EFFECTIVENESS OF PLYOMETRICS TRAINING IN SAND VERSUS GROUND IN BASKETBALL PLAYERS - A COMPARATIVE STUDY

DISSERTATION

Submitted for the partial fulfillment of the requirement for the degree of

MASTER OF PHYSIOTHERAPY (MPT)
(Elective-MPT sports**)**

April-2018

Done by

S.RAJAKAMAL
Regn. No: 271650225

Submitted to:

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI – 600032

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This is to certify that the Dissertation entitled "**EFFECTIVENESS OF PLYOMERTICS TRAINING IN SAND VERSUS GROUND IN BASKETBALL PLAYERS – A COMPARATIVE STUDY"** was done by **S.RAJAKAMAL** Bearing Regn. No:**271650225.** This work has been done under my direct guidance and supervision for the partial fulfillment of the requirement of Master of Physiotherapy degree at **Mohamed Sathak A.J College of Physiotherapy**, Chennai, and submitted during the year April 2018 to **The Tamilnadu Dr. M.G.R Medical University.**

Date:
Place: Chennai

Seal & Signature of Principal

……

Prof.R.Radhakrishnan,MPT.,PGDHM.,(PhD)
Mohammed Sathak A.J College of Physiotherapy.

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Signature of Guide

…..…….

Prof.S.Kalaivani, MPT (Sports)
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CERTIFICATE

MOHAMED SATHAK A.J COLLEGE OF PHYSIOTHERAPY

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…… ……

INTERNAL EXAMINER **EXTERNAL EXAMINER**

Place:

Date:

DECLARATION BY THE CANDIDATE

I hereby declare that the Dissertation entitled "**EFFECTIVENESS OF PLYOMETRICS TRAINING IN SAND VERSUS GROUND IN BASKETBALL PLAYERS – A COMPARATIVE STUDY**" was done by me for the partial fulfillment of the requirement of Master of Physiotherapy degree. The dissertation had been done under the direct supervision and guidance of my Guide Asst. at **Mohamed Sathak A.J college of Physiotherapy**, Chennai, and submitted the same during the year April 2018 to **The Tamilnadu Dr. M.G.R Medical University**.

Date :
Place : Chennai

…..
Signature of the Candidate

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ABSTRACT

Introduction

Sport specific training in basketball players should also focus on vertical jump height and agility in consistent with demand of the sport. Since plyometrics training improves vertical jump height and agility, it can be useful training strategy to improve the performance of basketball players. Sand training is gentle on joints and also makes the muscles work harder to improve vertical jump.

Purpose of the study

The purpose of the study is to compare the effects of Plyometric training on sand versus ground on vertical jump height and agility in male basketball players.

Materials and Methods

Convenience samples of thirty professional basketball players in the age of 18- 25 were recruited. Following pre-intervention assessment, Interventions using plyometric training on sand and ground protocol was administered on the basketball players. The outcome measures were assessed before the intervention and at the end of sixth week.

Results

The study concludes that plyometric training on sand as a useful training strategy to improve vertical jump height and agility in basketball players than plyometric training on ground.

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1.INTRODUCTION

Basketball requires high intensity activities such as jumping (for rebounds, blocks and shots), turns, dribbles, sprints, screens and low intensity activities such as walking, stopping and jogging.[1]

Basketball is a multifaceted and complex intermittent team sport that combines cyclic and acyclic movements[2.] Although basketball performance requires good aerobic capacity for recovery after high-intensity activity, many authors agree that the nature of basketball performance lies in anaerobic capacity [3.]

The high intensity movements of basketball players are closely related to the development of strength, speed and agility.[4]

During a basketball game, professional players cover about 3500–5000m [5].

Each player performs about 1000, mainly short, activities lasting around 2 seconds; time motion analysis has shown that these short activities are performed with a different frequency according to the player's position[6].

Explosive strength, take-off power, speed, and agility are abilities that make an important contribution to efficient movement with and without the ball, thus play an important role in basketball technique and tactics[7].

The main objective of each basketball player during a game is to score points. In an attempt to do so, an athlete might perform a jump shot, set shot, layup or a free throw. As the discipline has evolved and more athletic players have practiced this sport discipline, defense has become increasingly efficient. As a result, the two-legged jump shot has become more frequent, amounting to over 70% of all the shots during a game, which necessitates a greater performance level for athletes executing the jump shot to increase the height at which the ball is released (i.e., the release point[8].

This movement must be automated so that, regardless of the external factors, the player achieves maximum repeatability[9].

The factors that affect the height at which a shot is performed include the shooter body height, jump height and arrangement of body parts[10].

When a player is covered by an aggressive defender, his aim is to perform the shot at the highest possible release point.

Additionally, the shot must reach that release point in the shortest time frame. These factors result in an extension of the body in players performing the jump shot[11].

Jump height or jumping ability is very important for a basketball player, because of the player must jump as high as possible for achieving the ball during rebound task. Also, sprinting ability play a critical role in basketball game, because during turns the players must run as fast as possible for the offensive and defensive structures. Agility has been considered a physiological prerequisite in basketball, because players are frequently involved in a variety of sudden directional changes during the game in crossing the ball [12].

The sports training principle emphasizes that the muscle adaptations are very specific to the nature and type of exercises performed; intensity of exercises in which those exercise performed; the overload principle specifies that muscle power increases proportionally equal to the load with which it is trained [13].

Vertical jumping is a fundamental component of many sports and also may be predictive of performance in other sports in which it is not the primary component. The effects of plyometrics on vertical jump performance have been widely researched. Particularly, some authors have reported significant increases in vertical jump height after plyometrics training , whereas others have reported no significant effects[14].

The term Plyometrics can be used to describe any exercise that allows the athletes to take advantage of the stretch-shortening cycle to produce an explosive movement. Plyometrics training is one such training strategy to improve the performance of the basketballball players. This training gives the basic needs of agility and power; which in return increases the maximum muscle strength and speed of movement. The training also includes stretching cycle as warm up and cool down sessions. Several physiological adaptations were reported following plyometrics training like muscle hypertrophy results in increasing of muscle strength; increase in synchronous motor neuronal pool firing due to activation of stretch

reflex which increases muscle power; increase in ventilation and stroke volume and in increase in bone mass due to rapid mechanical loading[15].

Plyometrics can be a great way to increase an athlete muscular strength and their vertical jump. Plyometrics can best be described as the performance of the stretch shortening cycle through movements that involve a high intensity eccentric contraction, which is immediately the goal of increasing dynamic muscular performance. Therefore, Plyometrics has been widely used for increasing dynamic athletic performance such as vertical jump ability, speed , agility , and muscle activation of lower extremities[17].

Plyometrics are associated with high ground reaction forces during landing, which may exceed 5-7 times the body mass of individuals[18.] These forces may result in muscle soreness and ligament overloading and can cause musculoskeletal injuries. Impact landing may also contribute to knee injuries[19].

The sand makes your muscles work harder to get any higher limits on your jump. Plyometric exercise training on sand is more a muscle centric method of developing your vertical jump height. Jumping on sand causes a lower reuse of elastic energy and energy loss due to feet slipping during the concentric action. This might induce different training effects compared to training on a firm surface. On the other hand, the lower stress on the musculoskeletal system may decrease the risk of injuries and the overall physical strain of training sessions. The best way to use it is to focus on the joint friendly characteristics of the sand to train in a ballistic loaded manner. So the main purpose of the study is to compare the effects of plyometric exercise training on ground versus plyometric exercise training on sand on vertical jump height in male basket ball players.

Agility is a specific athletic attribute that is fundamentally important to sports performance. Basketball demands multi-directional speed during both offensive and defensive gameplay. An offensive player can gain an advantage on a defender by outmaneuvering them to achieve an uncontested shot, path to the basket, or passing lane.[20] Agility is a particularly prized trait in guards who frequently advance the ball up the court. The ability to create space between the ball handler and the defender presents advantageous offensive options. During drives to

the basket, offensive players that can produce explosive movements will be more likely to outmaneuver the defense. Agility has been defined as "a rapid whole body change of velocity or direction in response to a stimulus"[21].

Based on the reviewed studies, five limitations associated with the testing protocols and the strength and conditioning programs used in the studies were outlined, among them the use of multiple testing protocols and lack of experimental studies. Three recommendations for basketball and strength and conditioning coaches were suggested, for one of which was including plyometric training in the annual training program[22].

2.Aim of the study

The aim of the study is to compare the Effect of plyometric training in sand versus ground in basketball players.

Objective of the study

- To increase vertical jump height of subject.
- To increase agility of subject.

3.Need for the study

Plyometrics are primarily used by athletes, sprinters, high jumpers to improve performance and fitness. Plyometrics include explosive powerful training exercise that are trained to activate the quick response and elastic properties of the major muscles in the body. The effects of plyometrics on vertical jump performance have been widely researched. Particularly, some authors have reported significant increases in vertical jump height after plyometrics training , whereas others have reported no significant effects. Sand plyometric training will help athletes increase their speed , vertical strength , balance and core stability. Sand training will reduce the risk of injury. Basketball requires high level of agility. Basketball players need to have ability to change directions and positions quickly on a horizontal plane. This gives them an advantage over opponents and puts them in position that will enhance performance and techniques. This study is aimed to find out the effect of plyometric training on sand and ground in vertical jump height and agility of basketball players.

4.HYPOTHESIS

Null Hypothesis (H_0)

There is no significant difference in vertical jump and agility in players who has undergone sand plyometric or ground plyometric training.

Alternate Hypothesis (H_1)

There is significant difference in vertical jump and agility in players who has undergone sand plyometric or ground plyometric training.

5.REVIEW OF LITERATURE

CHETNA CHAUDHARY ET AL (2010) concluded that the plyometric training is an effective means for improving the following variables: agility, flexibility vertical jump and movement speed. On the other hand, plyometric training is not an effective means for improving the variable, that is, speed of movement (20-m dash)[23].

MICHAEL G. MILLER ET AL (2006) concluded that that plyometric training can be an effective training technique to improve an athlete's agility[24].

MAAMER SLIMANI ET AL (2016) concluded that many issues related to Plyometric Training remain to be resolved, the results presented in this review allow recommending the use of well-designed and sport-specific Plyometric Training as a safe and effective training modality for improving jumping and sprint performance as well as agility in team sport athletes[25].

KERIM SOZBIR ET AL (2016) concluded that Plyometric exercises are recommended as part of a regular academic program in order to increase important components of athletic performance for physical education students[26].

SINGH AMRINDER ET AL (2013) stated that the plyometric training on sand is viable option to enhance performance in athletes, while reducing risk of muscle soreness and damage[27].

T.N. SURESH ET AL (2017) concluded that the short term two weeks plyometrics training program on sand shows statistically significant improvements than plyometrics training program on ground in vertical jump height in male volley ball players[28].

SHARMA R ET AL (2013) stated that the six-week sand training program have an effect on the statistically relevant increase in the explosive type strength of the leg muscles, which in turn leads to an increase in the vertical jump[29].

OZKAN CIMENLI ET AL (2016) concluded that plyometric training program effective on jump performance of volleyball players despite this training surface doesn't effect on jumping performance. In conclusion plyometric training on wooden or synthetic surfaces haven't significant differences for improving jumping performance in healthy adult male volleyball players[30].

ABBAS ASADI ET AL (2013) concluded that a 6-week in-season plyometric training program has positive effects for improving power and agility performance in young male basketball players and this study provides support for coaches and basketball players who use this training method during competitive phase[31].

ALI FATTAHI ET AL (2015) stated that plyometric training in water can be an effective technique to improve biomechanical variables in young athletes[32].

RODRIGO RAMÍREZ CAMPILLO ET AL (2013) found that after 7 weeks of plyometric training, performance enhancement in maximal strength and in actions requiring fast SSC (such as DJ and sprint) were dependent on the volume of training and the surface on which it was performed[33].

HAMID ARAZI ET AL (2016) concluded that training in aquatic conditions and on sand may be beneficial for the improvement of performance, with a concurrently lower risk of muscle damage and soreness[34].

RAOUF HAMMAMI ET AL (2016) concluded that although either sequence of balance training followed by 4weeks of plyometric training or plyometric training proceeded by 4 weeks of balance training improved jumping, hopping, sprint acceleration, and Standing Stork and Y-Balance, balance training followed by 4 weeks of plyometric training initiated greater training improvements in reactive strength index, absolute and relative leg stiffness, triple hop test, and the Y-Balance test. balance training followed by 4 weeks of plyometric training may provide either similar or superior performance enhancements compared with plyometric training proceeded by 4 weeks of balance training[35].

BUCHHIET'S ET AL (2010) study showed a relationship between a person's vertical jump and sprint speed. It was found that a faster sprint speed equals a higher vertical jump height. Basketball players are constantly moving and jumping from play to play. The athletes may have to sprint down a ball and then jump very soon after. An effective way to train can be to do repeated sprints then jumping in between.

OGNJEN ANDREJI ET AL (2012) demonstrate that a short-term plyometric and strength training program significantly increases motor performance skills in young basketball players.

M E BROWN ET AL (1998) conclude that the plyometric training appears to enhance the coordination of the arms with strength development of the legs and provides a convenient in-season training method.

6. METHODOLOGY

6.1.Study Design : Quasi- Experimental

6.2.Sampling method : convenient sampling

6.3.Sample Size : 30 male basketball Players

6.4.Study setting : Outdoor setup

6.5.Study Duration : 6 weeks

6.6. Selection Criteria

6.6.1 Inclusion criteria

1) Male basket ball players
2) Age 18 to 25 years
3) Currently participating in basketball tournament
4) Vertical jump height > 51 cm to < 70 cm (above average and very good criteria)
5) Off season players

6.6.2 Exclusion criteria

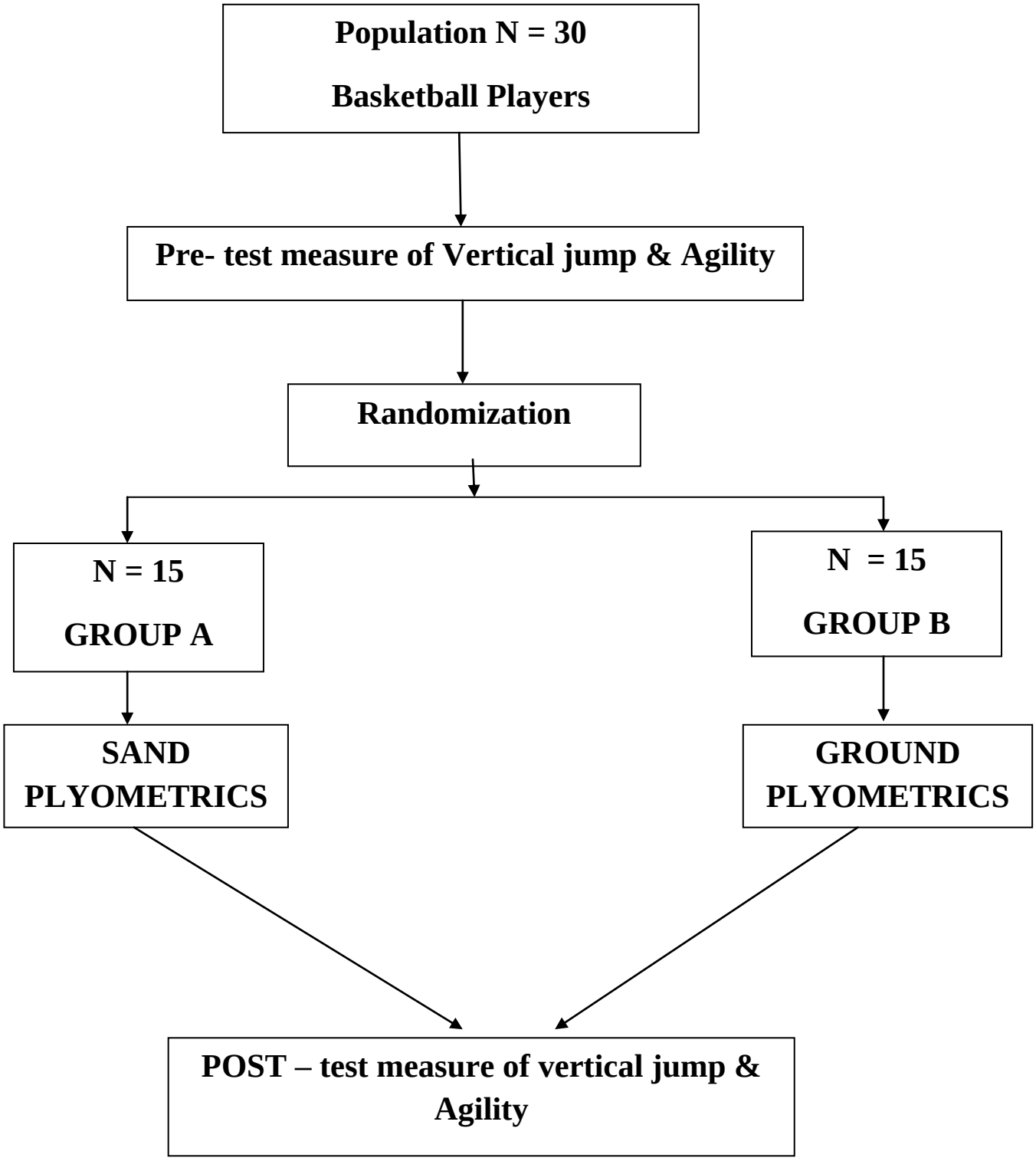
1) Previously injured (within 6 months)
2) Subjects who are undergoing other plyometric training
3) Limb length disrecrepancy
4) Previous surgeries to lower limb
5) Neuromuscular weakness
6) Ligament instability in lower limb
7) Back injury
8) Recreational players
9) Recent fracture
10) Subjects playing sports other than basketball

6.7 Measurement tool

1) Vertical Jump
2) T Test

6.8 Materials Used

1) Chalk powder
2) Inch Tape
3) Cones
4) Stopwatch


Population N = 30
Basketball Players
Pre- test measure of Vertical jump & Agility
Randomization
N = 15
GROUP A
N = 15
GROUP B
SAND PLYOMETRICS
GROUND PLYOMETRICS
POST – test measure of vertical jump & Agility

7.PROCEDURE

Assessment Procedure

VERTICAL JUMP

The vertical jump test involves measuring the difference between the standing reach and the height reached at the peak of a vertical jump.Initially jump technique is reviewed. Several easy jumps are done for warm up before proceeding to mesurement jump. During resting, player is made to stand with side towards wall and reach up as high as possible keeping the feet flat on ground. Stand reach height will be recorded. To test the jump height player is made to stand slightly away from the wall

He has to jump as high as possible using both arms and legs to assist in projecting the body upwards. He has to touch the wall at the highest point on jump. Three attempts are made in the same way and best of three readings was selected. Net height is calculated from subtracting the standing reach height from the jump height. Vertical jump is obtained by this.

T Test

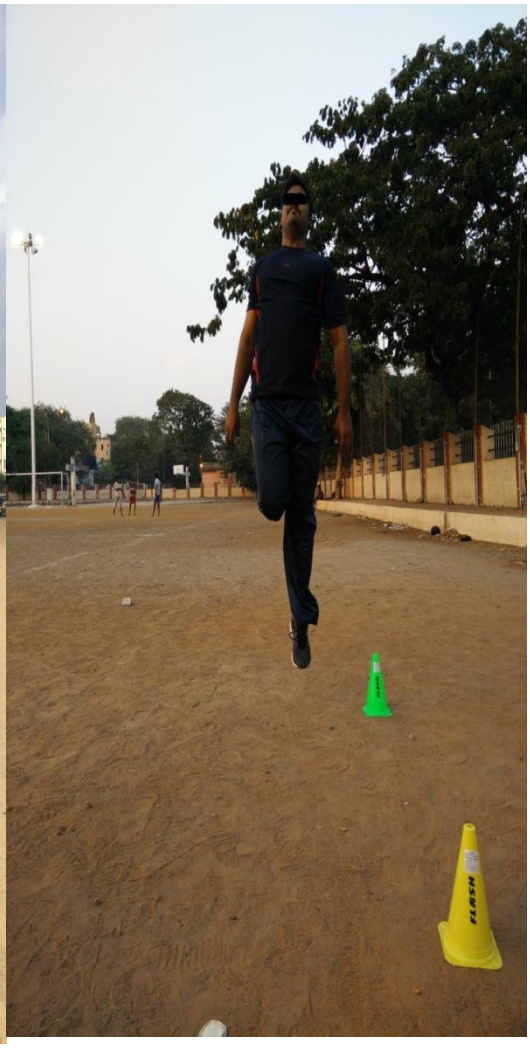
The T-Test is a test of agility for athletes, and includes forward, lateral, and backward running. The T-Test is an effective way to assess the players ability to change direction at speed.This test is a great test of agility and is easy to set up.Four cones are arranged in a " T " form, with two cones are placed 10m apart from each other. From one of the two placed cones place the remaining two cones 5m lateral to each side. The athlete begins at point A to the right side of the cone. On the 'go' command, the athlete sprints forward to point B and proceeds just beyond the cone so that the athlete may change directions without touching the cone. The athlete then side-shuffles 5m to the left to point C and touches the base of the cone with the left hand. The athlete then side-shuffles 10m to the right to point D and touches the base of the cone with the right hand. The athlete then side-shuffles 5m to the left to point B and proceeds just beyond the cone so that the athlete can change directions without touching the cone. The athlete then runs backwards to the left of the cones to point A where the timer will record the time to the nearest tenth of a second once the athlete passes the cone at point A. Thus the value of the T-Test is obtained.

Training Procedure

SINGLE LEG HOP

Subject has to stand upright on the leg in which exercise has to be performed, with knee slightly bent. The other knee is bent to 90° with the knees opposite each other thereby keeping pelvis neutrally aligned, legs hip width apart.Subject is asked to keep his lower tummy gently pulled in and chest raised to straighten the spine with the head up, arms at his sides. Then he is asked to hop in that position.

Single leg hop in sand



Single leg hop in ground

LATERAL SIDE HOPS

Player has to stand upright on one leg. The foot has to directly under his shoulder, lower tummy gently pulled in and knee slightly bent and the other leg bent at the knee and parallel and opposite the exercising leg. Ask him to perform a one leg side hop away from the foot in contact with ground. As he land comfortably on the hopping leg, concentrate on maintaining a level pelvis each time you land by tightening your buttock muscles. Repeat the hop back to the starting position to complete a repetition.

Lateral Hops in sand

Lateral hops in ground

SINGLE LEG BOUNDS

Player has to stand upright on single leg, lower tummy gently pulled in, chest raised to straighten the spine. On single leg he has to bound forward by jumping and land on the same leg. As he land, explosively push off again to bound forward to land on the same leg. Continue this series for 6 to 8 steps. Then do it on the other leg. Keep the knees slightly bent and focus on gently squeezing the Gluteals just before landing. This will help to perform better.

Single leg bounds in sand

Single leg bounds in ground

DOUBLE LEG JUMP

Player has to stand upright with feet together and hands at front. He has to jump upward and forward as much as he can. Once he has landed he has to repeat the motion. While jumping forward he has to swing his arms effectively to reach maximum distance.

Double leg jump in ground

Double leg jump in sand

TUCK JUMP

Tuck jump has to begin in a comfortable standing position with knees slightly bent. Hold hands in front of you, palms down with your fingertips together at chest height. This will be starting position. Rapidly dip down into a quarter squat and immediately explode upward. Drive the knees towards the chest, attempting to touch them to the palms of the hands. Jump as high as possible, raising knees up, and then ensure a good land be re-extending legs, absorbing impact through be allowing the knees to re-bend. This is how tuck jump is performed.

Tuck jumps in sand

Tuck jumps in ground

8.STATISTICAL ANALYSIS

The collected data were tabulated and analyzed using descriptive and interferential statistics. Mean and standard deviation were used to asses all the parameters of the data using statistical package for social science (SPSS) version 17. Paired t-test and independent t test was adopted to find out the effect of plyometric training in sand versus training in ground.

STATISTICAL TOOL

Paired t-test was used to find out the difference in the pre-test & post-test scores within the groups.

Formula : Paired t-test

$$S.D = \frac{\sqrt{\sum(d-d')}}{n-1}$$

$$S = SD/\sqrt{n}$$

$$t = \frac{d'}{S/\sqrt{n}}$$

d=x-y d'=∑d

Where

d' is the mean of change in values between pre and post treatment.

S.D is the standard deviation of pre and post treatment.

S is the standard error of the mean.

Table 1

COMPARISON OF PRE AND POST TEST OF VERTICAL JUMP HEIGHT IN GROUP A WHO UNDERWENT PLYOMETRIC TRAINING ON SAND

	Mean	N	S.D	Std.err	Sig
Pre test	65.13	15	2.973	.768	.000
Post test	68.73	15	3.305	.853	

P<.05

In this table p value is less than .05 which shows that there is a significant difference in vertical jump height in group A who underwent plyometric training in sand.

Graph 1

COMPARISON OF PRE AND POST TEST OF VERTICAL JUMP HEIGHT IN GROUP A WHO UNDERWENT PLYOMETRIC TRAINING ON SAND

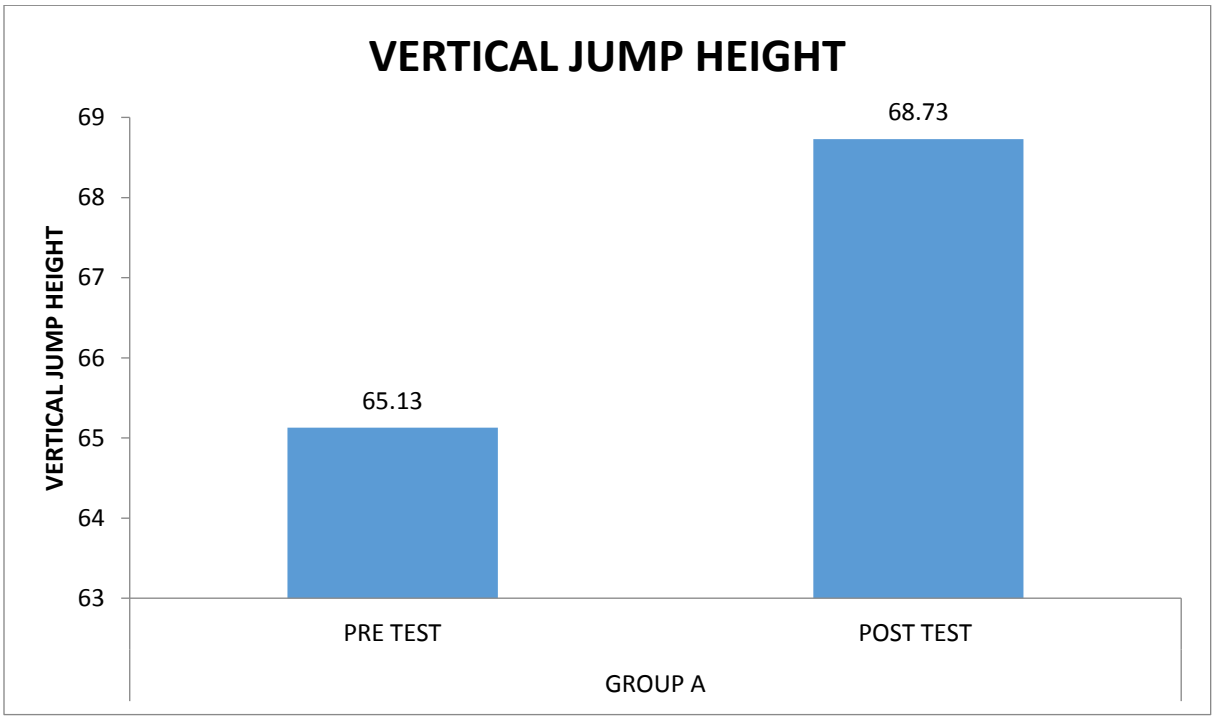


Table 2

COMPARISON OF PRE AND POST TEST OF VERTICAL JUMP HEIGHT IN GROUP B WHO UNDERWENT PLYOMETRIC TRAINING ON GROUND

	Mean	N	S.D	Std.err	Sig
Pre test	64.87	15	2.295	.593	.000
Post test	67.07	15	2.685	.693	

P<.05

In this table p value is less than .05 which shows that there is a significant difference in vertical jump height in group B who underwent plyometric training in ground.

Graph 2

COMPARISON OF PRE AND POST TEST OF VERTICAL JUMP HEIGHT IN GROUP B WHO UNDERWENT PLYOMETRIC TRAINING ON GROUND

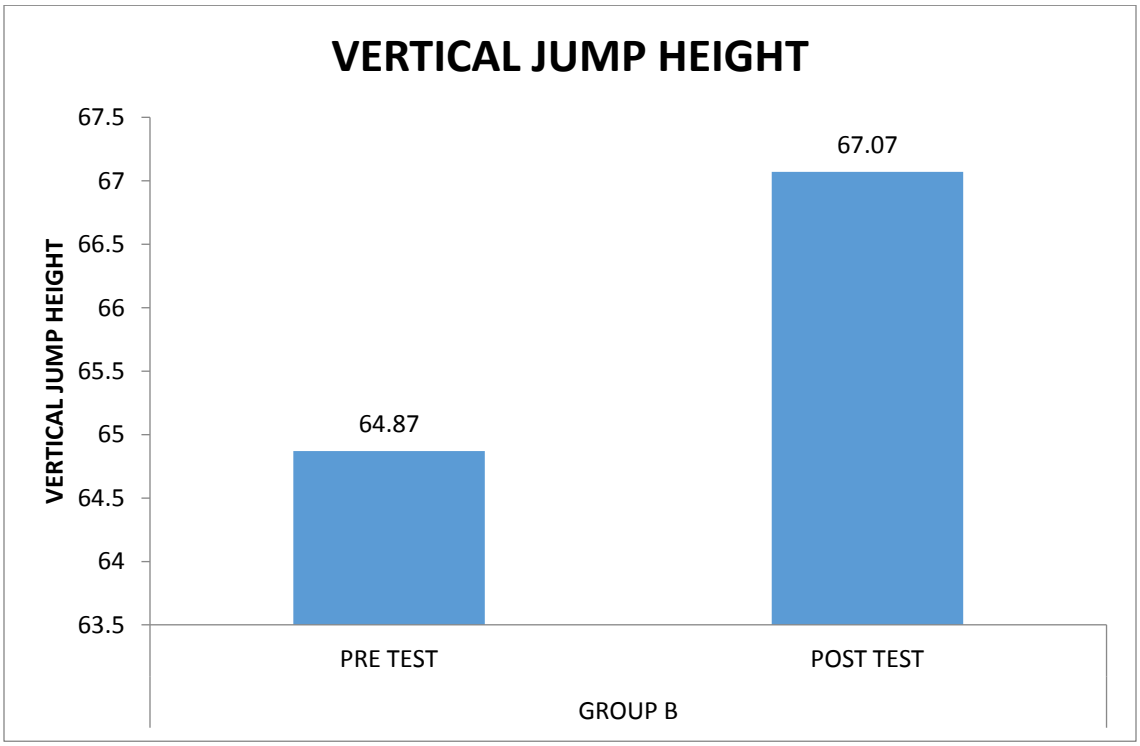


Table 3

COMPARISON OF PRE AND POST TEST OF AGILITY IN GROUP A WHO UNDERWENT PLYOMETRIC TRAINING ON SAND

	Mean	N	S.D	Std.err	Sig
Pre test	10.40	15	.554	.143	.000
Post test	10.14	15	.540	.139	

P<.05

In this table p value is less than .05 which shows that there is a significant difference in Agility T-test in group A who underwent plyometric training in sand.

Graph 3

COMPARISON OF PRE AND POST TEST OF AGILITY IN GROUP A WHO UNDERWENT PLYOMETRIC TRAINING ON SAND

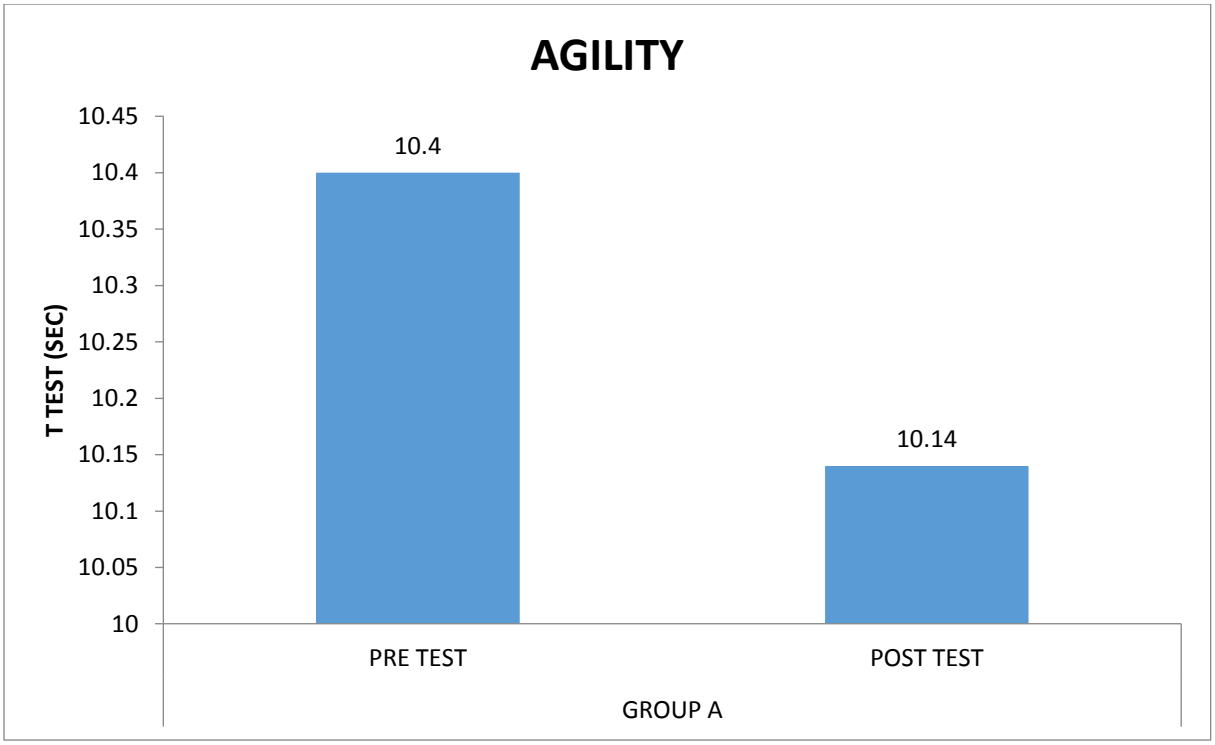


Table 4

COMPARISON OF PRE AND POST TEST OF AGILITY IN GROUP B WHO UNDERWENT PLYOMETRIC TRAINING ON GROUND

	Mean	N	S.D	Std.err	Sig
Pre test	10.52	15	.544	.140	.000
Post test	10.34	15	.554	.143	

P<.05

In this table p value is less than .05 which shows that there is a significant difference in Agility T-test in group B who underwent plyometric training in ground.

Graph 4

COMPARISON OF PRE AND POST TEST OF AGILITY IN GROUP B WHO UNDERWENT PLYOMETRIC TRAINING ON GROUND

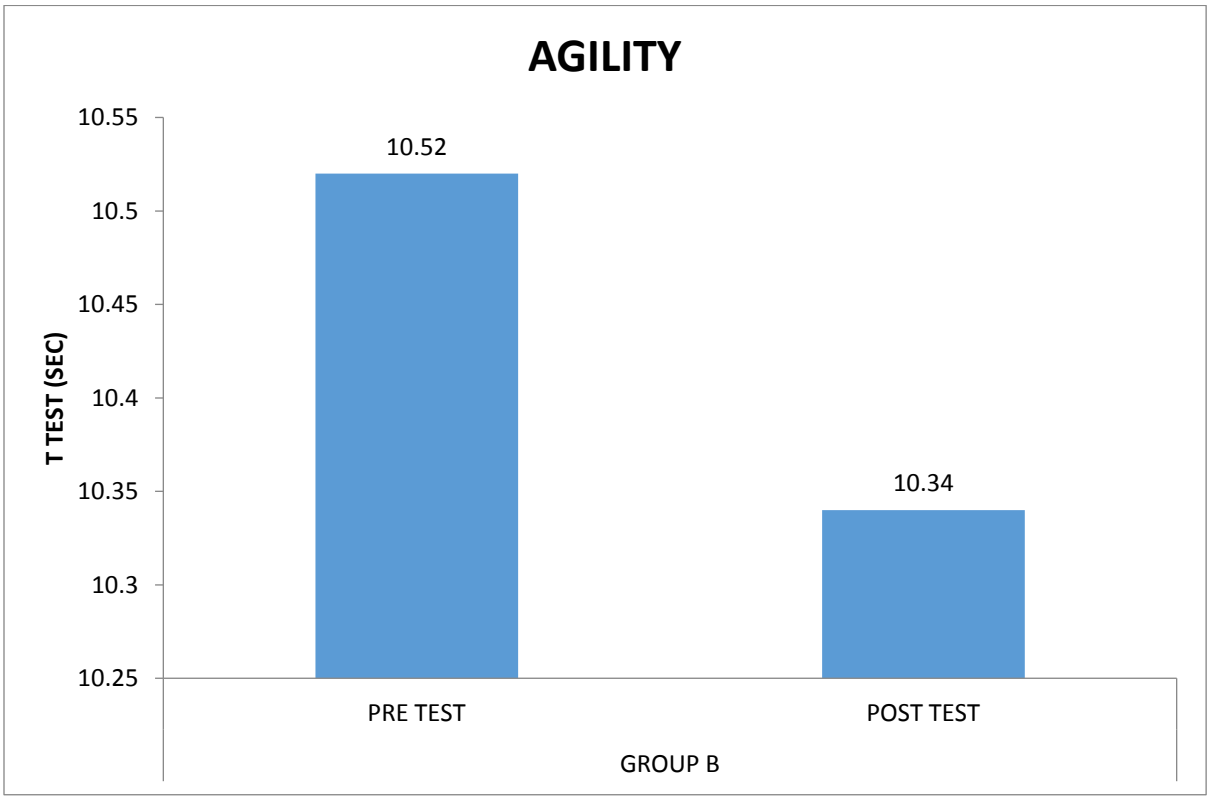


Table 5

DIFFERENCE BETWEEN POST VALUES OF VERTICAL JUMP HEIGHT BETWEEN GROUP A AND GROUP B

	Mean	N	S.D	Std.err	Sig
GROUP A	-3.600	15	.910	.235	.000
GROUP B	-2.200	15	.676	.175	.000

P<.05

In this table p value is lesser than .05 which shows that there is significant difference in vertical jump height between group A players trained on sand and group B players trained on ground.

Graph 5

DIFFERENCE BETWEEN POST VALUES OF VERTICAL JUMP HEIGHT BETWEEN GROUP A AND GROUP B

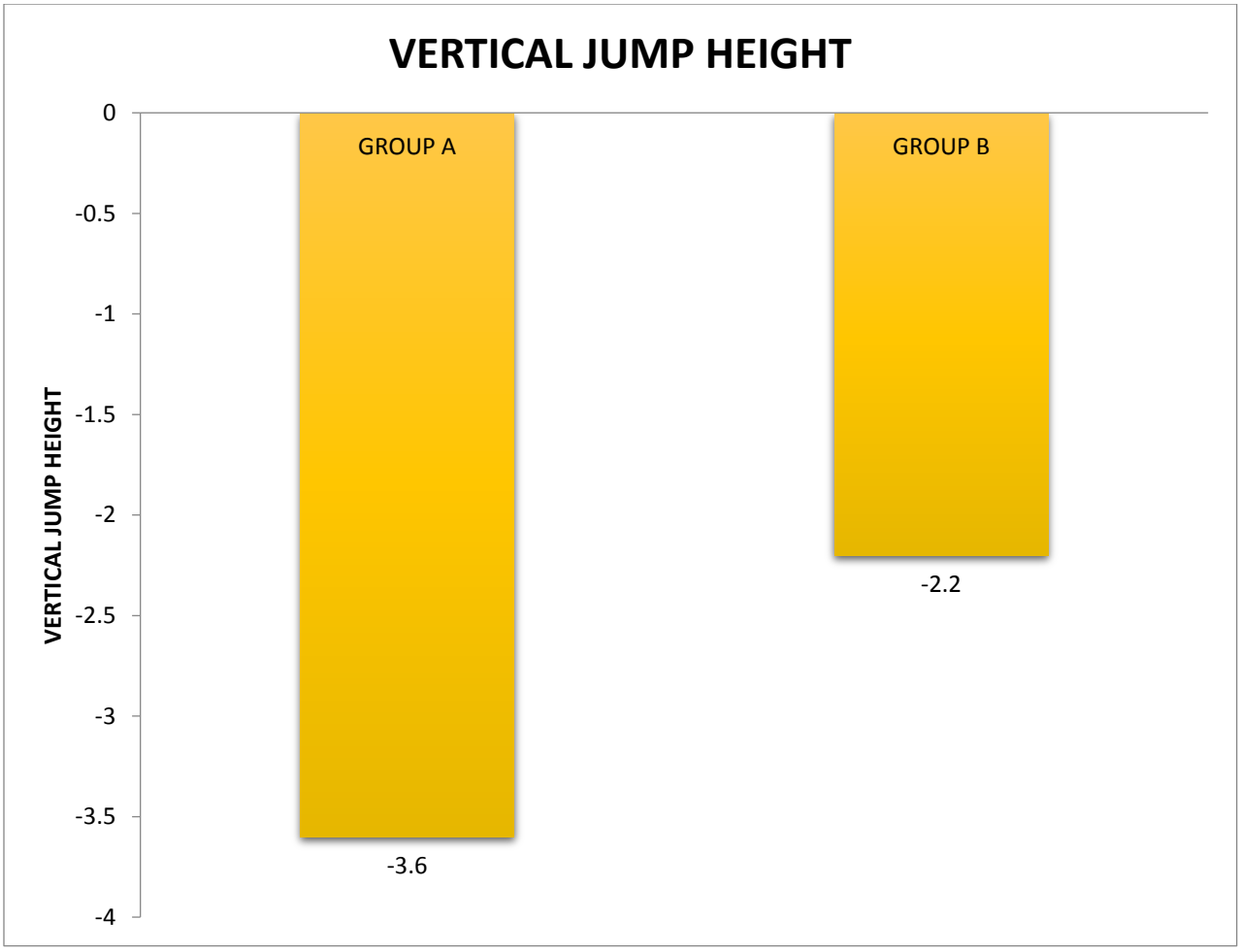


Table 6

DIFFERENCE BETWEEN POST VALUES OF AGILITY BETWEEN GROUP A AND GROUP B

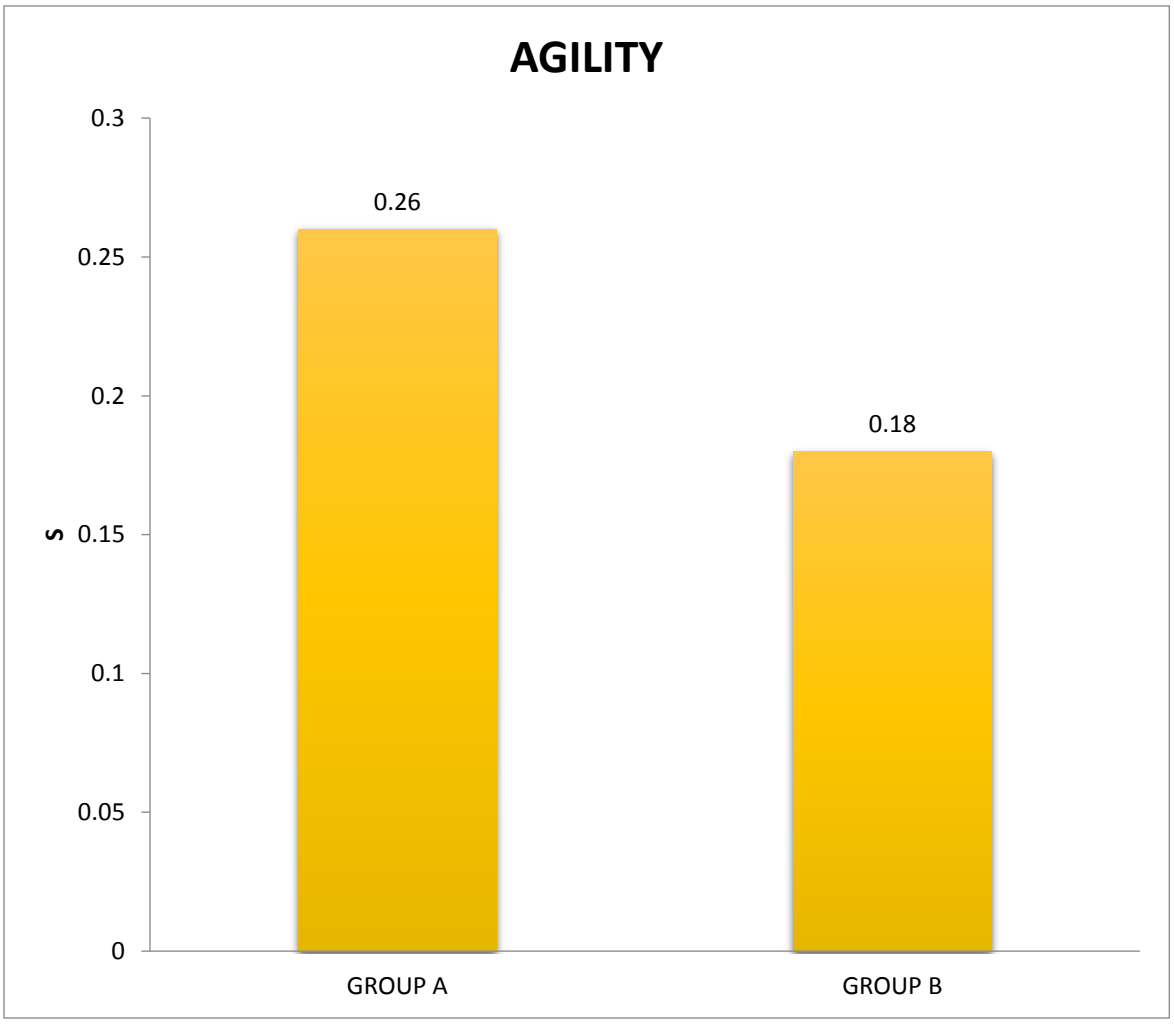
	Mean	N	S.D	Std.err	Sig
Pre test	.260	15	.083	.021	.000
Post test	.180	15	.056	.014	

P<.05

In this table p value is lesser than .05 which shows that there is significant difference in Agility T-test between group A players trained on sand and group B players trained on ground.

Graph 6

DIFFERENCE BETWEEN POST VALUES OF AGILITY BETWEEN GROUP A AND GROUP B



9.RESULT

In table 1 & graph 1, the pre test values were compared with post test values of vertical jump height of group A players trained on sand. According to this table p value is less than .05 which shows that there is a significant difference in vertical jump height in group A who underwent plyometric training in sand.

In table 2 & graph 2, the pre test values were compared with post test values of vertical jump height of group B players trained on ground. According to this table p value is less than .05 which shows that there is a significant difference in vertical jump height in group B who underwent plyometric training in ground.

In table 3 & graph 3, the pre test values were compared with post test values of Agility T-test of group A players trained on sand. According to this table p value is less than .05 which shows that there is a significant difference in Agility T-test in group A who underwent plyometric training in sand.

In table 4 & graph 4, the pre test values were compared with post test values of Agility T-test of group B players trained on ground. According to this table p value is less than .05 which shows that there is a significant difference in Agility T-test in group B who underwent plyometric training in ground.

In table 5 & graph 5, the post test values of vertical jump height are compared between group A trained on sand and group B trained on ground. According to this table p value is lesser than .05 which shows that there is significant difference in vertical jump height between group A players trained on sand and group B players trained on ground.

In table 6 & graph 6, the post test values of Agility T-test are compared between group A trained on sand and group B trained on ground. According to this table p value is lesser than .05 which shows that there is significant difference in Agility T-test between group A players trained on sand and group B players trained on ground.

10.DISCUSSION

This study aimed at comparing the effects of plyometric training on sand vs ground over the vertical jump height among basketball players. Athletes from various sports activities use Plyometric training to enhance their performance.So far only few research has been done over the area on which it is trained. Different trainers adapt the base of training according to their experience. So this study was done to provide a evidence based training for the better performance of the players. With the speed movements and unexpected quick turns, the basketball players need to be trained to produce an explosive strength that is very necessary for a power packed performance. In this type of play lots of movements are muscle stretching followed by muscle shortening which is the base of Plyometric training also.

In this study about 30 male basketball players were recruited and 15 underwent Plyometric training in sand and the other 15 underwent plyometric training in ground for a period of six weeks. The players in our study were followed up for six weeks duration and were monitored for any injuries during the total duration of training sessions. No injuries were reported. The stretching protocol adopted in our study has helped them to prevent injuries associated with short term Plyometrics training.

The results of this study says that there was a significant improvement post Plyometric training on ground for period of six weeks($p<0.05$).This can be explained by the fact that Pylometrics Improves the muscle ability to shorten after a stretch. These training make muscles to contract rapidly and explosively. This goes in hand with Fred Wilt (1975**)** who concluded that plyometrics produce "an overload of isometric-type muscle action which invokes the stretch reflex in muscles." This study shows that there was a significant improvement post Plyometric training on sand for a period of six weeks($p<0.05$).

Sand training is a gentle on the joints but harmful on the muscles way of improving the vertical jump. The softness of the sand, like the trampoline mat, absorbs and disperses the downward force which takes away any plyometric advantages of the stretch shorten cycle. The sand also makes muscles work that much harder to actually get any height on the jump.2

This goes in hand with FM Impellizzeri(2008) who concluded that plyometric training on sand "improved both jumping and sprinting ability and induced less muscle soreness". This study declares that sand plyometric training scores a better significant results in vertical jump height than ground Plyometric training for a period of six weeks.

The players who underwent plyometrics on sand reported better stability while jumping on sand during the last session as compared to the initial sessions. The players undergoing plyometric training on sand reported that they had more landing balance and that landing was more comfortable during the basketball practice sessions, following the training program. This goes in hand with Rajkumar sharma (2013**)** who concluded that the six week sand training program "increases the explosive type strength of the leg muscles, which in turn leads to an increase in the vertical jump height, spike and the long jump".

Both the groups reported an increase in their vertical jump following the training sessions. The group that underwent plyometrics on sand showed better improvement as compared to the group that underwent plyometrics on ground. This study proves that six weeks plyometrics training program in sand shows statistically significant improvements in vertical jump height. This study also shows statistically significant improvements in vertical jump height in basketball players. The six-week sand training program have an effect on the statistically relevant increase in the explosive type strength of the leg muscles, which in turn leads to an increase in the vertical jump. These results demonstrate that sand training can be used in sports to improve the vertical jump such as basketball, high jump in athletics, and volleyball etc. The athletes who trained on sand showed a greater average improvement in their vertical jump height than those athletes who trained on grass. This type of training is more a muscle centric method of developing the vertical jump.

Agility is one of the most important component for the basketballplayers to perform well. Basketball players need to change their direction swiftly and sprint quickly. Players also showed improvement in their agility after plyometric training. Post test values of Agility T Test showed a significant difference in the values compared with the pre test values of both the groups. Players who have been trained in sand shows a better significance in agility test values. This shows that plyometrics training shows a significant result in agility too.

11.CONCLUSION

The results obtained from this study shows significant difference for players trained in sand plyometrics as measured by vertical jump & T-test for agility. The mean difference for vertical jump showed significant increase in the sand group compared with ground group. Similarly , the mean difference for T-test for agility showed reduction in the timing which was more significant for the sand group than the ground group.

From the above result it can be concluded that six weeks plyometric training in sand is more effective in improving the vertical jump performance & agility among the basketball players. Hence it can be recommended that plyometric training in sand is more effective,useful & performance oriented rather than the usual training program.

12.LIMITATION AND RECOMMENDATIONS

LIMITATION

- Sample size was small.
- Study duration was short.

RECOMMENDATIONS

- Future studies can be done in larger sample size.
- Future studies can be done using other plyometric surfaces. Eg. Water, Grass.
- Future studies can be done on other players. ie. Hurdlers, High jumper
- Future studies can target more on agility performance using plyometrics.

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ANNEXURE I

CONSENT FORM

I Mr. …….. Age …….. have been properly explained about the procedure and consequence of the training. I voluntarily agree to participate in the study conducted by Mr. S.RAJAKAMAL on ‘‘ EFFECTIVENESS OF PLYOMETRICS TRAINING IN SAND VERSUS GROUND IN BASKETBALL PLAYERS - A COMPARATIVE STUDY ”. All the information given by me will be kept strictly confidential and used only for research purpose. I have the option of discontinuing at any point of time according to my personal needs or reasons.

DATE : PARTICIPANT’S SIGNATURE

ANNEXTURE II

EVALUATION FORM

Date : ……..

Name :

Age :

Gender :

Height : Cms. Weight : Kg.

Address :

Phone :

E-mail :

Dominance :

Level/ Team :

Position :

Experience :

Group : A / B

Screening questions :

1. Currently participating in competition Yes / No
2. Currently under any specific training Yes / No , if yes , specify
3. Recent Fracture Yes / No , if yes , specify
4. Presence of Back pain Yes / No

ANNEXURE III

DATA EVALUATION FORM

Measurement :

1. Vertical jump height measured in centimeters at 1st day & at the end of 6th week.
2. Agility T-test measured in seconds at 1st day & at the end of 6th week.

VERTICAL JUMP TEST

Trials	Pre-test Value (cm)	Post-test Value (cm)
1		
2		
3		
Best		

AGILITY T-TEST

S.No.	Pre-test (sec)	Post-test (sec)

ANNEXURE IV

MASTER CHART I

GROUP A (SAND TRAINING)				
S.NO	VERTICAL JUMP HEIGHT		AGILITY T-TEST	
	PRE TEST	POST TEST	PRE TEST	POST TEST
1	68	71	9.6	9.4
2	67	72	9.8	9.6
3	64	68	10	9.7
4	65	69	10.2	10.0
5	69	73	9.8	9.5
6	66	71	10.7	10.4
7	67	69	10.5	10.2
8	62	65	10	9.8
9	63	66	11.1	10.9
10	66	70	10.3	10.0
11	69	73	11.2	11.0
12	62	66	11.4	11.1
13	68	71	10.1	10.0
14	60	62	10.9	10.5
15	61	65	10.4	10.0

MASTER CHART II

GROUP B (GROUND TRAINING)				
S.NO	VERTICAL JUMP HEIGHT		AGILITY T-TEST	
	PRE TEST	POST TEST	PRE TEST	POST TEST
1	65	66	10.3	10.2
2	63	65	11.1	11.0
3	62	64	9.8	9.6
4	63	65	10.5	10.4
5	67	69	11.4	11.2
6	65	68	10.0	9.8
7	64	66	10.2	10.0
8	60	61	10.0	9.8
9	65	68	9.9	9.6
10	67	70	10.1	10.0
11	66	68	10.4	10.2
12	67	69	10.9	10.7
13	64	67	11.3	11.1
14	69	72	10.7	10.5
15	66	68	11.2	11.0