their pull up performance after 4, 8 and 12 weeks of plyometric treatment.

Present study showed that mean Pre-test performance of Jumpers in Pull up test was lower than their mean performances in Test-1, Test-2 and Test-3 respectively. Mean Test-2 and Test-3 scores were found greater than the Test-1 and Test-3 score was found greater than the Test-1 and Test-2 score so far as SR performance was concerted after the treatment. The differences were found more or less significant in many cases. The results were not satisfactory and require further studies.

Results of this study showed significant improvement in active shoulder flexion and external rotation for Thrower group in favor for the study group; that come in consistent with other studies found improvement in motor performance skills observed with plyometric training.

The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, number of pull up increased indicates betterment of the performance of shoulder strength (jumpers). In different post-test, gradually increased number of pull up means the performance of shoulder strength (jumpers) enhanced. That's why it was clear that the uniform plyometric training is very effective for the improvement of teen-age athletes (jumpers) performance.

4.15. REPEATED MEASURES ANOVA FOR THROWER (PULL UP TEST)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.12.1.

Table No. 4.15.1

Means Table for Within-Subject Variables of Pull up Test (Thrower)

Variable	MEAN(NUMBER)	SD
Pre-Test-T-PU	11.70	2.26
T1-T-PU	11.60	2.22
T2-T-PU	11.30	2.15
T3-T-PU	11.60	2.21

Note. n = 10.

Table- 4.12.1 showed the Mean and SD of the pull up test performance of the thrower in Pre-Test, Test-1, Test-2, and Test-3.

Figure 15

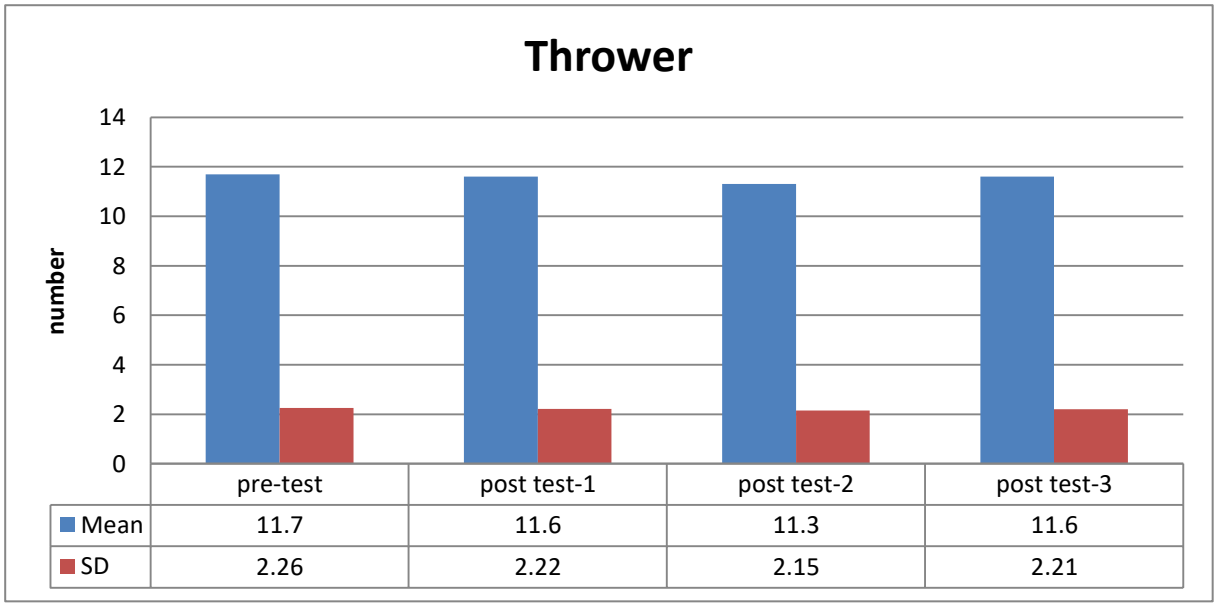

Figure 14: Graphical Representation of Mean and SD of Pull up Test (Thrower)

A repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether not significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as pull up test(thrower) performance was concerned.

Table No. 4.15.2

Repeated Measures ANOVA Results of Pull up Test (Thrower)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	90.90	30.30	0.55	0.601	0.67
Residuals	27	44.10	51.63			

The results were examined based on an alpha of 0.05. The main effect for the within-subjects factor was no significant F (3, 27) = 0.55, p=0.601, indicating there were no significant differences between the values of Pre-Test-T-PU, T1-T-PU, T2-T-PU, and T3-T-PU. Table 15.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 15.2 and Figure 15.

Schulte Edelmann et al. (2005) conducted a study that was to find out the effectiveness of a 6 week plyometric training period on power production of the posterior shoulder and elbow musculature. 28 normal college aged volunteer were divided into control and plyometric training groups. Both groups were pre- and post-tested using shoulder and elbow isokinetic test and the Closed Kinetic chain Upper extremity stability test. The plyometric training group (n=13) showed significant improvement in the power generated in the elbow extensor muscles; however, no other significant changes were observed within this group. The control group (n=15) showed no significant changes in power output over the course of this study. It was concluded that plyometric training of the upper extremity enhances power of the elbow extensor muscles.

Matti Peitz, Michael Behringer, and Urs Granacher, (2018) conducted a study entitled "A systematic review on the effects of resistance and plyometric training on physical fitness in youth- What do comparative studies tell us?" and they argued that comparative studies had shown that different types of strength and plyometric training can be effective. They seem to follow the principle of training specificity and should therefore be designed with respect to the children's or young athletes' needs. When comparing these training types against one another, no clear picture evolves. Nevertheless, a combination of training types will likely result in the largest training-induced improvements in physical fitness. Recently**, Behm et al**. postulated that resistance training should be incorporated at an early age and prior to

power/plyometric training in order to establish an adequate foundation of strength for power training activities. In present study it was found that the plyometric treatment of 4 weeks, 8 weeks and 12 weeks did not effect significantly to the strength and endurance performance of the arm and shoulder muscles of the throwers. As a researcher I think that it was due to the previous training effect that evidently improved the musco-skeletal strength of the thrower, otherwise there was some insufficiency in the formation or design of the exercise structure.

- **4.16. Repeated Measures ANCOVA for Test-3(Pull up Test):**

A repeated measures Analysis of Covariance (ANCOVA) with one within-subjects factor was conducted to determine whether significant differences exist among T3-S-PU, T3-J-PU, T3-T-PU, and T3-C-PU after controlling for Pre-S-PU, Pre-J-PU, Pre-T-PU, and Pre-C-PU.

Table No. 4.16.1

Repeated Measures ANCOVA Results for Pre-Test and Post Test-3 (Pull up Test)

Source	df	SS	MS	F	p	η_p^2
Between-Subjects						
Pre-S-PU	1	22.28	22.28	2.75	.158	0.35
Pre-J-PU	1	0.07	0.07	0.01	.928	0.00
Pre-T-PU	1	6.58	6.58	0.81	.409	0.14
Pre-C-PU	1	36.01	36.01	4.44	.089	0.47
Residuals	5	40.56	8.11			
Within-Subjects						
Within Factor	3	5.94	1.98	0.26	.851	0.05
Pre-S-PU:Within.Factor	3	27.53	9.18	1.22	.338	0.20
Pre-J-PU:Within.Factor	3	34.85	11.62	1.54	.245	0.24
Pre-T-PU:Within.Factor	3	6.38	2.13	0.28	.838	0.05
Pre-C-PU:Within.Factor	3	136.48	45.49	6.03	.007	0.55
Residuals	15	113.10	7.54			

The results were examined based on an alpha of 0.05. The covariate, Pre-S-PU, was not significantly related to T3-S-PU, T3-J-PU, T3-T-PU, and T3-T-PU, $F(1, 5) = 2.75$, $p = .158$. The covariate, Pre-J-PU, was significantly related to T3-S-PU, T3-J-PU, T3-T-PU, and T3-C-PU, $F(1, 5) = 0.01$, $p = .928$. The covariate, Pre-T-PU, was not significantly related to T3-S-

PU, T3-J-PU, T3-T-PU, and T3-C-PU, F(1, 5) = 0.81, p = .409. The covariate, Pre-C-PU, was not significantly related to T3-T-PU, T3-J-PU, T3-T-PU, and T3-C-PU, F (1, 5) = 4.44, p = .089. The main effect for the within-subjects factor was not significant F (3, 15) = 0.26, p = .851, indicating the values of T3-S-PU, T3-J-PU, T3-T-PU, and T3-C-PU were all similar. Table 4.16.1 presents the ANCOVA results.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.16.2

A Comparision of Post Test-3(Pull Up Test) for Sprinter, Jumper and Thrower

Contrast		Difference	SE	df	t	P
T3-S-PU	T3-J-PU	-3.90	1.60	5	-2.43	.188
T3-S-PU	T3-T-PU	4.80	0.90	5	5.31	.012
T3-S-PU	T3-C-PU	1.50	1.04	5	1.45	.527
T3-J-PU	T3-T-PU	8.70	1.63	5	5.34	.012
T3-J-PU	T3-C-PU	5.40	1.25	5	4.32	.027
T3-T-PU	T3-C-PU	-3.30	0.60	5	-5.47	.010

Note. Tukey Comparisons were used to test the differences in estimated marginal means. **Significance was judged at 0.05 levels of significance.

Within Effects. T3-J-PU was significantly greater than T3-T-PU, t(5) = 5.34, p = .012, T3-J-PU was significantly greater than T3-T-PU, t(5) = 4.32, p = .027, and T3-T-PU was significantly less than T3-C-PU, t(5) = -5.47, p = .010. Table 4.16.2 presented the marginal means contrasts for the Repeated Measures ANCOVA. From Post-hoc test it was concluded that the Post-test performances were significantly improved by the treatment of uniform plyometric. But there was so difference between different post tests so far as pull up test performance was concerned.

Table No.16.3

Analysis of covariance (ANCOVA) for Three Experimental Groups and the Control Group with Regard to Shoulder Strength as Measured by Pull up (number) Test.

Group	Pre-test means	Post-test 3 means	Difference between means	Standard error of difference	t-ratio
Sprinter group (experimental)	20.20	20.40	0.90	0.16	1.25
Jumper group (experimental)	21.50	24.30	2.80	0.22	1.81
Thrower group (experimental)	11.70	11.60	0.10	0.085	1.78
Control group	19.30	19.31	0.01	0.022	0.45

*significant was judged at 0.05 level of significance t=2.09

It is proved from this table that all the experimental group (only jumper) had exhibited significant improvement in the variable shoulder strength as measured by pull up test after period of 12-weeks plyometric training as obtained ratio 1.81(jumper), were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence except sprinter (1.25), thrower (1.78) and control group (0.45).

Also it was observed from the table that the experimental group of jumper(12.73) had shown much more significant differences between pre-test and final post-test than the experimental group of sprinter(1.25) and thrower(1.78).

Present study showed that Pull ups performance of all the groups changed after the treatment and performance of all three groups were different as well as greater than the performance of the control group. Significant difference found among performances of more or less all groups in Pull ups. After 12 weeks of plyometric treatment Sprinters and Throwers shows greater performance improvement in comparison to others.

Sprinters mean performance in PU was found lower, after treatment of 12 weeks, than the performances of Jumpers, and lower than the Throwers as well as than the Control also. At the same time Jumpers mean performance in PU was also found greater than the performance of Throwers and Control also. The mean performance in PU of the Throwers also found greater than the Control. The difference was found more or less significant.

Wilson, Murphy and Giorgi (1996) conducted a study that was to determine performed in an effort to again greater insights into the adaptation invoked by plyometric and weight training.

The following test items were performed prior to and after the completion of the training period: (a) vertical jump, (b) a series of is inertial concentric and eccentric tests, (c) push –up test, and (d) maximal bench press and squat lifts. The results do indicate that plyometric training significantly enhanced the rate of eccentric lower body force production. The weight-training group primarily enhanced concentric function. The result of present study is relevant to the above study. The control group showed less performance improvement so far as Pull ups performance was concerned.

Schulte Edelmann et al. (2005) conducted a study that was to find out the effectiveness of a 6 week plyometric training period on power production of the posterior shoulder and elbow musculature. 28 normal college aged volunteer were divided into control and plyometric training groups. Both groups were pre- and post-tested using shoulder and elbow isokinetic test and the Closed Kinetic chain Upper extremity stability test. The plyometric training group (n=13) showed significant improvement in the power generated in the elbow extensor muscles; however, no other significant changes were observed within this group. The control group (n=15) showed no significant changes in power output over the course of this study. It was concluded that plyometric training of the upper extremity enhances power of the elbow extensor muscles. The result of above studies significantly related to present study.

- **4.17. Repeated Measures ANOVA for Sprinter (Reaction Time Test)**

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.16.1.

Table No. 4.17.1

Means and SD Table for Within-Subject Variables of Reaction Time (Sprinter)

Variable	MEAN(SEC)	SD
Pre Test-S-RTT	73.30	6.04
T1-S-RTT	72.50	4.62
T2-S-RTT	72.20	4.24
T3-S-RTT	71.10	5.69

Note. n = 10.

Table- 4.17.1 showed the Mean and SD of reaction time test performance of the sprinter in Pre-Test, Test-1, Test-2, and Test-3.

Figure 17

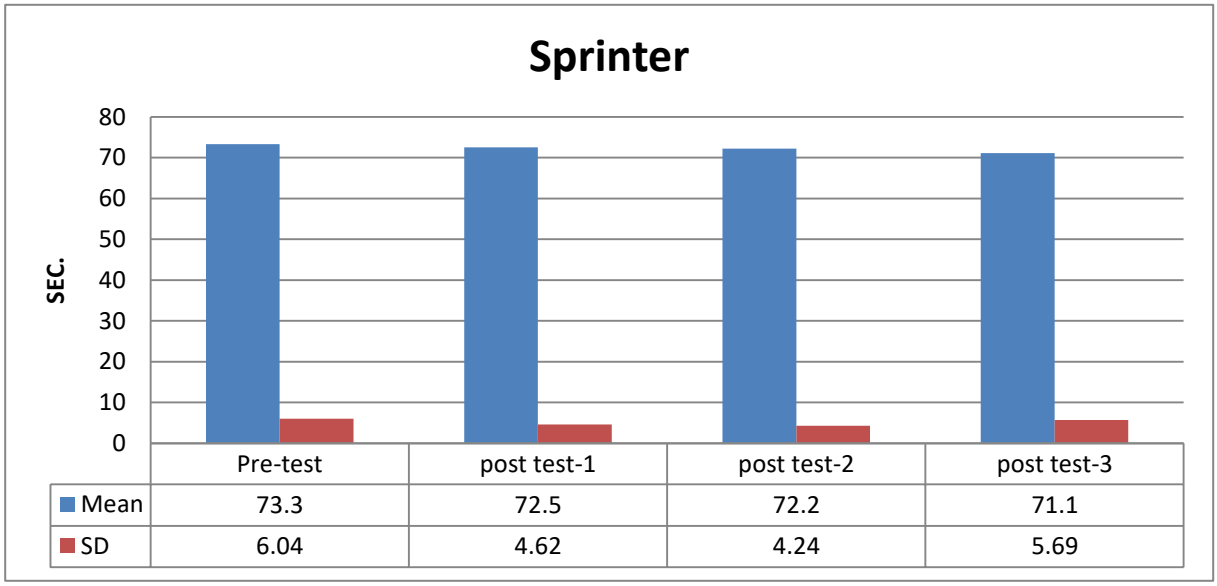

Figure 17: Graphical Representation of Mean and SD of Reaction Time Test (Sprinter)

A repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test , Test-1, Test-2, and Test-3 so far as reaction time test(sprinter) performance was concerned.

Table No. 4.17.2

Repeated Measures ANOVA Results of Reaction Time Test (Sprinter*)*

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	210.88	70.29	21.12	< .001	0.70
Residuals	27	89.87	3.33			

The main effect for the within-subjects factor was significant F (3, 27) = 21.12, p < .001, indicating there were significant differences between the values of T1-S-RTT, T2-S-RTT, T3-S-RTT, and Pre-S-RTT. Table 17.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table 17.2 and Figure 17.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.17.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
T1-S-RTT	T2-S-RTT	2.20	0.70	9	3.16	.047
T1-S-RTT	T3-S-RTT	3.90	1.04	9	3.76	.019
T1-S-RTT	Pre-S-RTT	2.20	0.49	9	4.49	.007
T2-S-RTT	T3-S-RTT	1.70	0.56	9	3.04	.056
T2-S-RTT	Pre-S-RTT	4.40	0.73	9	6.00	< .001
T3-S-RTT	Pre-S-RTT	6.10	1.16	9	5.26	.002

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. T1-S-RHR was significantly less than T2-S-RTT, $t(9) = 3.16$, $p = .047$, T1-S-RTT was significantly less than T3-S-RTT, $t(9) = 3.76$, $p = .019$, T1-S-RTT was significantly greater than Pre-S-RTT, $t(9) = 4.49$, $p = .007$, T2-S-RTT was significantly greater than Pre-S-RTT, $t(9) = 6.00$, $p < .001$, and T3-S-RTT was significantly greater than Pre-S-RTT, $t(9) = 5.26$, $p = .002$. Table-4.17.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of uniform polymeric. But there was so difference between different posttests so far as reaction time performance was concerned.

Considering the important role of plyometric exercise and training for improving muscular performance, the effects of this exercise on cardiovascular responses is important and few studies have focused on this area and information about this aspect is little and scarce.

In a study by **Arazi, H. et al. (2013),** the researchers found that it is possible that Plyometric exercises induces a reduction in sympathetic nerve activity to the heart and blood vessels during the recovery period. **Chen et al. (1995)** observed a decrease in sympathetic tone to the

heart after mild exercise in spontaneously hypertensive rats and **Floras et al. (1989)** and **Halliwill et al. (1996)** found a significant decrease in muscle sympathetic nerve activity after acute exercise in hypertensive and normotensive humans.

Previous authors observed that after an acute bout of exercise, baro reflex control of heart rate and blood vessels is distinctly regulated. In other words, sympathetic drive to the heart increases, while sympathetic drive to blood vessels decreases. Thus, it is possible that different exercise intensities may distinctly affect the baro reflex control of heart rate, but not the bar reflex control of blood vessels. Moreover, the vasodilatory response and/or the decrease in blood volume may play a role in the post-exercise blood pressure fall. It is well understood that muscle metabolites and heat accumulation are directly related to exercise intensity, and sweating rate is greater during intense exercise. In addition, the increased local muscle metabolites and/or heat production are also potential stimuli for the increased heart rate responses after Plyometric exercises. On the other hand, a decrease in muscle cell pH following Plyometric exercises may stimulate chemo sensitive afferent fibers, thereby elevating HR. The forces and intensity of Plyometric exercises, greater involvement of the fast-twitch muscle fibers and size of activated muscle mass may also stimulate increases in HR and BP.

Binthu Mathavan, S. (2016) concluded a study that variables such as reaction time and resting rate had been positively influenced by plyometric training to men soccer players. He also concluded that this results showed that the given plyometric training was suitable for developing positively for above said resting heart rate and respiratory rate variables. The present study is very much relevant to the above study.

The present study clearly showed that the different post test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of reaction time (sprinter). In different post-test, gradually decreased of time means the performance of reaction time (sprinter) enhanced. That’s why it was proved that the uniform plyometric training was very effective improvement for the teen-age athletes (sprinter) performance.

4.18. REPEATED MEASURES ANOVA FOR JUMPER (REACTION TIME TEST)

The Mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table: 4.18.1.

Table No. 4.18.1

Means and SD Table for Within-Subject Variables of Reaction Time (Jumper)

Variable	MEAN(SEC)	SD
Pre-J-RTT	71.90	5.55
T1-J-RTT	71.60	5.23
T2-J-RTT	70.60	4.20
T3-J-RTT	69.90	3.57

Note. n = 10.

Table- 4.18.1 showed the Mean and SD of reaction time test performance of the jumper in Pre-Test, Test-1, Test-2, and Test-3.

Figure 18

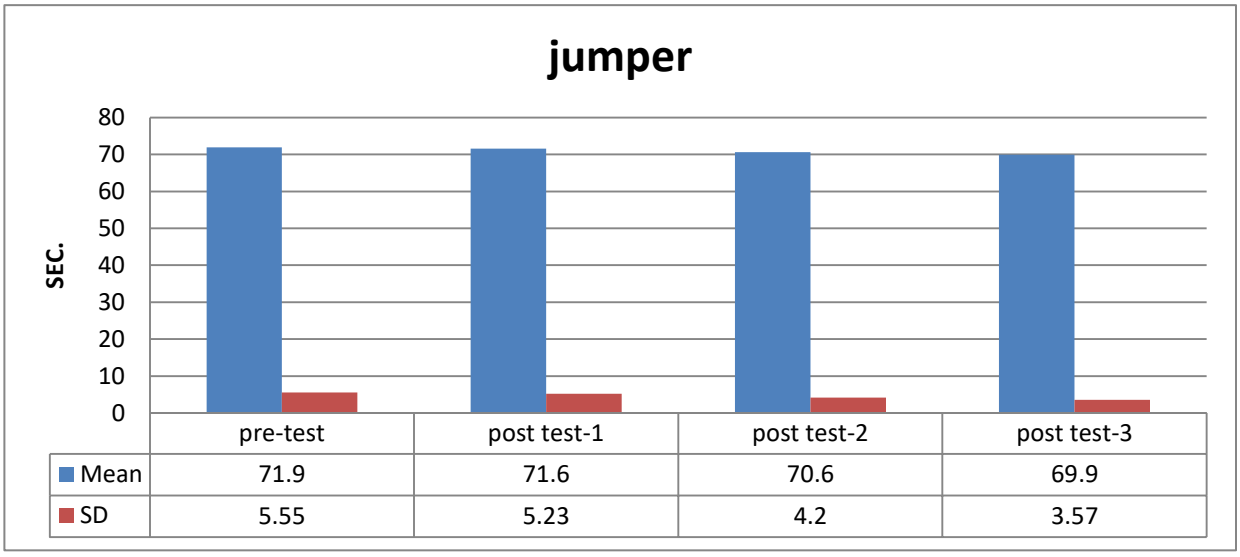

Figure 18: Graphical Representation of Mean and SD of Reaction Time Test (Jumper)

A repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test, Test-1, Test-2, and Test-3 so far as reaction time test (jumper) performance was concerned.

Table No. 4.18.2

Repeated Measures ANOVA Results of Reaction Time (Jumper)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	50.90	16.97	6.22	.002	0.41
Residuals	27	73.60	2.73			

The main effect for the within-subjects factor was significant F (3, 27) = 6.22, p = .021, indicating there were significant differences between the values of Pre-J-RTT, T1-J-RTT, T2-J-RTT, and T3-J-RTT. Table-4.18.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table-4.18.2 and Figure -18.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.18.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	p
Pre-J-RTT	T1-J-RTT	0.70	0.33	9	2.09	.227
Pre-J-RTT	T2-J-RTT	1.70	0.65	9	2.61	.107
Pre-J-RTT	T3-J-RTT	3.00	1.01	9	2.97	.063
T1-J-RTT	T2-J-RTT	1.00	0.54	9	1.86	.308
T1-J-RTT	T3-J-RTT	2.30	1.03	9	2.23	.188
T2-J-RTT	T3-J-RTT	1.30	0.60	9	2.18	.201

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. Significant differences were found between Pre-J-RTT, T1-J-RTT, T2-J-RTT, and T3-J-RTT. Table-4.18.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are

significantly improved by the treatment of uniform plyometric. But there was so difference between different post-tests so far as reaction time test performance was concerned.

The present studies showed that Pre Test mean was significantly lower that mean of Test-1 data and Test-3 data. At the same time mean of Test-2 data was significantly lower than the mean of Test-3 data so far as reaction time test was concerned.

Anitha, J. (2017) concluded that twelve weeks Plyometric training significantly improved the Breath holding time and reaction time of the inter collegiate male Volleyball players. She also concluded that Plyometric training is one among the most appropriate means to bring about the desirable changes over motor fitness variables of Volleyball players. She recommended and suggested that coaches and the experts deal with Volleyball players to incorporate Plyometric training as a component in their training programme.

Vishnu Raj R. (2017) had conducted a study entitled with "Effect of plyometric training on selected physical and physiological variables among college level volleyball players". From the result of the study, he speculated that the observed changes in speed, explosive power, Breath Holding Time, Resting Heart Rate may properly designed Plyometric training which are suitable for men Volleyball players at college level. The present study is relevant to that study and authenticated by the result. Though volleyball players are possessing jumping ability, therefore we may authenticated the result of present study by the findings of above study.

The present study clearly showed that the different post test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of reaction time (jumper). In different post-test, gradually decreased of time means the performance of reaction time (jumper) enhanced. That's why it was clear that the uniform plyometric training is very effective improvement for the teen-age athletes (jumper) performance.

4.19. REPEATED MEASURES ANOVA FOR THROWER (REACTION TIME TEST)

The mean and SD of the Pre-test, Test-1, Test-2 and Test-3 performance variable have been presented in Table:-4.19.1.

Table No. 4.19.1

Means Table for Within-Subject Variables of Reaction Time (Thrower)

Variable	MEAN(SEC)	SD
Pre-T-RTT	75.80	4.76
T1-T-RTT	74.40	4.65
T2-T-RTT	72.60	2.91
T3-T-RTT	71.60	3.24

Note. n = 10.

Table- 4.19.1 showed the Mean and SD of reaction time test performance of the thrower in Pre-Test, Test-1, Test-2, and Test-3.

Figure 18

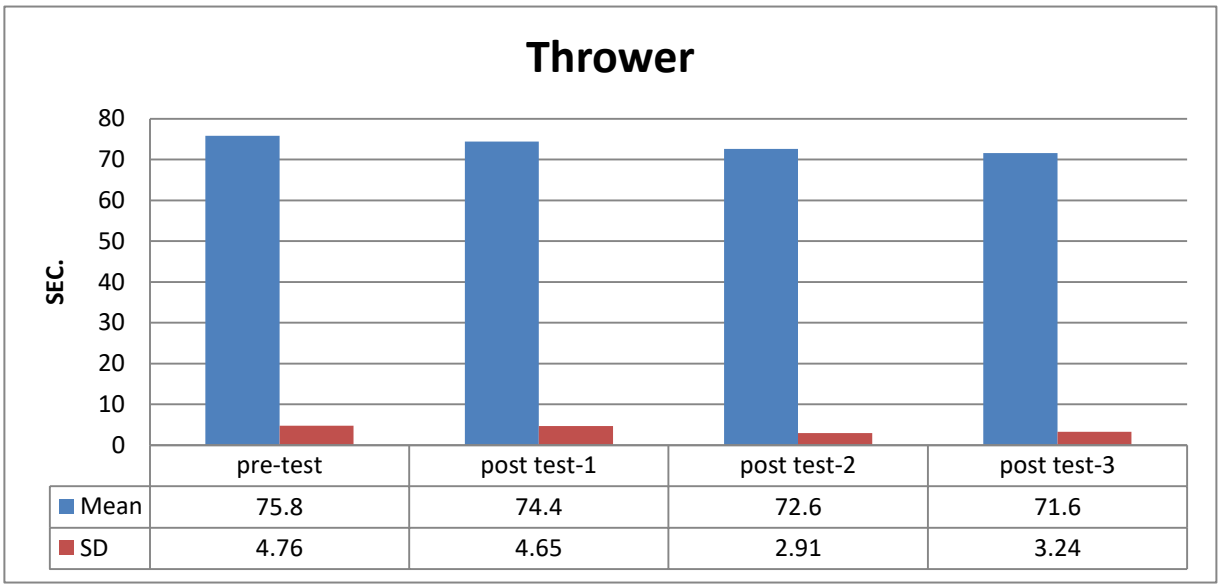

Figure 19: Graphical Representation of Mean and SD of Reaction Time Test (Thrower)

A repeated measures Analysis of Variance (ANOVA) with one within-subjects factor was conducted to determine whether significant differences exist among Pre Test, Test-1, Test-2, and Test-3 so far as reaction time test (thrower) performance is concerned.

Table No. 4.19.2

Repeated Measures ANOVA Results of Reaction time Test (Thrower)

Source	df	SS	MS	F	p	η_p^2
Within-Subjects						
Within Factor	3	86.80	28.93	6.26	.002	0.41
Residuals	27	124.70	4.62			

The main effect for the within-subjects factor was significant F (3, 27) = 6.26, p = .016, indicating there were significant differences between the values of Pre-T-RTT, T1-T-RTT, T2-T-RTT, and T3-T-RTT. Table-4.19.2 presented the ANOVA results. The means of the within-subjects factor are presented in Table -4.19.2 and Figure 19.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.19.3

The Marginal Means Contrasts for each Combination of Within-Subject Variables for the Repeated Measures ANOVA

Contrast		Difference	SE	df	t	P
Pre-T-RTT	T1-T-RTT	0.60	0.31	9	1.96	.269
Pre-T-RTT	T2-T-RTT	0.80	1.32	9	0.60	.928
Pre-T-RTT	T3-T-RTT	3.80	0.74	9	5.12	.003
T1-T-RTT	T2-T-RTT	0.20	1.23	9	0.16	.998
T1-T-RTT	T3-T-RTT	3.20	0.71	9	4.50	.007
T2-T-RTT	T3-T-RTT	3.00	1.06	9	2.82	.079

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. Pre-T-RTT was significantly less than T3-T-RTT, t (9) = 5.12, p = .003 and T1-T-RTT was significantly less than T3-T-RTT, t (9) = 4.50, p = .007. Table-4.19.3 presents the marginal means contrasts for the Repeated Measures ANOVA. From Post-hoc test it was concluded that the Post-test performances are significantly improved by the treatment of

plyometric. But there was so difference between different post-tests so far as reaction time test performance was concerned.

The present studies showed that Pre Test performance of RTT was lower than performance of Test-1, Test-2 and Test-3 data. But the difference was found significant only between Pre Test and Test-3. At the same time mean of Test-1 data was found lower than the means of Test- 2 and Test-3 data, but the difference was found significant only between Test-1 and Test-3 so far as Reaction time test was concerned. Mean Test-2 result was found lower than the result of Test-3, but the difference was not significant. The result was satisfactory and further study should be conducted with modified design of treatment.

Senthil, P. (2015) concluded that a plyometric exercise (PE) can reduce SBP and DBP post-exercise and therefore we can say that PE has significant effects for reducing BP and HR or post-exercise hypotension. **Gi Duck Park,(2014)** PhD et al., also conducted study about the physical strength elements required for athletic throwing events include muscle strength, swiftness, agility, speed, flexibility, and physical balance. Although plyometric training and weight training are implemented as representative training methods for improving swiftness and agility, most studies of it have been conducted with players of other sports. They concluded that Plyometric training positively affected high school throwing event athletes. To summarize the study findings, the application of plyometric training with high intensity and loads improved the results of athletes who perform highly intensive exercises at normal times. The result of present study is significantly related to the above findings.

The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of reaction time (thrower). In different post-test, gradually decreased of time means the performance of reaction time (thrower) enhanced. That's why it was clear that the uniform plyometric training is very effective improvement for the teen-age athletes (thrower) performance.

4.20. REPEATED MEASURES ANCOVA FOR TEST-3(REACTION TIME TEST):

A repeated measures Analysis of Covariance (ANCOVA) with one within-subjects factor was conducted to determine whether significant differences exist among T3-S-RTT, T3-J-RTT,

T3-T-RTT, and T3-C-RTT after controlling for Pre-S-RTT, Pre-J-RTT, Pre-T-RTT, and Pre-C-RTT.

Table No. 4.20.1

Repeated Measures ANCOVA Results for Pre Test and Post Test-3(Reaction Time Test)

Source	df	SS	MS	F	p	η_p^2
Between-Subjects						
Pre-S-RTT	1	9.29	9.29	2.48	.176	0.33
Pre-C-RTT	1	25.19	25.19	6.72	.049	0.57
Pre-J-RTT	1	30.11	30.11	8.03	.037	0.62
Pre-T-RTT	1	18.73	18.73	4.99	.076	0.50
Residuals	5	18.75	3.75			
Within-Subjects						
Within Factor	3	6.71	2.24	2.38	.767	0.07
Pre-S-RTT:Within.Factor	3	108.32	36.11	6.18	.006	0.55
Pre-C-RTT:Within.Factor	3	102.49	34.16	5.85	.007	0.54
Pre-J-RTT:Within.Factor	3	60.74	20.25	3.47	.043	0.41
Pre-T-RTT:Within.Factor	3	29.94	9.98	1.71	.208	0.25
Residuals	15	87.59	5.84			

The results were examined based on an alpha of 0.05. The covariate, Pre-S-RTT, was significantly related to T3-S-RTT, T3-J-RTT, T3-T-RTT, and T3-C-RTT, $F(1, 5) = 2.48$, $p = .176$. The covariate, Pre-C-RTT, was significantly related to T3-S-RTT, T3-J-RTT, T3-T-RTT, and T3-C-RTT, $F(1, 5) = 6.72$, $p = .049$. The covariate, Pre-J-RTT, was significantly related to T3-S-RTT, T3-J-RTT, T3-T-RTT, and T3-C-RTT, $F (1, 5) = 8.03$, $p = .037$. The covariate, Pre-T-RTT, was significantly related to T3-S-RTT, T3-J-RTT, T3-T-RTT, and T3-C-RTT, $F(1, 5) = 4.99$, $p = .076$. The main effect for the within-subjects factor was significant $F(3, 15) = 2.38$, $p = .767$, indicating the values of T3-S-RTT, T3-J-RTT, T3-T-RTT, and T3-C-RTT were all similar. Table -4.20.1 presented the ANCOVA results.

Post-hoc. The mean contrasts utilized Tukey comparisons based on an alpha of 0.05. Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject effects.

Table No. 4.20.2

A Comparision of Post Tst-3(Reaction Time Test) for Sprinter, Jumper and Throwers Group.

Contrast		Difference	SE	df	t	P
T3-S-RTT	T3-J-RTT	1.70	1.36	5	1.25	.628
T3-S-RTT	T3-T-RTT	2.40	1.17	5	2.05	.283
T3-S-RTT	T3-C-RTT	10.50	1.52	5	6.93	.004
T3-J-RTT	T3-T-RTT	0.70	0.55	5	1.27	.613
T3-J-RTT	T3-C-RTT	12.20	0.88	5	13.89	< .001
T3-T-RTT	T3-C-RTT	12.90	0.64	5	20.11	< .001

Note. Tukey Comparisons were used to test the differences in estimated marginal means. ∗∗Significance was judged at 0.05 levels of significance.

Within Effects. T3-S-RTT was significantly greater than T3-C-RTT, t (5) = 6.93, p = .004, T3-J-RTT was significantly greater than T3-C-RTT, t(5) = 13.89, p < .001, and T3-T-RTT was significantly greater than T3-C-RTT, t(5) = 20.11, p < .001. Table 4.20.2 presented the marginal means contrasts for the Repeated Measures ANCOVA. From Post-hoc test it was evident that the Post-test performances are significantly improved by the treatment of uniform plyometric. But there was so difference between different post tests so far as reaction time test performance was concerned.

Table No. 4.20.3

Analysis of Covariance (ANCOVA) for Three Experimental Groups and the Control Group with Regard to Reaction Time Test as Measured by Nelson Choice Movement Response Reaction Test (sec) Test.

Group	**Pre-test means**	**Post-test 3 means**	**Difference between means**	**Standard error of difference**	**t-ratio**
Sprinter group (experimental)	73.30	71.10	2.20	0.32	6.8
Jumper group (experimental)	71.90	69.90	2.00	0.43	4.65
Thrower group (experimental)	75.80	71.60	4.20	0.37	11.35
Control group	74.30	74.20	0.20	0.12	1.67

*significance was judged at 0.05 level of significance t=2.09

It is proved from this table that all the three experimental group (sprinter, jumper and thrower) had exhibited significant improvement in the variable reaction time as measured by nelson choose movement response reaction test after period of 12-weeks plyometric training as obtained ratio 6.87(sprinter), 4.65(jumper) and 11.35(thrower) respectively were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence except control group (1.67).

Also it was observed from the table that the experimental group of thrower(11.35) had shown much more significant differences between pre-test and final post-test than the experimental group of sprinter(6.87) and jumper(4.65).

Present study showed that RTT result of all the groups changed after the treatment and performance of all three groups were different as well as greater than the performance of the control group. Significant difference found among performances of more or less all groups in RTT. After 12 weeks of plyometric treatment Sprinters and Throwers showed greater performance improvement in comparison to others.

Present study showed significant differences in Test-3 scores i.e. post test scores after 12 weeks of uniform plyometric treatment. All the groups showed significant improvement in reaction time performance, which was greater than the control group. There appeared significant difference between performances of all groups after the adjustment of Pre Test scores of 4 groups. That's why it was clear that the uniform plyometric training is very effective significant improvement for the teen-age athlete's performance.

4.21 TESTING OF HYPOTHESIS:

The formulated hypothesis is rejected as because the result established that, the 3 months uniform plyometric training produced significant improvement in speed, agility, power, shoulder strength and reaction time for teen-age sprinter, jumper and throwers.

CHAPTER-V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER-V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF THE STUDY:

The ability of plyometric training to improve athletic performance, particularly in sprinter, jumper and thrower continuously a matter of discussion in the field of sports training. Many researchers have searched and still searching the mysteries of plyometric training. Based on scientific discoveries, today we are at the passion that with proper preparation, instruction and progressions, uniform plyometric training can be an effective method to train athletes for motor fitness and physiological performance. But "Research" always tries to 'Re' and 'Search' the fact with innovative ideas and under new settings.

The purpose of the study was to investigate the effect of uniform plyometric training on motor fitness parameters of teen-age athletes. To achieve these purpose forty state level (school games) athletes were selected at randomly from barasat athletic coaching center, Barasat, North 24 parganas, West Bengal. Their age ranged from 14-19 years. They were divided into four groups of 10 subjects each at random. The different experimental groups are group-I(sprinters),group-II(jumpers), group-III(thrower) and group-IV(control); the control group was consisted of four sprinters, three jumpers and three throwers. The 12 weeks uniform plyometric training schedule is over for the study.

During the training time, the three experimental groups underwent their supporting training programme, four days per weeks on alternate days for twelve weeks in addition to their regular programme. Control group did not participate in any of the training programme except from their regular programme. The selected subjects were tested on selected criterion parameters such as speed, agility, power, shoulder strength, reaction time test. The above criterion parameters were a determined by 50 mt. sprint, 4x10 meter shuttle run, standing broad jump, pull up test, and nelson choice movement response reaction time test method.

Prior to the training and after the 12 weeks of uniform plyometric training programme data were collected tested through pre-test and three different post-test(post-1,post-2,post-3)in different duration from the subjects . The subjects were tested for all the selected criterion

parameters. The collected data were statistically analyzed in SPSS by Repeated Measure Analysis of Variance (ANOVA) and Repeated Measure Analysis of Covariance (ANCOVA). The Analysis of Covariance and Variance were used to find out the significant differences if any among the experimental group and control group. 'F'ratio was computed to assess the variation in the groups. Where ever the 'F'ratio for the post-test result was found significant and the Tukey's Post Hoc test was used as a Post Hoc test to find out the compare mean differences. In all the cases 0.05 level of significance was fixed to test the significance.

5.2 CONCLUSIONS OF THE STUDY:

Within the limitation of the study and based on the result of the study the following conclusions may be drawn-

1. The twelve week of uniform plyometric training produces more effective improvement in motor fitness parameters for sprinters.
2. The twelve week of uniform plyometric training enhances the performance in motor fitness parameters for jumpers.
3. The twelve week of uniform plyometric training produces more effective changes in motor fitness parameters for throwers.
4. The performance of the speed is more effective, increased by uniform plyometric training. The speed of the jumper is most effectively improve as compare to sprinter and throwers.
5. The performance of the power highly improves by uniform plyometric training. The power of the thrower is most effectively improved as compare to sprinters and jumpers.
6. The agility of the thrower is most effectively improves as compare to sprinters and jumpers. The performance of the power highly improves by uniform plyometric training.
7. There is no effective improvement of shoulder strength in sprinter and throwers after three month of uniform plyometric training. The shoulder strength is improved for the jumpers as a result of uniform plyometric training.

8. The reaction time is improved by the uniform plyometric training programme .The reaction time of the sprinters is mostly effected by the uniform plyometric training programme.

9. It is concluded that the uniform plyometric training protocol adopted for the study capable of improving motor fitness parameters for sprinters, jumpers and throwers.

10. The uniform plyometric training betterly improve the motor fitness parameters like speed, agility, power, reaction time and shoulder strength for throwers as compared to the sprinters and jumpers. Whereas, there are no much more differences in between the shoulder strength improvement for the different groups.

11. The uniform plyometric training programme for a period of twelve weeks may be the most appropriate protocol to produce more effective improvement in motor fitness parameters for the teen-age athletes like sprinter, jumpers and throwers.

5.3 RECOMMENDATIONS OF THE STUDY:

Although the investigator has put in his best efforts on the present study, still the topic has a wide scope for further research. Thus, for future research and in the light of the results and conclusions of the present study following recommendations is made:

1. It is assumed that twelve weeks of plyometric training may be sufficient to bring desirable changes in the fitness level of the beginners. Hence further studies may be under taken by extending the training period for the sports person.

2. The similar study may be conducted by using only female or only male athletes.

3. Based on the results of the study, the investigator suggests that there is a need to encourage youth and children to participate in plyometric dominated sports in order to maintain good health and a successful life.

4. Similar study may be conducted by Plyometric training which one may be considered as a regular part of training programme for an athlete of various sports and games.

5. It is recommended that, coaches, trainers and athletes interested in developing different type of motor fitness and skills, should adopt these types of plyometric exercises in training with this objective, research may be organized.

6. A similar study may be conducted with longer duration and larger sample to find out any better result.

7. Such study may be conducted among different age groups, players of different disciplines and extending the training period or modifying the same.

8. The results of the present study may be very much useful for physical educators and coaches for screening and selecting potential players at national level and inter-national level by knowing their attitude, hence new research may be conducted for the above purposes.

9. It is also recommended that football, hockey and for the other team sport the players/coaches at any level should have knowledge about plyometric training for enhancing performance, so the research may be undertaken.

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APPENDICES

APPENDIX-I

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: DATA FOR EXPERIMENTAL GROUP-I (SPRINTER)

Sl. No.	Subjects	50 mt. Run	Standing broad jump	4x10 mt. shuttle run	Pull up test	Nelson-choice reaction movement test
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-II

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: DATA FOR EXPERIMENTAL GROUP-II (JUMPERR)

Sl. No.	Subjects	50 mt. Run	Standing broad jump	4x10 mt. shuttle run	Pull up test	Nelson-choice reaction movement test
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-III

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: DATA FOR EXPERIMENTAL GROUP-III (THROWER)

Sl. No.	Subjects	50 mt. Run	Standing broad jump	4x10 mt. shuttle run	Pull up test	Nelson-choice reaction movement test
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-IV

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: DATA FOR EXPERIMENTAL GROUP-IV (CONTROL)

Sl. No.	Subjects	50 mt. Run	Standing broad jump	4x10 mt. shuttle run	Pull up test	Nelson-choice reaction movement test
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-V

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: MOTOR FITNESS PARAMETERS FOR EXPERIMENTAL GROUP-I (SPRINTER)

SL.NO..	SUBJECT	SPEED	SHOULDER STRENGTH	AGILITY	POWER	REACTION TIME
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-VI

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: MOTOR FITNESS PARAMETERS FOR EXPERIMENTAL GROUP-II (JUMPER)

SL.NO..	SUBJECT	SPEED	SHOULDER STRENGTH	AGILITY	POWER	REACTION TIME
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-VII

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: MOTOR FITNESS PARAMETERS FOR EXPERIMENTAL GROUP-III (THROWER)

SL.NO..	SUBJECT	SPEED	SHOULDER STRENGTH	AGILITY	POWER	REACTION TIME
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

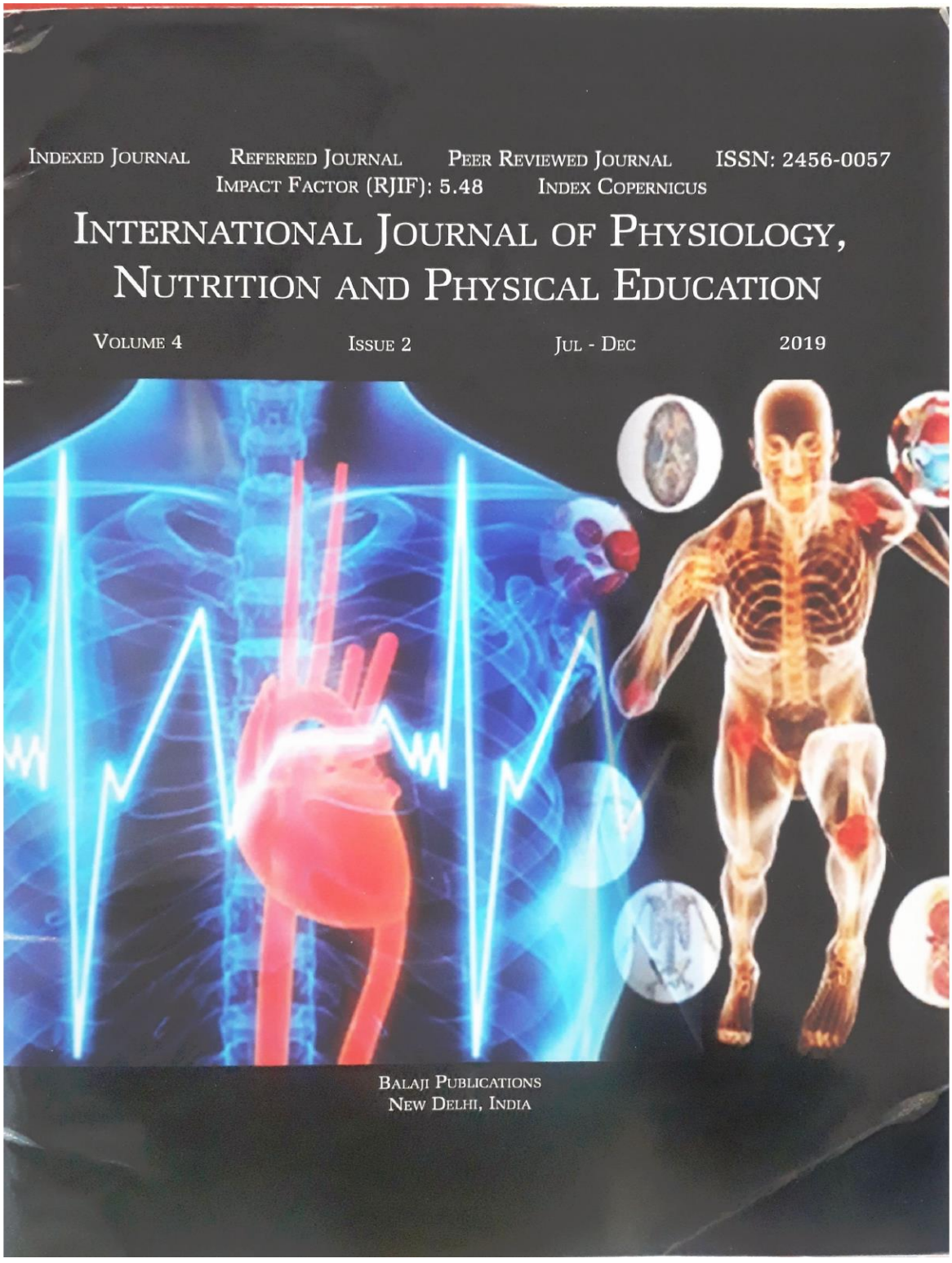
APPENDIX-VIII

SAMPLE SCORE SHEET FOR PRE-TEST AND POST TEST: MOTOR FITNESS PARAMETERS FOR EXPERIMENTAL GROUP-IV (CONTROL)

SL.NO..	SUBJECT	SPEED	SHOULDER STRENGTH	AGILITY	POWER	REACTION TIME
1	Subject-1					
2	Subject-2					
3	Subject-3					
4	Subject-4					
5	Subject-5					
6	Subject-6					
7	Subject-7					
8	Subject-8					
9	Subject-9					
10	Subject-10					

APPENDIX-IX

PUBLICATION FRONTPAGE



APPENDIX-X

PULICATION INDEX

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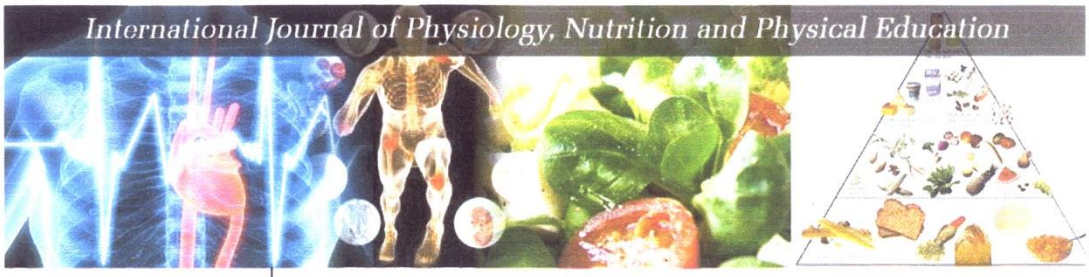

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Persuade of plyometric training and stationary training on speed and explosive power of college female basketball players

Md Hasanuz Zaman and Dr. Papan Mondal

Abstract
The underlying principle of the study was to access the Persuade of plyometric training and stationary training on speed and explosive power of college female basketball players. 45 female basketball players from Pondicherry University at the age ranged between 17 to 22 years. The selected subject were assigned into three equal groups with fifteen each subjects. The investigational group-I plyometric training, investigational group-II stationary training and control group. The training regimens lasted for eight weeks. Speed was measurement by 50 meter dash and explosive power was measurement by standing broad jump was taken for both the groups. The initial and the final readings derived from the experimental and the control group underwent a procedure of statistical analysis using ANCOVA. The confidence level was 0.05. These finding suggest that the plyometric training and stationary training program has a statistically significant influence in developing the selected criterion variables.

Keywords: Plyometric training, stationary training, speed, explosive power, college female basketball players

Introduction

Basketball is an extremely dynamic sport that requires its intermittent high intensity activity that requires players to perform actions jumping sprinting shuffling or changing directions. Basketball is becoming a game that revolves around athleticism and if athletes of a team are not fit it is going to be difficult to get on the floor. Basketball is an extremely dynamic sport that requires movements in multiple planes of motion as well as rapid transitions from jogging to sprinting to jumping.

Plyometric, also referred to as play or jump training exercise, is a physical exercise in which muscles receive maximum power in a comparatively shorter span of time increasing the strength. Plyometric it is a method of moving from a muscle extension move to compressive move in a less period or simply termed explosive way (Matavulj, D 2001) [4]. It involves bodyweight exercises to the next level by including the maximum power jump the muscles become active with the maximum force in a short span of time also increases muscle speed over time. Plyometric exercises that allow the muscle to contract eccentrically before explosive contraction which enable the muscle to reach maximum explosive strength in a shortest period of time (Khlifa 2010) [1].

Plyometric activities can be utilized to improve strength with speed to produce power and perseverance. Muscle perseverance and stamina is enhanced enabling the legs to work and performs at a higher timeframe (Manoranjith 2019) [3]. Plyometric may exclusively consume more amounts of calories but can increase the resting metabolic rate. Plyometric combines quality preparing and cardiovascular exercise.

Stationary training is a continuous series of exercises attempting to improve as many components of physical fitness as possible especially endurance. Stationary training is a method of physical conditioning in which one moves from one exercise to another usually in a series of different stations or pieces of equipment. It works well for developing strength, endurance, flexibility and coordination (Miller 1993) [9]. The Stationary training format utilizes a group of 6 to 10 Strength exercises that are completed by doing one exercise after another. Each exercise is performed for a specified number of repetitions or for a prescribed time

before moving on to the next exercise. The exerciser gains muscle through the resistance training and increases his/her cardiovascular endurance during the slightly elevated heart rate that is maintained in between sets and throughout the overall program (Rodgers Jr 1996) [8].

Statement of the problem

The intention of the exploration was Persuade of plyometric training and stationary training on speed and explosive power of college female basketball players

Subject and variables

Pondicherry University at the age ranged between 17 to 22 years. The selected subject were assigned into three equal groups with fifteen each subjects. The investigational group-I plyometric training, investigational group-II stationary training and control group. The plyometric training and stationary training underwent training for a period of eight weeks (60 days) of 24 sessions. The training sessions were conducted three days a week (Monday, Wednesday and Friday). Measurement of speed and explosive power variables was taken for both the groups.

Training protocol

The persuade of plyometric and stationary training were selected as training protocol. The both plyometric training and stationary training was provided in the morning time the subjects were involve in proper warming up practice. The plyometric exercises are High Knees, Shuttle Run, Squat Jump, Lateral Box Jump, Mini Hurdle Jump, Split Jump and Medicine Ball Chest Push with Partner. Plyometric training protocol in intensity will be increase week by weeks. The stationary exercises are High Knees, Back Kick, Pushup, Mountain Climber, Burpee, Side Plank, Russian Twist, Scissor Cuts, Split Walk, Lateral Jump and Tuck Jump.

Table 1: Selection of the test measures

Sn.no	Variables	Test Items	Units
1.	Speed	50 Mts Dash	Seconds
2.	Explosive Power	Standing Broad Jump	Meters

The data's were collected before and after the training period. The initial and the final readings derived from the experimental and the control group underwent a procedure of statistical analysis using ANCOVA. The IBM-SPSS-V22 software was used and the confidence level is maintained at 0.05 levels.

Result and Discussion

Table 2: Analysis of Co-Variance of Speed and Explosive Power of Plyometric Training and Stationary Training of Female Basketball Players

Speed							
tests	**Plyometric training group**	**Stationary training group**	**Control group**	**Sum of square**	**df**	**Mean square**	**F ratio**
Pre test	7.75	7.77	7.90	0.154	2	0.077	0.84
				3.86	42	0.091	
Post test	7.57	7.60	7.94	1.321	2	0.660	8.25*
				3.37	42	0.080	
Adjust post test	7.59	7.61	7.87	0.614	2	0.307	23.61*
				0.561	41	0.013	
Explosive power							
tests	**Plyometric training group**	**Stationary training group**	**Control group**	**Sum of square**	**df**	**Mean square**	**F ratio**
Pre test	1.27	1.25	1.25	0.004	2		1.87
				0.04	42		
Post test	1.41	1.39	1.24	0.245	2	0.122	122.5*
				0.029	42	0.001	
Adjust post test	1.41	1.40	1.25	0.204	2	0.102	188.3*
				0.026	41	0.0001	

*Significant at 0.05 level of confidence

Table shows that the pretest mean value of speed for plyometric training group, stationary training group and control group are 7.75, 7.77 and 7.90 correspondingly. The table value 3.23 for df 2 and 42 required the obtain f ratio 0.84 is lowest than the table value.3.23 and 0.05 level of confidence. The post mean value of speed for plyometric training group, stationary training group and control group are 7.57, 7.60 and 7.94 correspondingly. The table value 3.23 for df 2 and 42 required the obtain f ratio 8.25* is highest than the table value.3.23 and significant at 0.05 level of confidence. Hence the adjust posttest mean value of speed for plyometric training group, stationary training group and control group are 7.59, 7.61 and 7.87 correspondently. The table value 3.23 for df 2 and 42 required the obtain f ratio 23.61* is highest than the table value.3.23 and significant at 0.05 level of confidence.

The pretest mean value of explosive power for plyometric training group, stationary training group and control group are 1.27, 1.25 and 1.25 correspondingly. The table value 3.23 for df 2 and 42 required the obtain f ratio 0.84 is lowest than the table value.3.23 and 0.05 level of confidence. The post mean value of explosive power for plyometric training group, stationary training group and control group are 1.41, 1.39 and 1.24 correspondingly. The table value 3.23 for df 2 and 42 required the obtain f ratio 122.5* is highest than the table value.3.23 and significant at 0.05 level of confidence. Hence the adjust posttest mean value of explosive power for plyometric training group, stationary training group and control group are 1.41, 1.40 and 1.25 correspondently. The table value 3.23 for df 2 and 42 required the obtain f ratio 188.3* is highest than the table value.3.23 and significant at 0.05 level of confidence.

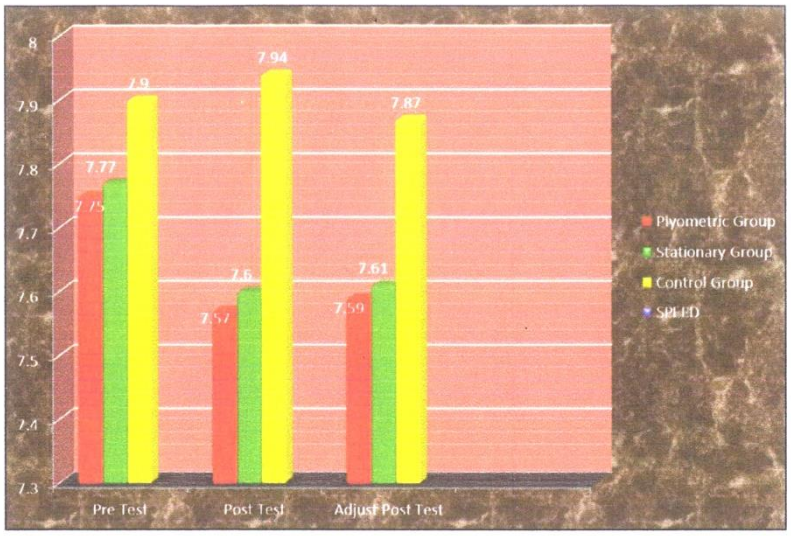

Fig 1: Bar Diagram of Speed and Explosive Power of Plyometric Training and Stationary Training of Female Basketball Players

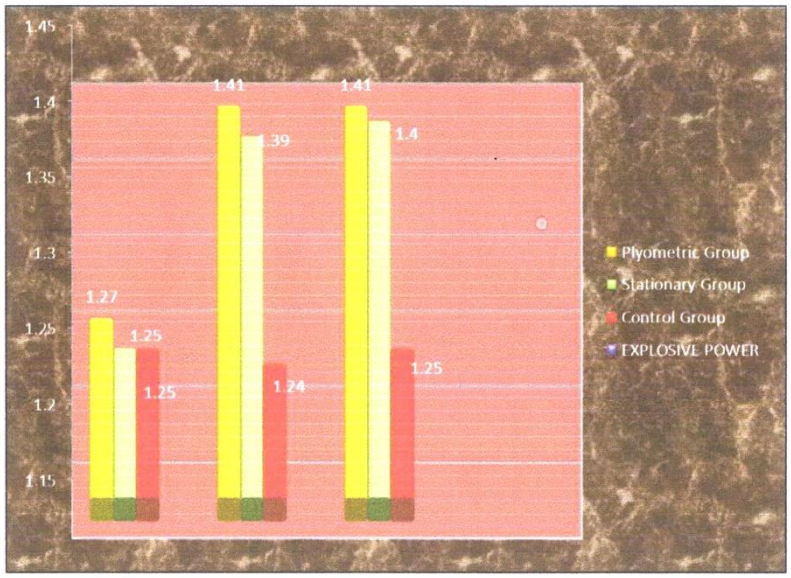

Fig 2: Bar Diagram of Explosive Power of Plyometric Training and Stationary Training of Female Basketball Players

Conclusion

Based on the result the conclusion was drawn. The result of the study reveals that there was a significant improvement in the experimental group on speed and explosive power when compare to the control group after the eight weeks of plyometric training and stationary training.

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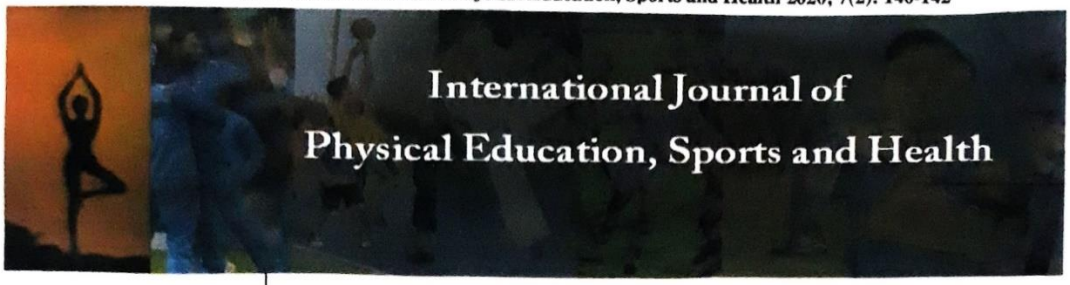
APPENDIX-XII

PUBLICATION IN INTERNATIONAL JOURNAL-2

International Journal of Physical Education, Sports and Health 2020; 7(2): 140-142



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Effects of plyometric exercise and circuit training on physical fitness selected variably speed and agility of tennis players

Md Hasanuz Zaman and Dr. Papan Mondal

Abstract
The aim of the research is to study the Effects of Plyometric Exercise and Circuit Training on Physical Fitness Selected Variably Speed and Agility of Tennis Players. Total 45 students from Tennis Players Jaipur Rajasthan. were selected as the subject. These students were divided into three groups i.e. 15 students in Plyometric Exercise group, 15 students in Circuit training group and 15 students in control group. Speed and Agility were tested by 50 Yard Dash Test and Shuttle Run Test, respectively twice i.e. before and after the particular six weeks training. ANCOVA was applied at 0.05 level of significance to test the hypothesis. It was observed from the result of the study that both the experimental groups improved significantly in Speed, Agility, due to the particular Plyometric Exercise and Circuit training.

Keywords: Plyometric exercise and circuit training, speed and agility

Introduction

Today, modern world is a world of competition. In every phase of life people have to face one or other kind of competition. In this competitive world sports and games occupy a unique position. It is the area of friendly rivalry. Top class international sports meets are considered to be the international ambassadors for world supermodel in various sports and games.

Games and sports have been part of human life almost since the time immemorial. Be if a necessary for his survival i.e. hunting for food, shelter and safety from wild animals or other enemies or as a pursuit of pleasure. The games and sports have been indispensable to mankind and have become part of his culture. The games and sports are a great unifying force and have tremendous effect on the national and international integration people used sports.

Today, life mostly depends upon science and technology. In such circumstance people need more exercise to keep the body and mind fit to execute the activity efficiently.

Sport training is a physical, technical, moral and intellectual participation of an athlete with the help of physical exercises. It is a planned process for the participation of athlete and players to achieve top level performance (Hardayal singh, 1984). Training is much like constructing a multi-storey building. One needs materials for the building such as aerobic, anaerobic running, comprehensive conditioning, flexibility, etc. Several kinds of materials like training intensities and modalities should be utilized in an on-going process to complete the goal of finished buildings or competitively fit athlete. Depending on the progress in the construction plan, the relative mix of all these materials will vary. As a training season develops, compressive conditioning work for strength of endurance will gradually form a transition into an emphasis on power with a substitution of intensity of volume in determining the total load.

The purpose of the training programme is to produce metabolic, physiological and psychological adaptation that allows the sportsperson to achieve top level performance (Hardayal singh, 1983). When the training increases the demand for aerobic energy, the number and size of muscle mitochondria will increase so that in these chemical factories where aerobic metabolism takes place becomes larger and more numerous. These will help athletes to provide more energy from aerobic metabolism. There are three steps of adaptation: the first involves creating the need for more aerobic energy. Training must be sufficient in both duration and intensity to accomplish. The second step is to provide nutrients to build and

It is observed from table – 2 that the adjusted means of Plyometric Exercise Group, Circuit training Group and Control Group are 0.149, 0.281 and 0.430 respectively and the CD is 0.201. Mean difference among these groups shows significant difference among Plyometric Exercise and Circuit training Groups, Plyometric Exercise and Control Group, Circuit training and Control Group.

Table 3: Means and ANCOVA of Agility for Plyometric Exercise, Circuit training and Control Group

Test	Group			ANCOVA table			
	Plyometric Exercise	Circuit training	Control	Sum of Square	Degree of Freedom	Mean Sum of Square	'F'
Pretest Mean	11.724	11.992	11.718	0.738	2	0.369	0.920
				16.841	42	0.400	
Posttest Mean	11.044	7.221	11.696	175.302	2	87.651	270.634*
				13.602	42	0.323	
Adjusted Mean	11.049	7.209	11.701	169.401	2	84.700	256.550*
				13.536	41	0.330	

* Sig. Level at 0.05 (2,42) (2,41) = 3.150

It is observed from table – 3 that the means of Plyometric Exercise Group; Pre-test is 11.724, post-test mean is 11.044 and adjusted mean is 11.049. Circuit training Group; Pre-test is 11.992, post-test mean is 7.221 and adjusted mean is 7.209. Control Group; Pre-test is 11.718, post-test mean is 11.696 and adjusted mean is 11.701. The calculated 'F' value of pre-test means of all the groups is not significant, calculated 'F' value of post-test means of all the groups is significant and calculated 'F' value of adjusted means of all the groups is significant.

Table 4: Means and LSD of Agility for Plyometric Exercise, Circuit training and Control Group

Mean			MD	(CD)
Plyometric Exercise	Circuit training	Control		
11.049	7.209		3.839*	0.423
11.049		11.701	0.652*	
	7.209	11.701	4.491*	

* Sig. Level at 0.05

It is observed from table – 4 that the adjusted means of Plyometric Exercise Group, Circuit training Group and Control Group are 3.839, 0.652 and 4.491 respectively and the CD is 0.423. Mean difference among these groups shows significant difference among Plyometric Exercise and Circuit training Groups, Plyometric Exercise and Control Group, Circuit training and Control Group.

Conclusion

It was observed from the result of the study that both the experimental groups improved significantly in Speed and Agility, due to the particular of Plyometric Exercise and Circuit training.

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APPENDIX-XIII

PUBLICATION IN INTERNATIONAL JOURNALS-3

IOSR Journal of Sports and Physical Education IOSR-JSPE)

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IOSR-JSPE

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Effect of plyometric training on agility for sprinter, jumper and throwers

Md. Hasanuz zaman (Phd.scholar, jadavpur university)

Abstract: *The purpose of the study was to collect information about fitness awareness of school teacher, a section of educated mass. Fitness is now a very popular term ever one wants to be keep fit in this modern highly technological society. India slowly but steadily growing its fitness awareness. Total 130 school teachers were servant from seven schools in West Bengal State in India .A fitness awareness questionnaire was development from the previous work and with the help of the experts. In the fitness awareness questionnaire there were eight subunits as stated here , unit I-Rest and Sleep, unit ii-Diet, unit iii- Exercise , unit iv-Stress, unit- v-Avoid smoking , alcohol and drugs , unit vi-To maintains a healthy body weight , unit vii -Protect from disease and injury, unit viii- maintenance of fitness. - Most of the school teacher was aware about fitness. But they were not involved themselves that much for the maintenance as a whole .A nation wise campaign for the maintenance of fitness is recommended*

Keyword: *Fitness; fitness awareness; Primary school teachers.*

I. Introduction

Fitness was commonly defined as the capacity to carry out the day's activities without undue fatigue. However, as automation increased leisure time, changes in lifestyles following the industrial revolution rendered this definition insufficient. In current contexts, physical fitness is considered a measure of the body's ability to function efficiently and effectively in work and leisure activities, to be healthy, to resist hypokinetic diseases, and to meet emergency situations. Fitness is generally defined as the ability of a person to live a happy, well-balanced life. It embraces the physical, intellectual, social, and spiritual aspects of a person's life. It is a relative term, depending on individual circumstances and for what a person needs to be fit. These components interact and are interdependent so that if any component deviates from normal it affects the overall fitness and ability of an individual to meet the demands made by his or her way of life. The term fitness now changes into wellness.

The idea of fitness is not a new one each and every ancient civilization (India, Greek, China etc.) gave more important or fitness which was found in the remains of that civilization. In India we have a long history of this fitness awareness. In that time Harappa Mohenjo-Daro civilization one big swimming pool with very wide roles were excavated rallicks found in the time of vaidick civilization the Ayurveda or science of life was born in Ayurveda there are many sloker are on health , maintainers a good health , food ,balance diet , exercise and effect of regular exercise were there they applied , exercise , for preventive curative and rehabilitee measures. For physical health they used Vayama (exercise) and for mental health they introduce yoga. They understand how to maintain long and healthy life (Ayur).Their idea were very much similar with the modern days health and fitness concept. Other ancient civilization such as Greeks, China etc. also gave same important to health and fitness awareness. In Greeks the expression of high level of fitness was exposed through the ancient Olympic Games.

Awareness is the state or ability to perceive, to feel, or to be conscious of events, objects or sensory patterns. In this level of consciousness, sense data can be confirmed by an observer without necessarily implying understanding. More broadly, it is the state or quality of being aware of something. In biological psychology, awareness is defined as a human's or an animal's perception and cognitive reaction to a condition or event.

II. Methodology

This project work was organized in India and the state of west Bengal eastern part of the country. According to conventions to the researcher the data were collected from the seven schools. To observe the fitness awareness the researcher selected a small segment of educated population in India. The population was secondary school teachers (male and female both).From the sever schools total 130 teachers fitness awareness response were recorded by the questionnaire method. But four incomplete questions set were eliminated finally. The age range of school teachers was 25 to 60 years the mixture and junior and senior teachers. The percentile method was used in this project on the basis of teacher's opinion. The Watkinson's questionnaire booklet were used in and A. j.Stones percentile methods are used in this projects. In the fitness awareness questionnaires there

are 3 types of answer agree, undecided disagree. The researcher his self with the help of his follow classmate counted the answers the entire question under the eight units.

III. Statistical Procedur

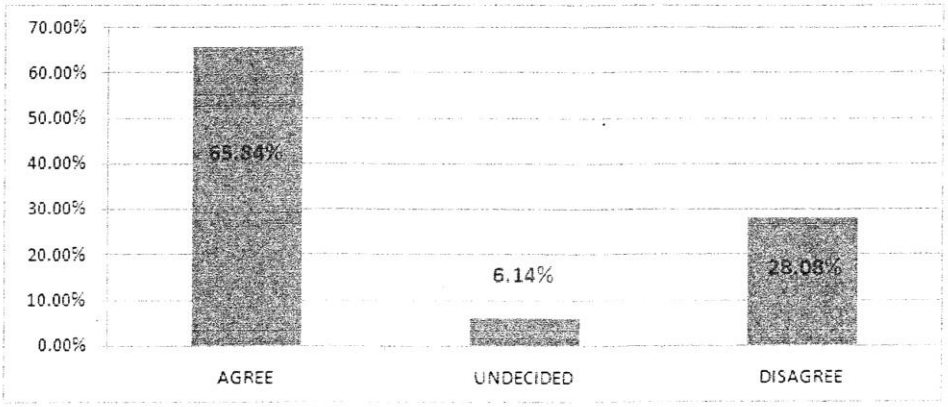
The percentage of response (agree, disagree, undecided) were calculated and made graphical presentation to know the nature of response.

IV. Result

Fitness is a very common word in this modern high speed age. To maintain a balance between the demands of high speed in each and every work fitness is essential to everybody. So most of educated person those who want to achieve successes in their respective fields are very much aware about fitness or in other word fitness conscious. In this project the researcher selects d small section of educated within his reach. There is no such previous Indian data in the internet sources which may help the present researcher s endeavor. School teacher are the are responsible member of socially who can propagate the fitness awareness to the tacks and care rows of the student.

The questionnaire divided into eight units: unit-I Rest and sleep. Unit-ii diet, Unit –iii Exercise, Unit-iv-Stress, Unit-v-Avoid alcohol and drugs, Unit-vi- Injury maintain a healthy body weight unit-vii-Protect from disease and Unit-viii-Maintain fitness. Total 45 questions were asked and gathered information about fitness. Total data were collected and expressed by graphical plot in percentage.

Graphical Presentation Of The Subjects Opinion



Percentage of subjects opinion

V. Discussion

Fitness is now a household word. In a educated family every one may have some idea about fitness. In the modern speedy word fitness is essential and everyone needs fitness. The school teachers are not the exception as a responsible part of this society. Fitness awareness from the school teachers may create a long lasting effect to student as an individual and for a future responsible citizen as a whole. It was said that 'fit people make a fit nation'. The reflection of that idea one may observe in the Olympic medal tally. On the other hand fitness decreases the health coast of a nation. The prevention is better than cure is a century old sentence. To prevent disease and injury fitness provides strong support. The teachers of the back bone of a nation and they are the producer of healthy citizen.

In the present study the researcher wanted to observe physical fitness awareness among the school teacher with the help of some experts the scholar developed a questionnaire consisting of eight sub-areas to know the fitness awareness. In the most the cases the teachers are aware of fitness but in practical life most of them were not practicing properly to maintain their level of fitness. The reflections of their mental set up were reflected in their answers. The researcher may concluded that school teachers are moderate aware about fitness. To make them fully aware a nationwide publicity, incentive skim, and encouragement should be started as early as possible.

VI. Conclusion

Most of the responses in this study agreed that regular exercise is good for health and essential for the maintenance of level of fitness. But below 50 %(45.38%) were practicing regularly deferent forms of exercises. This study very much aware about the ill effect of smoking alcohol, drugs. A very high percentage of the subjects in this study were having smoking habits through the strongly agree that smoking injuries to health. The subject were agree that 'prevention is better that cure ' and most of them were in favors to introduced periodical medical cheek up camp in the school level for the students and other stuff member. These studies_were agreed that maintenance of fitness is essential for successful life and fit people are the base of a fit nation.

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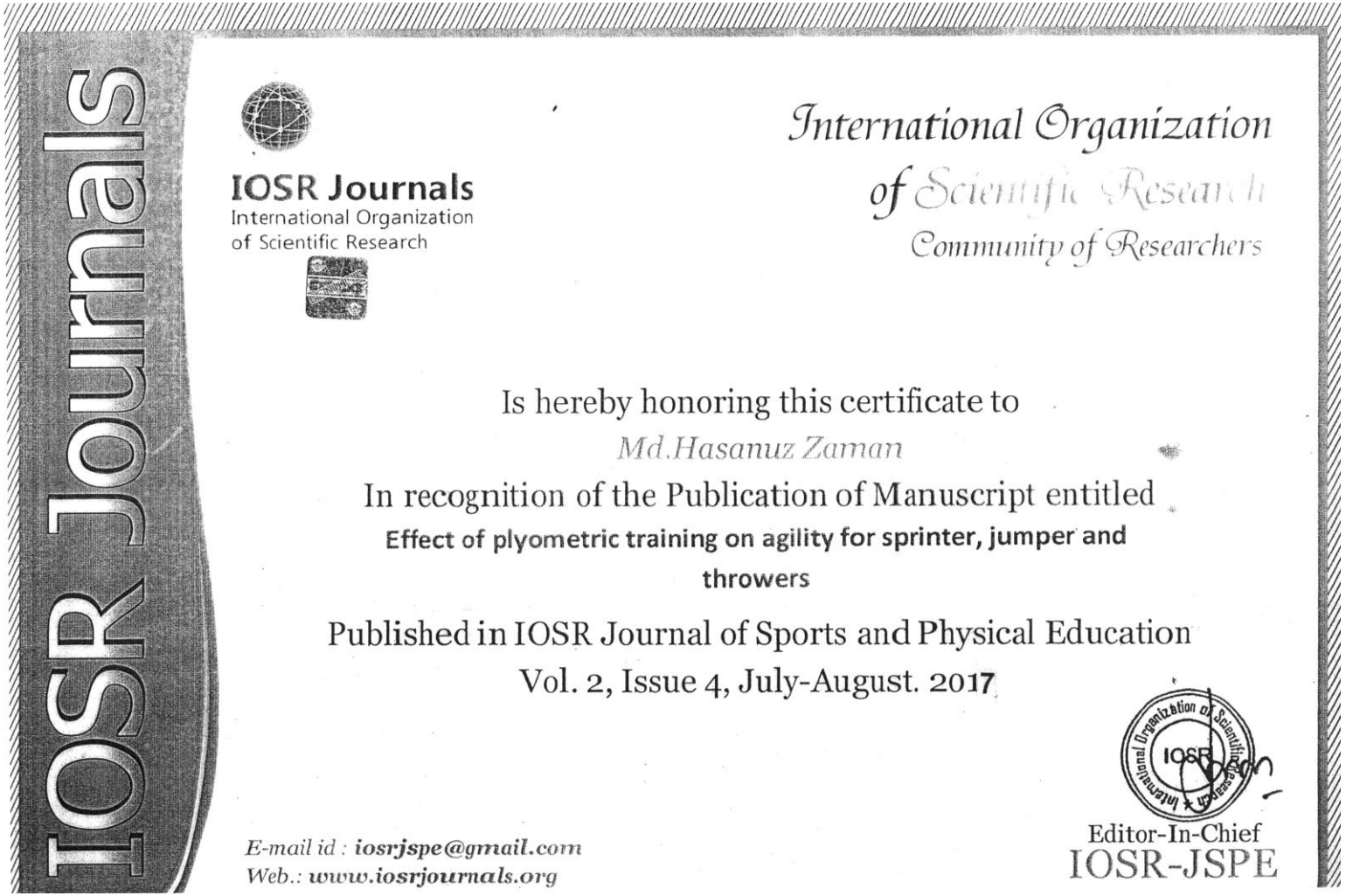
APPENDIX-XIV

PUBLICATION CERTIFICATE IN INTERNATIONA JOURNAL



APPENDIX-XV

CERTIFICATE OF INTERNATIONAL SEMINAR

One Day International Seminar

On

Trends, Issues and Development in Physical Education & Sports Sciences

20th September, 2019

Organized by

IQAC & Department of Physical Education, Sree Chaitanya Mahavidyalaya, Habra

In collaboration with

Post Graduate Govt. Institute for Physical Education, Banipur

Certificate

This is to certify that Prof/Dr/Mr/Ms/Mrs Md. Hasanuzzaman.

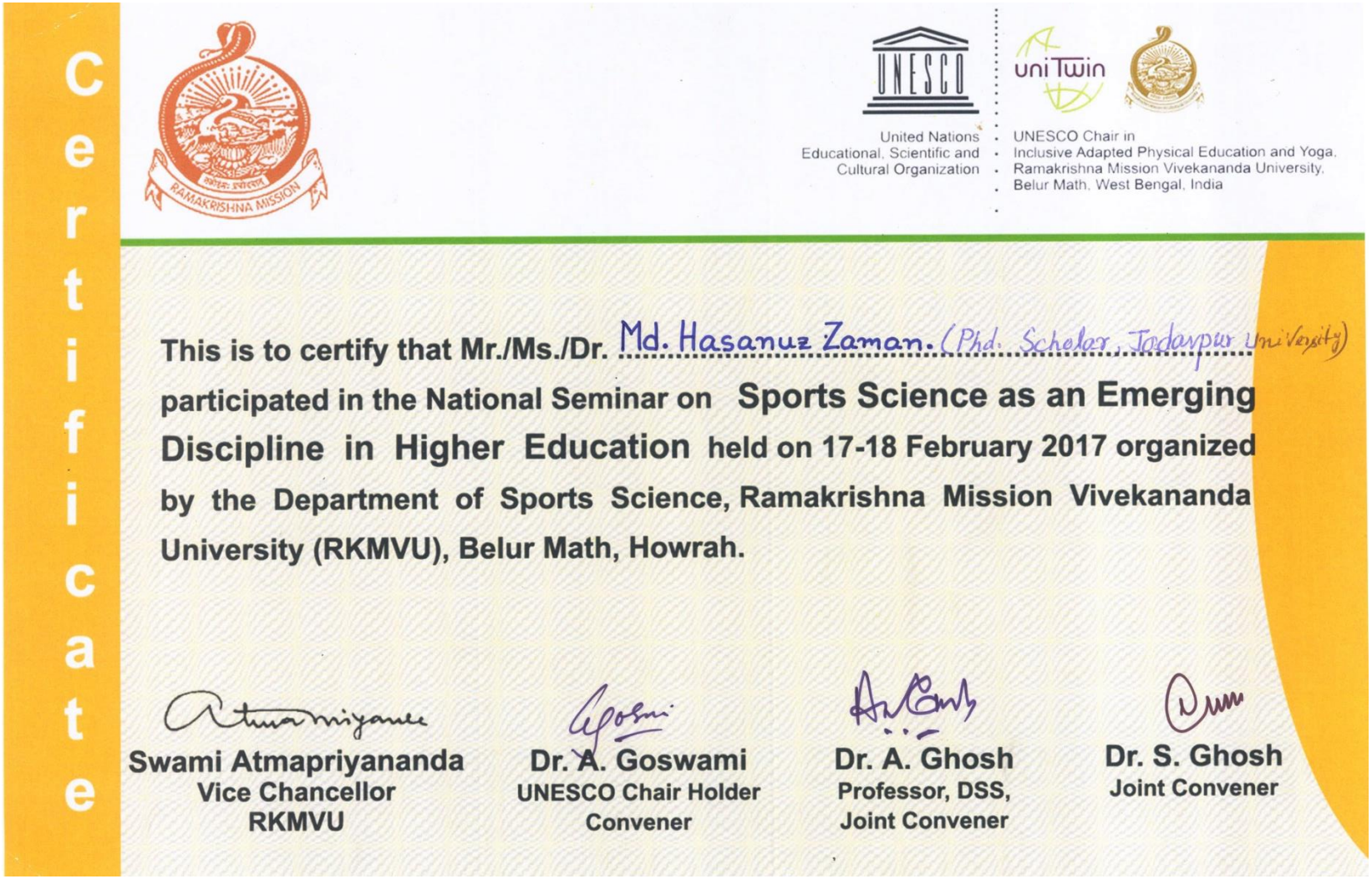
of Jadavpur University has ~~participated~~/presented a paper entitled Effect of playometric training on agility for sprinter, jumper and thrower in the International Seminar on "Trends, Issues and Development in Physical Education & Sports Sciences" held on 20th September,2019 at Sree Chaitanya Mahavidyalaya, Habra, West Bengal, India.

Place: Habra
Date: 20th September, 2019

Dr Chandana Chakraborty	Dr Prasenjit Chattopadhyay	Mr. Shibananda Mridha	Dr Subrata Chatterjee
Officer-in-Charge	*Secretary*	*Convener*	*Principal & Chairman*
Post-Graduate Government Institute for Physical Education	Seminar Organizing Committee	Seminar Organizing Committee	Seminar Organizing Committee

APPENDIX-XVI

CERTIFICATE OF INTERNATIONAL SEMINAR



Certificate

United Nations Educational, Scientific and Cultural Organization

UNESCO Chair in Inclusive Adapted Physical Education and Yoga, Ramakrishna Mission Vivekananda University, Belur Math, West Bengal, India

This is to certify that Mr./Ms./Dr. Md. Hasanuz Zaman. (Phd. Scholar, Jadavpur University) participated in the National Seminar on **Sports Science as an Emerging Discipline in Higher Education** held on 17-18 February 2017 organized by the Department of Sports Science, Ramakrishna Mission Vivekananda University (RKMVU), Belur Math, Howrah.

Swami Atmapriyananda
Vice Chancellor
RKMVU

Dr. A. Goswami
UNESCO Chair Holder
Convener

Dr. A. Ghosh
Professor, DSS,
Joint Convener

Dr. S. Ghosh
Joint Convener

APPENDIX-XVII

CERTIFICATE OF NATIONAL LEVEL WORKSHOP

Ramakrishna Mission Vidyamandira

Belur Math, Howrah 711202

An Autonomous Residential College affiliated to the University of Calcutta

Re-Accredited by NAAC with 'A' Grade; College with Potential for Excellence

Seven Day National Workshop

on

Society, Literature & Antonio Gramsci

Organised by

Swami Vivekananda Research Centre

CERTIFICATE OF PARTICIPATION

This is to certify that Md. Hasanuz Zaman of Jadavpur University, participated in the seven day National Workshop on "Society Literature & Antonio Gramsci" organised by the Swami Vivekananda Research Centre, Ramakrishna Mission Vidyamandira during 15 to 22 February 2017.

Belur Math, Howrah
22 February 2017

(Swami Shastrajnananda)
Principal
Ramakrishna Mission Vidyamandira
&
Director
Swami Vivekananda Research Centre

Memo No. VM Beng-Workshop 2017/51

APPENDIX-XVIII

CERTIFICATE OF INTERNATIONAL LEVEL WEBNAR

ONE DAY INTERNATIONAL WEBINAR

Organized by

Department of Physical Education

Certificate ID WJQWNA-CE000122

HINGALGANJ MAHAVIDYALAYA

LIVE on Youtube.com/Banglasahitya

Yoga for healthy life

Certificate of participation

This is to certify that MD HASANUZ ZAMAN of Jadavpur university has participated in the international level webinar entitled **Yoga for healthy life** conducted on 21st june 2021 by the department of physical education, HINGALGANJ MAHAVIDYALAYA.

Dr. Shaikh Kamal Uddin
PRINCIPAL
HINGALGANJ MAHAVIDYALAYA

Kamalesh Gayen
Convener, organising committee
HINGALGANJ MAHAVIDYALAYA

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