THE EFFECTIVENESS OF NOVEL QUADRUPEDAL MOVEMENT TRAINING ON BALANCE, AGILITY AND JUMP PERFORMANCE IN COLLEGIATE JUMPERS – A RANDOMIZED CONTROLLED TRIAL

by

CHARUHASINI MAHAPATRA

Dissertation submitted to the

Utkal University, Bhubaneswar, Odisha

In partial fulfillment

of the requirements for the degree of

MASTER OF PHYSIOTHERAPY (MPT)

In

SPORTS PHYSIOTHERAPY

Under the guidance of

Prof. Joseph Oliver Raj

Dean

Abhinav Bindra Sports Medicine & Research Institute, Bhubaneswar, Odisha

2023

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled "**The effectiveness of novel quadrupedal movement training on balance, agility and jump performance in collegiate jumpers- A Randomized controlled trial"** is a bonafide and genuine research work carried out by me under the guidance of **Prof. Joseph Oliver Raj, Dean , ABSMARI.**

Date **:** Signature of the candidate

Place: **CHARUHASINI MAHAPATRA**

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **The effectiveness of novel quadrupedal movement training on balance, agility and jump performance in collegiate jumpers- A Randomized controlled trial** is a bonafide research work done by **CHARUHASINI MAHAPATRA** in partial fulfillment of the requirement for the degree of **MPT - Master of Physiotherapy**.

Date**:** Signature of the Guide

Place: **Prof. Joseph Oliver Raj**

DEAN, ABSMARI

ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled **"The effectiveness of novel quadrupedal movement training on balance, agility and jump performance in collegiate jumpers- A Randomized controlled trial**" is a bonafide research work done by **CHARUHASINI MAHAPATRA** under the guidance of **Prof. Joseph Oliver Raj , Dean , ABSMARI.**

Date: Seal & Signature

Place : **Dr. Chinmay Kumar Patra** (**PT)**

Principal

ENDORSEMENT BY THE DEAN

This is to certify that the dissertation entitled **"The effectiveness of novel quadrupedal movement training on balance, agility and jump performance in collegiate jumpers- A Randomized controlled trial**" is a bonafide research work done by **CHARUHASINI MAHAPATRA** under the guidance of **Prof. Joseph Oliver Raj , DEAN, ABSMARI.**

Date: Signature

Place: **Prof. Joseph Oliver Raj**

Dean, ABSMARI

COPYRIGHT

Declaration by the Candidate

I **CHARUHASINI MAHAPATRA** of **Abhinav Bindra Sports Medicine and Research Institute** hereby declare that the Utkal University, and Abhinav Bindra Sports Medicine & Research Institute Odisha , Bhubaneswar shall have the perpetual rights to preserve, use and disseminate this dissertation / thesis in print or electronic format for academic / research purpose.

Date : Signature of the Candidate

Place: **CHARUHASINI MAHAPATRA**

ACKNOWLEDGMENT

I am thankful to supreme Lord who has bestowed his blessings on me throughout this journey. I would like to extend my gratitude towards our respected chairman of ABSMARI **Dr. Apjit Singh Bindra.** Many thanks to the founder of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar and Padma Bhushan Shri. **Abhinav Bindra.** I'm grateful to our Executive Director of ABSMARI **Dr. Digpal Singh Ranawat.**

A special acknowledgement to our **Dean, ABSMARI** and my guide **Prof. Joseph Oliver Raj,** for allowing me to conduct study and for his guidance, encouragement and support.

I would like to devote my heartily gratitude towards all my subjects for their participation and co-operation as well. I should also thank our lab assistant **Mr. Sushanta sir and Mr.satya sir** who helped me to line up the things and allow me use lab materials.

I also would like to thank all staff of ABSMARI to guide and motivate me throughout my research work. A warm thanks to **Dr. Chinmay Kumar Patra** , principal of ABSMARI for their inspiration and faith in me. I wish to thank my **parents** for their support and encouragement without which I could not have done many things so far. In the end, I want to thank my **Batchmates and juniors** who displayed appreciation for my work and motivated me to complete my work. A special thanks to **Mr . Majji Manidhar** who help me throughout my data collection.

Date:

Signature of candidate
CHARUHASINI MAHAPATRA

Place:

LIST OF ABBREVIATIONS

1. **ABSMARI –** Abhinav Bindra Sports Medicine and Research Institute
2. **ACSM –** American College of Sports Medicine
3. **ANOVA –** Analysis Of Variance
4. **BMI –** Body Mass Index
5. **BJ –** Broad Jump
6. **CON -** Control
7. **MCID-** Minimal Clinically Important Differences
8. **MTT –** Modified T Test
9. **PLYO –** Plyometric
10. **QMT –** Quadrupedal movement training
11. **SD-** Standard Deviation
12. **SPSS –** Statistical package for social science
13. **VJ –** Vertical Jump
14. **YBT –** Y Balance Test

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

ABSTRACT

THE EFFECTIVENESS OF NOVEL QUADRUPEDAL MOVEMENT TRAINING ON BALANCE, AGILITY AND JUMP PERFORMANCE IN COLLEGIATE JUMPERS – A RANDOMIZED CONTROLLED TRIAL

Background: Long jump is an event that requires speed, strength, and agility to perform well. Balance is needed at the time of launch so the body position and center of mass are at the proper point . Long jump performance also depends upon the ability to vertical jump at the time of takeoff. There is a strong correlation between the long jump and agility. There are several fitness training programs to improve performance in athletes but the novel Quadrupedal movement training is gaining more popularity in fitness industry because without any equipment, it is believed to improve fitness drastically. Unfortunately there were less evidences to support effects of QMT on fitness improvement. The aim of this study was to see the effects of novel quadrupedal movement training on dynamic balance, agility, and jump performance among collegiate long jumpers.

Methods: Sixty collegiate jumpers aged between 18-25 years of age were randomly assigned to a QMT (n=20), QMT combined with plyometric (n=20) and control (n=20) group . Each training intervention consisted of 45 minutes of exercise and 10 minutes of warm up and 5 minutes of cool down. Balance, Agility and jump performance were asses before and after the 4 weeks of

intervention using Y balance test, Modified T tests, Broad jump test and vertical jump test respectively.

Results: There was no significant difference between combined and control group ($p>0.05$) whereas a significant difference between QMT alone group and both combined and control group ($p<0.05$).Where combined and control group showed a significant improvement as compared to QMT alone on dynamic balance, agility, broad jump and vertical jump.

Interpretation and Conclusion: Our results indicates that QMT along with plyometric showed better improvement than QMT alone in balance, agility and jump performance on collegiate long jumpers. These results can be used as a unique way of fitness training.

Keywords: Quadrupedal movement training; Plyometric training; collegiate; long jumpers; Fitness

INTRODUCTION

Track and field events are generally individual sports with athletes challenging opponents to decide a single victory. Track and field sport includes several events that require jumping, running, and throwing skills. Players have more interest in running and throwing event than jumping. The jumping events include long jump, high jump triple jump, and pole vault. A long jump is an event that requires speed, strength, and agility to perform well. Balance is important for proper control during takeoff and in the flight phase. The long jump is subdivided into 4 phases – the approach run, the final two strides, the action in air and landing. Athletes are exposed to ground reaction force on the takeoff leg that are several times their body weight.(1) Balance is needed at the time of launch so the body position and center of mass are at the proper point (2). Long jump performance also depends upon the ability to vertical jump at the time of takeoff(3). There is a strong correlation between the long jump and agility(4)

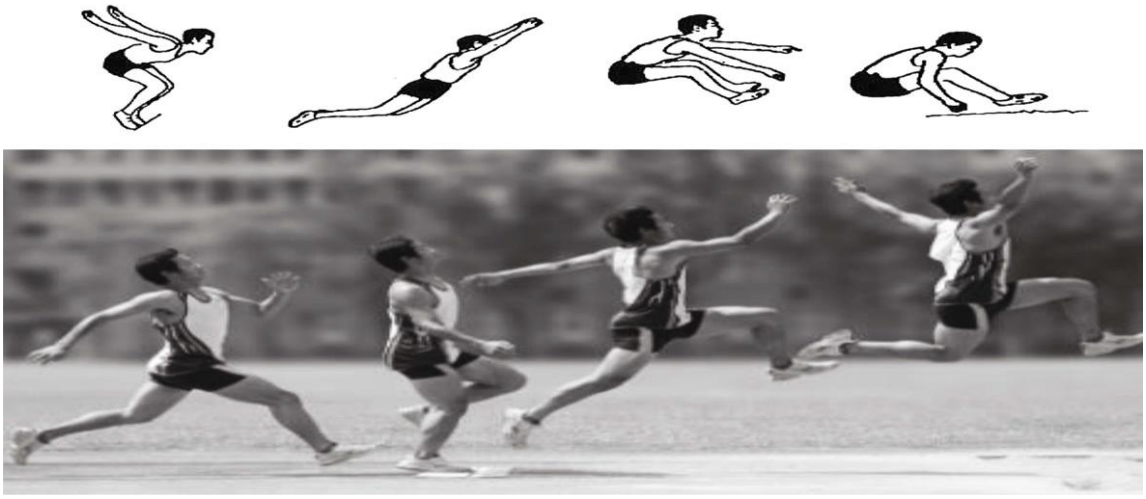


FIG 1.1 Phases of long jump[1]

Quadrupedal Movement Training: It is an emerging style of bodyweight training that is gaining popularity in the fitness industry. Quadrupedal movement training incorporates posture and movements mimicking the neurodevelopmental sequence and animal posture and movement. Many movements of quadrupedal movement training are used in physical rehabilitation of injury and neurological diseases (5).Quadruped position consists of progression of static hold, stationary contralateral arm and leg lift and a traveling crawling movement with neutral spine in each, it is also a distal muscle stabilizer and with knee raises slightly off the ground it serves pelvic position same as plank. Mendrin et al 2016 has already proven bear crawl is an effective isometric trunk exercise. Quadrupedal movement training helps to improve various fitness parameter and cognitive capacity(6).

FIG 1.2 Quadrupedal movement training[6]

Plyometric: Rehabilitation science improves day by day but when we think about athletes the primary things that come to our mind is to mainly focus on the terminal stage of rehabilitation which include performance enhancement, development of power and return to the sports. Plyometric play a significant role in late stage of rehabilitation. Plyometric are used by athletes as a training technique in all types of sports to increase strength and explosiveness. It consists of a rapid stretching of muscles (eccentric) immediately followed by a concentric or shortening action of the same muscle and connective tissue. The stored elastic energy within the muscle is used to produce more force than can be provided by concentric muscle action alone.(7,8).Previous research has shown that plyometric training when used with a periodized strength training program can contribute to improved vertical jump, acceleration, muscle power, increased joint awareness, and overall proprioception. Plyometric training helps to improve dynamic balance ,proprioception (9) also it improve agility ,vertical jump and broad jump performance(10)

FIG1.3 Plyometric training[7]

Need of The Study

There are several fitness training programs to improve performance in athletes but the novel Quadrupedal movement training is gaining more popularity in fitness industry because without any equipment, it is believed to improve fitness drastically. There is a strong association between the trunk and gluteus muscle strength and long jump performance(11), A study done by Pyka et al show traveling form of trunk exercise activates trunk muscles more as compared to static form of exercise. Other fitness training programs such as plyometric, weight lifting etc. can cause more stress on joints where novel QMT is the inclusion of low joint impact on movements. A previous study by Jeffrey D Buxton et.al suggests that a further study can be done to see the difference between the effects of QMT and other training on fitness parameters.

AIM OF THE STUDY

To see the effects of novel quadrupedal movement training on dynamic balance, agility, and jump performance among collegiate long jumpers.

OBJECTIVE OF THE STUDY

1. To see the effects of novel quadrupedal movement training on dynamic balance by using the Y balance test.

2. To see the effects of novel quadrupedal movement training on agility by using a modified T-test.

3. To see the effects of novel quadrupedal movement training on jump performance by using broad jump test and vertical jump test.

Hypotheses

Null Hypotheses:

1. There will be no significant effects of novel quadrupedal movement training on balance, agility, and jump performance in collegiate long jumpers.

2. There will be no significant effects of novel quadrupedal movement training along with plyometrics on balance, agility and jump performance in collegiate long jumpers.

3. There will be no significant difference between QMT group and QMT along with plyometric group as compare to control group.

Alternative Hypotheses:

1. There will be a significant effect of novel quadrupedal movement training on balance, agility, and jump performance in collegiate long jumpers.

2. There will be a significant effects of novel quadrupedal movement training along with plyometric on balance, agility and jump performance in collegiate long jumpers.

3. There will be a significant difference between QMT group and QMT along with plyometric group as compare to control group.

REVIEW OF LITERATURE

1. **Amir vazini Taher et al 2021**conducted a study on the "effect of vertical and horizontal plyometric exercise on explosive capacity and kinetic variable in professional long jump athletes" in Iran. It was a randomized controlled trial where 20 subjects are divided into 2 groups experimental group receives plyometric training and control group receive general training for 6-week outcome measures are like 30m sprint test, vertical jump test, and standing long jump test where they found experimental group have significant improvement as compared to the control group.

2. **Zarizi Ab Rahman et al 2021** conducted a study on reliability, validity, and norm reference of standing broad jump. This study involved 60 subjects and 6 raters for reliability and validity findings showed ICC was high among male raters (.96)and female rater (.99) study also indicates new norms of standing broad jump (male-2.54 and female- 2.06 and above (excellence), M-2.26-2.53 and F-1.74-2.05(good), M-2.97-2.25 and F-1.40-1.73(average), M-1.69-1.90 and F-1.06-1.39(poor), M-1.68, and F-1.05 (below) results suggest that standing broad jump the test is highly reliable and valid with norms reference to asses leg power.

3. **Jeffery D. Buxton et al 2020** conducted a study on the effect of novel quadrupedal Movement training on functional movement, range of motion,strength and endurance, balance in 42 active college-age subjects (19.76 + 2.10 years) were randomly assigned to a QMT and

control group for 8 weeks. The QMT group Shows significant improvement in FMS than the control group, with No significant difference in range of motion, strength, and endurance.

4. **Ana F. Sliva et al 2019** conducted a study on The effect of plyometric training on volleyball player – A systemic review, conducted according to preferred reporting items for systemic review and meta-analysis (PRISMA) guidelines using Pubmed, SciELO, sports discus, Medline, Scopus, CINAHL since December 2018Research mainly focus on the interventional study,1831 article was found,5 added from another source duplicate articles have removed the title and abstracts are seen from where 21 articles are selected for review 15 articles for vertical jump,4 article for strength,4 articles for horizontal jump,4 articles for flexibility, and 3 article for agility. It indicates that plyometric training helps to improve strength, vertical and horizontal jump, flexibility, and agility in volleyball players.

5. **Ranna alikhani et al 2019** conducted a study on “the effect of 6 week plyometric training on dynamic balance and knee proprioception in female badminton players” in Toronto. It was a randomized controlled trial where 22 subject were divided into 2 groups experimental group (n=12) that received plyometric 20 min per session 3 sessions per week for a 6-week control group(n=10) received the general training program, the Y test is used to measure dynamic balance and proprioception

measured by auto CAD software which shows an experimental group have significant improvement as compared to the control group.

6. **Darien T. Pyka et al 2017** conducted a study on the effects of static, stationary and traveling trunk exercise on muscle activation by using surface EMG in recreational individuals from where 7 women (mean age- 22.4+_2.4) and 23 men (mean age - 23.6+_3.9) subject perform voluntary muscle contraction of each muscle and measurement taken by EMG then all subjects perform 3 exercise randomly for 30 sec each with 2 min rest in between them. There was a greater muscle activation in all muscles tested in the stationary and traveling forms of exercise compare to the static form of exercise.

7. **Laura J. Smith et al 2017** conducted a study on the performance and reliability of the Y balance test in high school athletes. It is an observational cross sectional study where 51 male and 59 female athlete participants were included where they found Anterior direction good reliability (ICC-0.84), posterolateral direction moderate reliability (ICC-0.76), posteromedial direction moderate reliability (ICC-0.63), MDC95 for anterior direction was 6% and 12% for both posteromedial and posterolateral direction.

8. **Kevin N. Kijowksi et al 2015** conducted a study on short-term resistance and plyometric training improves eccentric phase kinetics in jumping. Purpose of the study examined the effects of an abbreviated resistance and plyometric training on force and power time curve variables during jumping .19 male subjects were assigned from where 9 are in the experimental group 10 are in the control group. Training consist of performing 3 set repetition squat (90% of 1RM)and 5 sets of 6 repetition drop jump from 40 cm twice per week for 4 weeks.1 RM in squat and countermovement and static jump performance was assessed Before and after training; in both force time and power time curves there is Significantly increase in the eccentric rate of force and decrease eccentric time to produce impulse which concluded short-term resistance training and plyometric improve eccentric phase kinetics in jumping.

9. **Radhouan H. Sassi et al 2009** conducted a study on relative and absolute reliability of modified T-test and its relationship with vertical jump and straight sprint,86 subject participated in this study where all participants performed modified T-test, force countermovement jump, and 10-meter straight sprint the significant difference between test-retest modified T test scores .Interclass reliability of the modified T-test was greater than 0.90 across trials where Females=0.92 and males=0.95) significant correlation also found between Modified T-test and force countermovement jump and modified T-test and 10 m straight sprint. Results indicate Modified T-test is a reliable test to assess agility.

10.Peter Maulder et al 2005 conducted a study on horizontal and vertical jump assessment: reliability, symmetry, discriminative and predictive ability.18 sports person were included in this study who perform horizontal squat jump, horizontal countermovement jump, horizontal repetitive jump and vertical squat jump, vertical countermovement jump, and vertical repetitive jump test-retest reliability of horizontal jump (ICC=0.90), vertical jump (0.84-0.90) which concluded that the horizontal jump test is reliable for assessing leg power.

METHODOLOGY

Study design- Randomized controlled trial

Study setting- Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar

Study population – collegiate long jumpers

Sample size- 60

The sample size was calculated by using the formula – $2K \times sd^2 / d^2$

Sampling technique – purposive sampling (Non-random sampling)

Study duration - 8 months

Inclusion Criteria

1) Age – 18-30 years(12)

2) Gender- Both male and female long jumpers

3) Physically active (30 minutes of moderate-intensity structured activity, 3 days per week for at least 6 months).

4) According to ACSM pre-participation health screening participants should perform moderate-intensity exercise without any complication.(13)(14)

5) Subjects those who have given consent.

Exclusion Criteria

1) Any recent fractures in the upper and lower limb in the past 6 months, knee and ankle ligament injury since 1 month.

2) Subjects having vestibular disorder.

3) Subjects having asthma.

4) Subjects having severe depression in the Beck depression inventory(15)

5) Involved in any kind of balance, agility, or jump training program.

6) Subjects who are not willing to participate in the study.

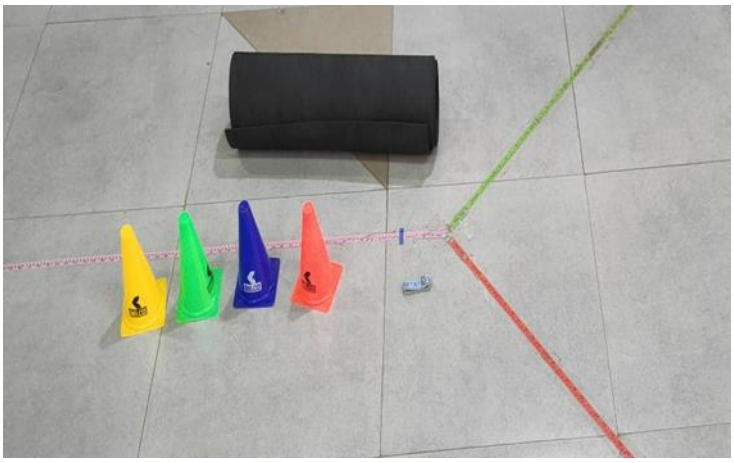


FIG 4. 1. Materials used

Materials Used:

1) Stopwatch
2) Yoga mat (13mm extra thick)
3) Measuring tape-04
4) Agility cones- 04
5) Marker/ powder

Outcome Measures:

1. Balance – Y balance test
2. Agility – modified T-test
3. Jump performance – Broad jump test

Vertical jump test

FIG 4.2. Y Balance Test Measurement

FIG 4. 3. Modified T Test Measurement

FIG4. 4. Broad jump Test

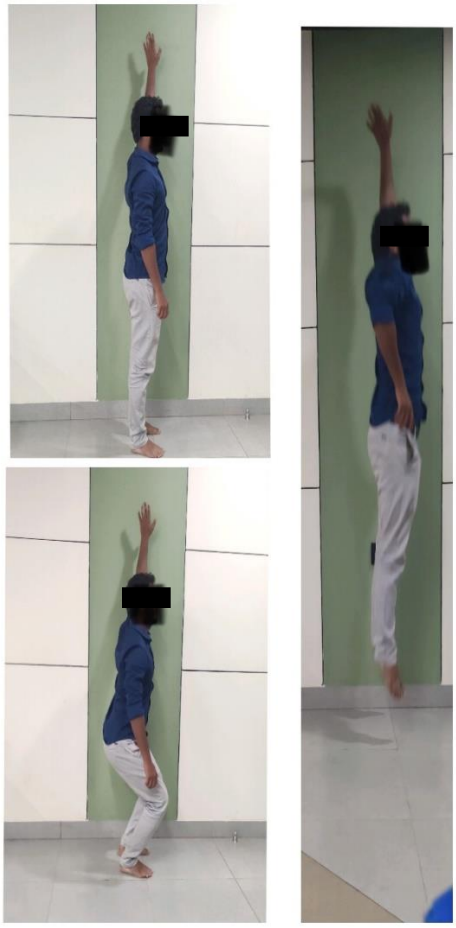


Fig 4.5. Vertical jump Test

PROCEDURE

The present study was reviewed and approved by the institutional Ethical Committee. A total of 75 samples were selected by using purposive sampling the method from where 60 subjects were selected based on inclusion criteria And exclusion criteria and 15 subjects were excluded. They were included in these Study with some criteria like the collegiate long jumpers who were practicing long jump three to five times per week at the time of investigation and according to ACSM pre-participation evaluation who can perform moderate intensity exercise without any complications. The study Protocol was explained to all participants and their informed consent were obtained Groups allocation was done by using Block Randomization (2 boxes for male and 2 for female each box contain 15 pieces of paper (5 -A, 5-B, 5-C)) 20 subjects (10 males, 10 females) were placed in Group A (Experimental group) 20 subjects (10 males, 10 females) were placed in Group B (Experimental group) 20 subjects (10 males, 10 females) were placed in group C (Control group) Baseline assessments were taken which include dynamic balance, agility and Jump performance. The assessment for dynamic balance was taken using Y Balance test, agility was taken using a modified T-test and jump performance was taken using broad jump test for horizontal jump and vertical jump test for vertical Jump.

Y Balance Test

Three tapes were placed on the floor for the YBT, so as to form an angle of 90 degrees between the two posteriorly directed tapes and the other two angles

of 135 degrees between the anterior and the posteromedial and posterolateral tapes respectively. The participant had to place one leg in the center of the three tapes and try to reach as far as possible anteriorly, postero-medially and postero laterally with the other leg. The left and right sides were measured separately with the score corresponding to the stance leg. The scoring was calculated as the percentage of reach distance to the limb length. The test has a high interclass and intra-class reliability of 0.93(16).

Modified T Test

Four cones were used in this test. During the test the participants runs to the front cone which will be at a distance of 5 Meters, moving laterally to the left covering a distance of 2.5 meters (by shuffling) later returning to the center and moving to the right for another 2.5 meters (by shuffling),returning to the center and running backward to the finish line. The stopwatch were start at the time when participant started and stop when the cross the last cone. Time were calculated. The test has interclass and intraclass reliability of 0.90(17).

Broad jump Test

One measuring tape were required for this test. Participants stand with there feet apart as shoulder level. Bend there knees to sit back into half squat ,explode into the air ,pushing off toes and swing there arms forward and straight up above there head and jump as far as possible. The measurement were done from heel contact from the starting point to heel distance during landing. The best of three attempts were recorded .The test has interclass and intraclass reliability of 0.97(18).

Vertical jump Test

One measuring tape and one chalk were required for this test. The participant stands side on to a wall and reaches up with the hand closest to the wall. Keeping foot flat on the ground ,the point of fingertips is marked .The person standing away from the wall and jump vertically as high as possible using both arm and leg and attempt to touch the wall at the heighest point of jump .the difference distance between standing reach height and jump height is the score. The best of three attempts were recorded . The test has interclass and intraclass reliability of 0.92(19). All groups were mandated to perform a warm-up before intervention which included Jogging and dynamic stretching for 10 minutes and cooling down after intervention which Included slow walking and static stretching for 5 minutes. All groups took intervention for a total of 60 minutes from which 15 minutes are for Warm-up and cool down and 45 minutes for the intervention. Group A performed only quadrupedal movement training; Group B performed quadrupedal movement training and low-intensity plyometric trained; Group C Performed only low-intensity plyometric training.

While performing training they used 13 inch yoga mat. Subjects took intervention 3 days(every alternative day) per week for 4 weeks First training program continues for 2 weeks then the progression Given for next 2 week. At the end of 4^{th} week, post-intervention data were assessed For both groups data were analyzed. The difference between pre-intervention and post Intervention within the group was assessed using paired t-test and differences between groups were analyzed by one-way ANOVA followed by post hoc TURKEY test.

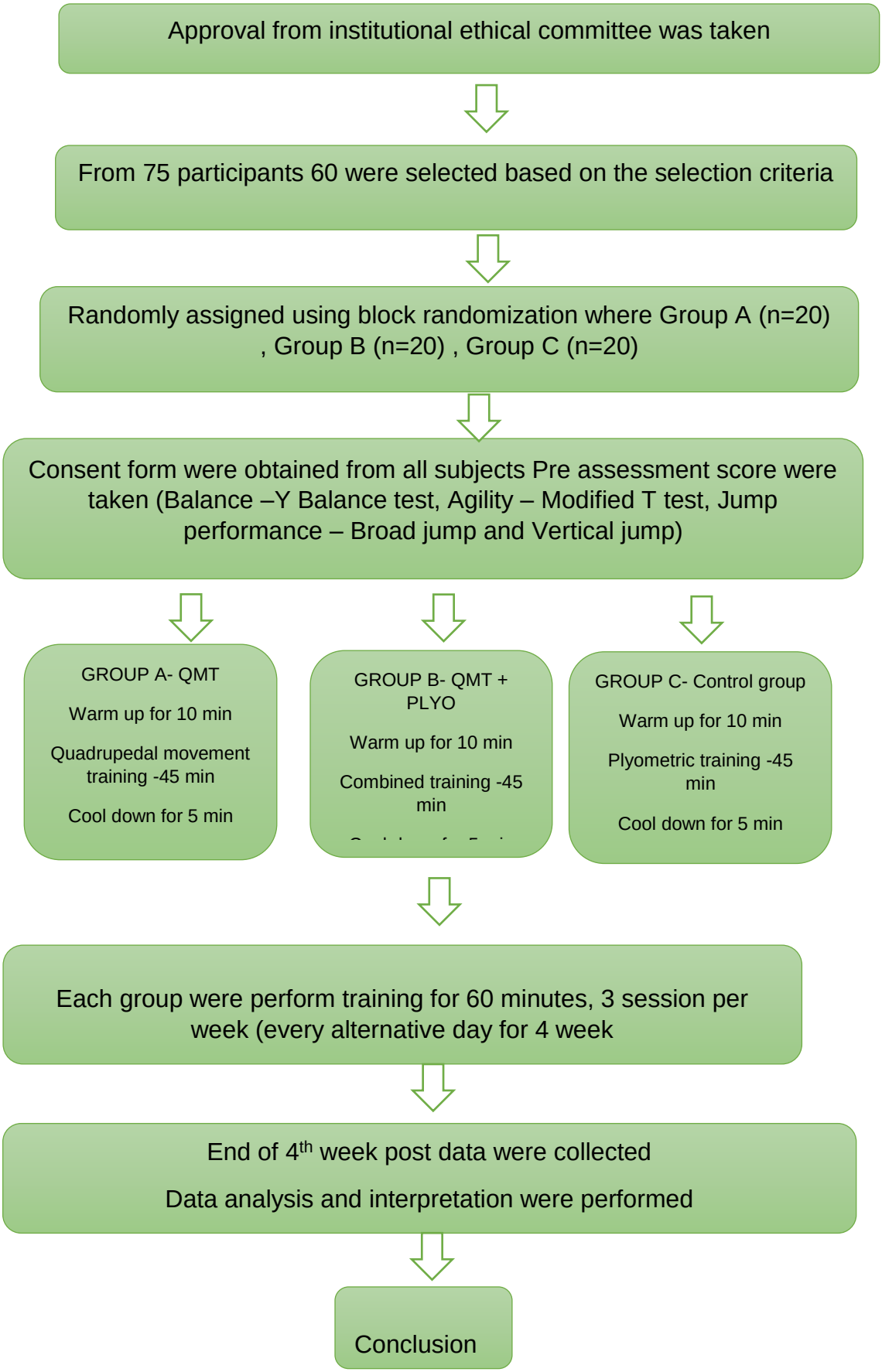


FIG4.6 flow chart of study procedure

Training Programs

Quadrupedal Movement Training Group

For 1st And 2nd Weeks

Type	Exercises	Repetitions /Sets	Rest
Quadrupedal movement training	Wrist rolls , Wrist waves, Prayer stretch Quadruped wrist Activation Form stretch, traveling form, switch	30 sec each/1 10-15 sec/3 2 rep /3	0 30 sec

For 3rd And 4th Week

Type	Exercises	Repetitions /Sets	Rest
Quadrupedal movement training	wrist mobilization Form stretch flows Activate mobilize move circuit 1,2 Switches flows	30 sec/3 1/2 10/3 5 per side/2 1round	30 sec

Combined Training Group (Qmt + Plyometrics)

For 1st And 2nd Weeks

Type	**Exercises**	**Repetitions /Sets**	**Rest**
Quadrupedal movement training	Wrist rolls ,Wrist waves, Prayer stretch Quaderuped wrist Activation Form stretch, traveling form, switch	15 sec /1 6 sec/1 2 rep /1	0 15 sec
Plyometric	Side to side ankle hop standing jump and reach front cone hops double leg and lateral cone hops Diagonal cone hops lateral jump single limb squat jump 90 squat jump 180 squat jump split squat jump	5 rep/1	15 sec

For 3rd And 4th Weeks

Type	Exercises	Repetitions /Sets	Rest
Quadrupedal movement training	Wrist mobilization Activation Activate mobilize move circuit 1,2 Switches flows	15 sec/1 1/1 2/1 2/1 1round	15 sec
Plyometric	Single leg vertical jump double leg zig zag hop lateral barrier hop lateral hop kangaroo jumps Jump to box squat box jump lateral box jump depth jump	5 rep /2 set	15 sec

Plyometric Training

For 1st And 2nd Week

Type	Exercises	Repetitions /Sets	Rest
Plyometric	Single leg vertical jump double leg zig zag hop lateral barrier hop lateral hop kangaroo jumps Jump to box squat box jump lateral box jump depth jump	10 rep/2set	30 sec

For 3rd And 4th Week

Type	Exercises	Repetitions /Sets	Rest
Plyometric	Side to side ankle hop standing jump and reach front cone hops double leg and lateral cone hops Diagonal cone hops lateral jump single limb squat jump 90 squat jump 180 squat jump split squat jump	10 rep/3 set	30 sec

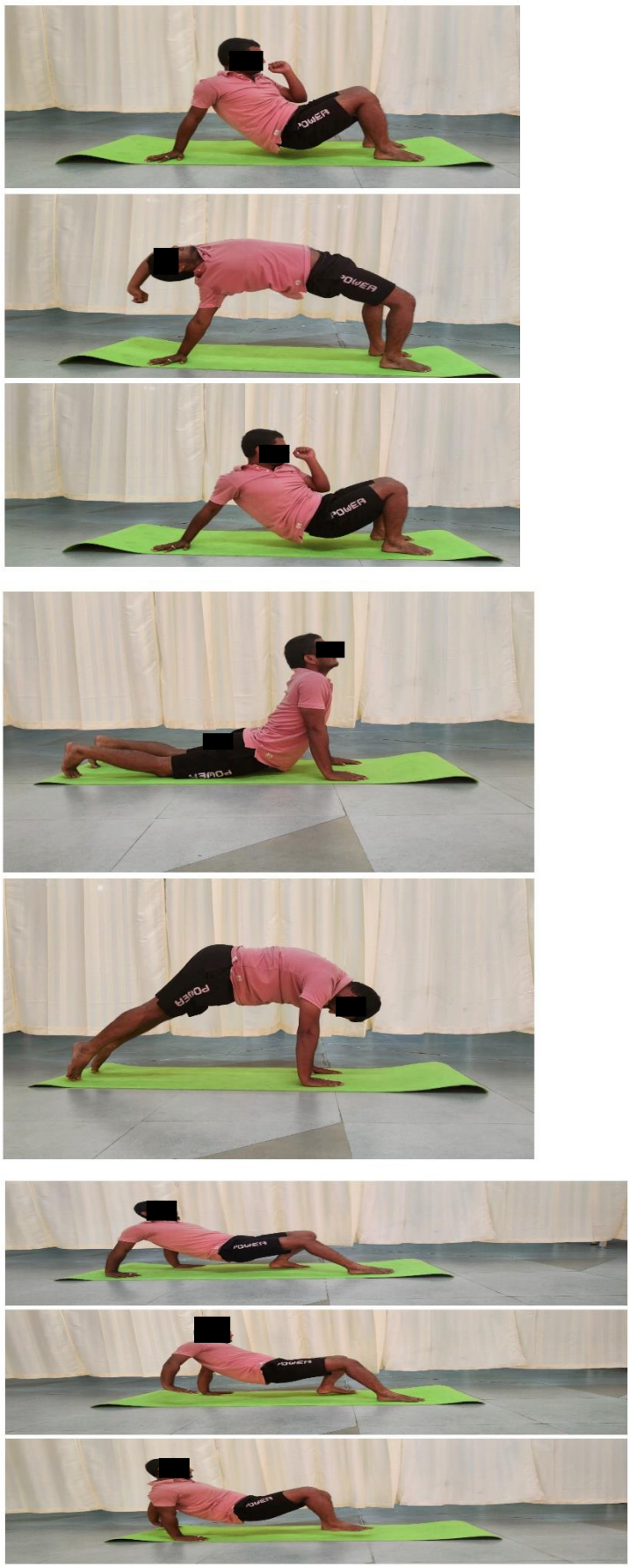
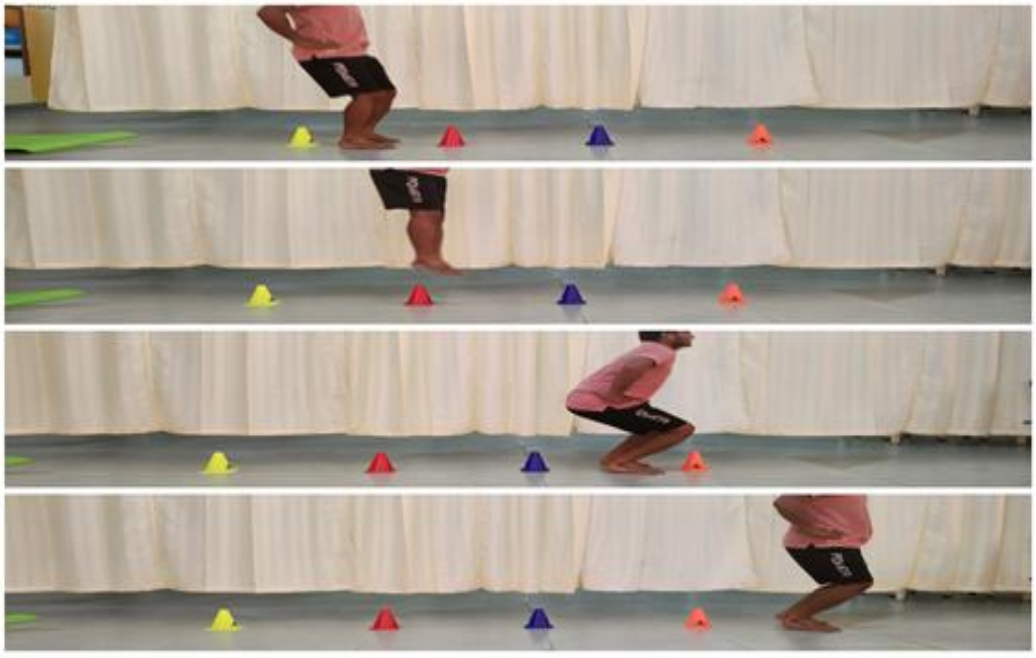


Fig 4.6 Quadrupedal movement training



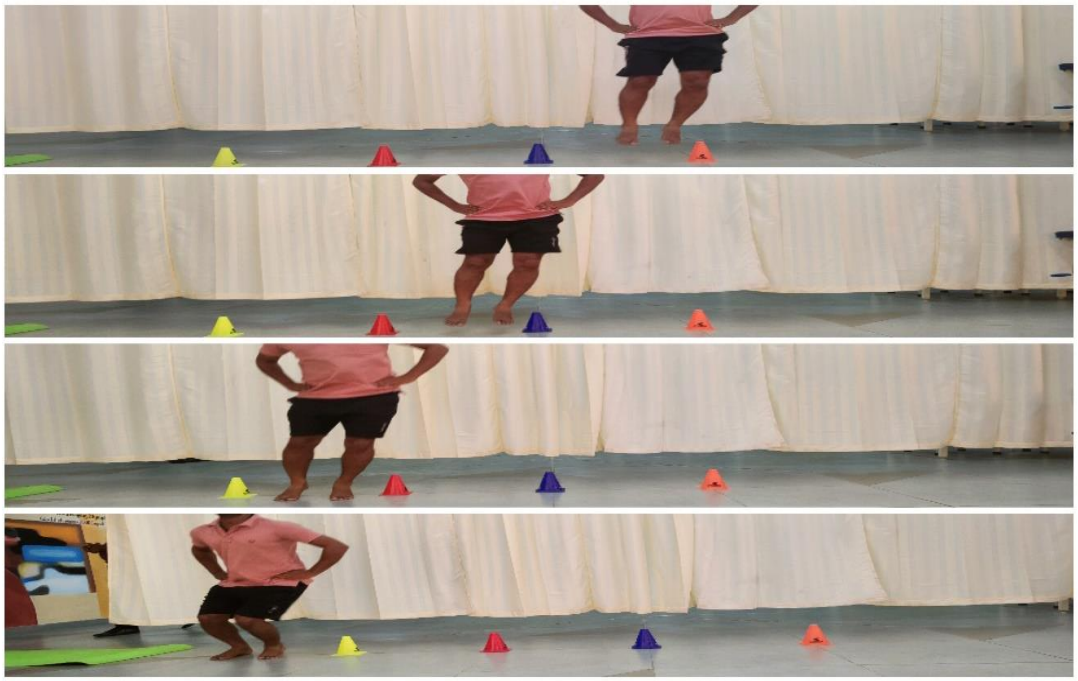


Fig 4.7 Plyometric training

SAMPLE SIZE ESTIMATION

Sample size calculation was done by using the formula for experimental studies

(outcome – balance)

$$n=2k\ SD^2 / d^2$$

where

n= Number of samples

k= Power

SD=Standard Deviation

d = MCID Value K =10.5

SD= 5.14

d (MCID value)=5.5

$n= 2k * SD^2/d^2$

$2x10.5 x (5.14)^2/(5.5)^2$

=21x0.87=18.27 added 2 dropout

=20 per group (3 groups are there so total of 60 subject)

RESULT

Statistical Analysis

Data was analyzed using statistical package **SPSS 29.0** (SPSS Inc,Chicago,IL) and level ofsignificance was set at **p<0.05 Descriptive statistics** was performed to assess the mean and standard deviation of specific groups. Normality of the data was assessed using **Kolmogorov-smirnov test. Interferential statistics** to find out the difference between groups was done using **paired t test** and analysis between three groups was done using

ONE WAY ANOVA followed by Tukey's HSD post hoc analysis to find out difference between any two groups.

TABLE 7.1.Mean Age Analysis

	MEAN	SD
QMT	**21.6**	**2.72**
QMT+PLYO	**21.3**	**3.55**
CON	**20.7**	**3.23**

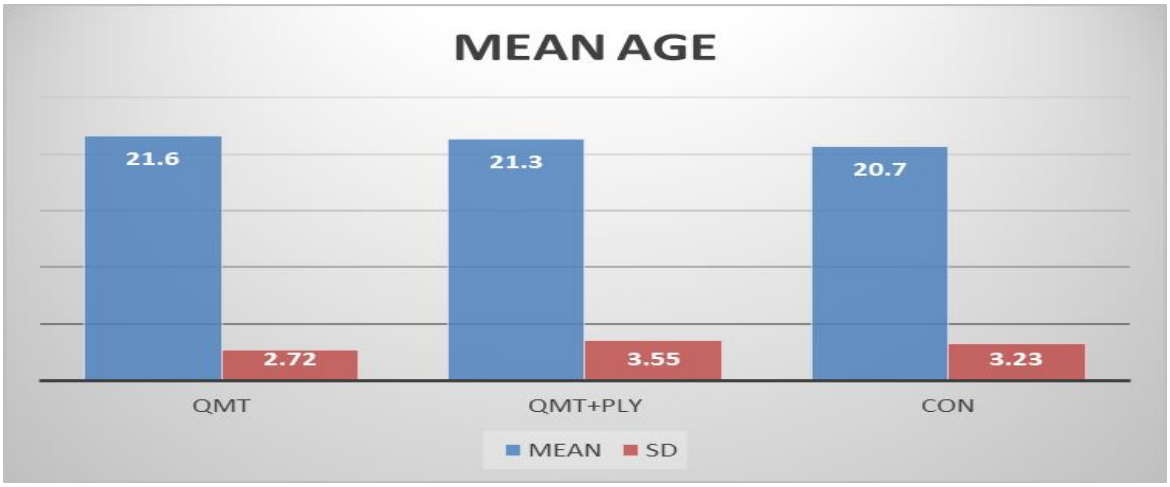


FIG 7.1 Graphical presentation of mean age

TABLE 7.2 Mean BMI Analysis

	MEAN	SD
QMT	25.1	4.16
QMT+PLYO	24.6	3.7
CON	23.7	3.73

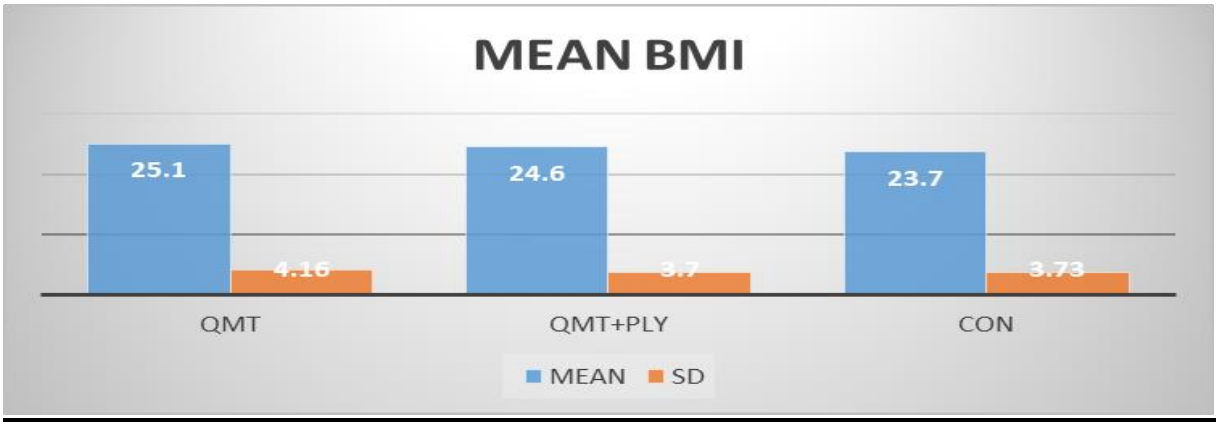


FIG 7.2 Graphical presentation of mean BMI

TABLE 7.3 Y BALANCE TEST OF LEFT LEG WITHIN GROUP ANALYSIS

	PRE	POST	P VALUE	MEAN DIFFERENCE
QMT	77.7±12.4	80.3±12.4	0.001	2.55
QMT+PLYO	76.3±10.4	82.5±10.3	0.001	6.1
CON	76.5±10.2	81.8±10.7	0.001	5.3

Y balance test of left leg analysis with paired t test indicates statistically significant difference within the group in QMT group ($p < 0.05$), QMT+PLYO

group (p<0.05), CON group (p<0.05).The difference in mean value was reported was as follows, QMT+PLYO group> CON group>QMT group.

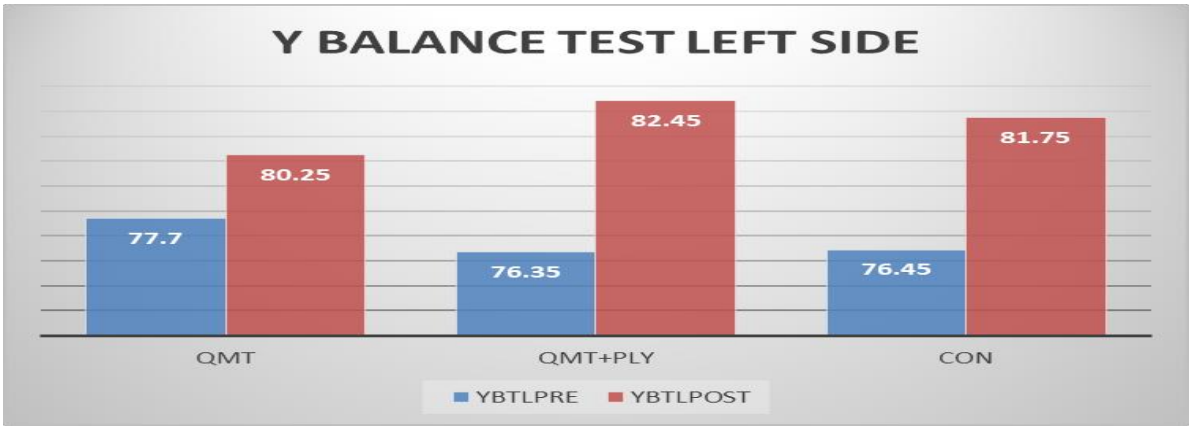


FIG 7.3 Graphical presentation of Within group analysis of left Y balance test

TABLE 7.4 Y BALANCE TEST OF RIGHT LEG WITHIN GROUP ANALYSIS

	PRE	POST	P VALUE	MEAN DIFFERENCE
QMT	74.45±11.6	77.2±11.2	0.001	2.75
QMT+PLYO	72.65±10.2	78.2±10.7	0.001	5.55
CON	76.65±10.2	82.6±10.9	0.001	5.95

Y balance test of right leg analysis with paired t test indicates statistically significant difference within the group in QMT group (p <0.05), QMT+PLYO group (p<0.05), CON group (p<0.05). The difference in mean value was reported was as follows, CON group> QMT+PLYO group>QMT group.

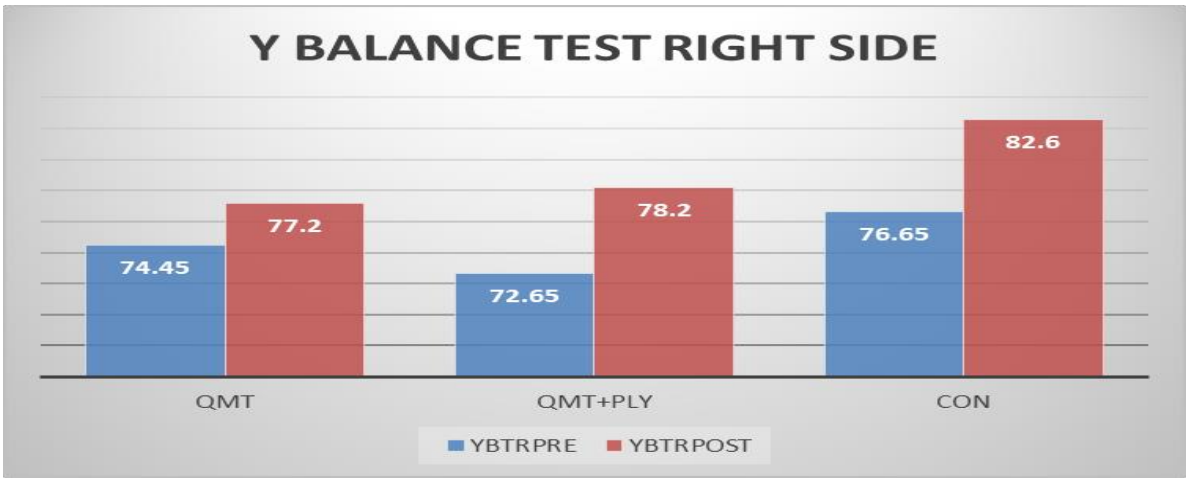


FIG 7.4 Graphical presentation of within group analysis of Right Y balance test

TABLE 7.5 MODIFIED T TEST WITHIN GROUP ANALYSIS

	PRE	POST	P VALUE	MEAN DIFFERENCE
QMT	**10.11±1.88**	**9.6±1.88**	**0.001**	**0.5**
QMT + PLY	**12.57±1.86**	**9.72±1.56**	**0.001**	**2.85**
CON	**12.49±2.09**	**9.48±1.52**	**0.001**	**3.01**

Modified T test analysis with paired t test indicates statistically significant difference within the group in QMT group ($p < 0.05$), QMT+PLYO group ($p<0.05$), CON group ($p<0.05$). The difference in mean value was reported was as follows, CON group> QMT+PLYO group>QMT group.

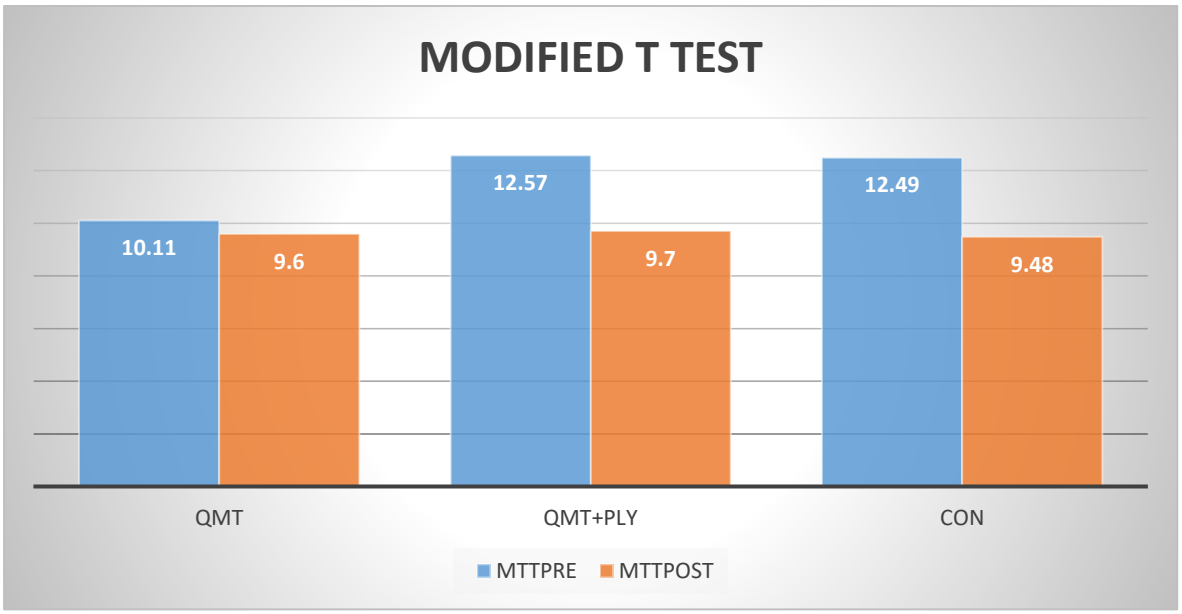


FIG 7.5 Graphical presentation of within group analysis of modified T test

TABLE 7.6 BROAD JUMP WITHIN GROUP ANALYSIS

	PRE	POST	P VALUE	MEAN DIFFERENCE
QMT	137.4±58	138.55±57.9	0.001	1.15
QMT+PLYO	120.25±41.9	123.85±41.6	0.001	3.6
CON	132.5±47	136.35±47	0.001	3.8

Broad jump analysis with paired t test indicates statistically significant difference within the group in QMT group ($p < 0.05$), QMT+PLYO group ($p<0.05$), CON

group (p<0.05) The difference in mean value was reported was as follows, CON group> QMT+PLYO group>QMT group.

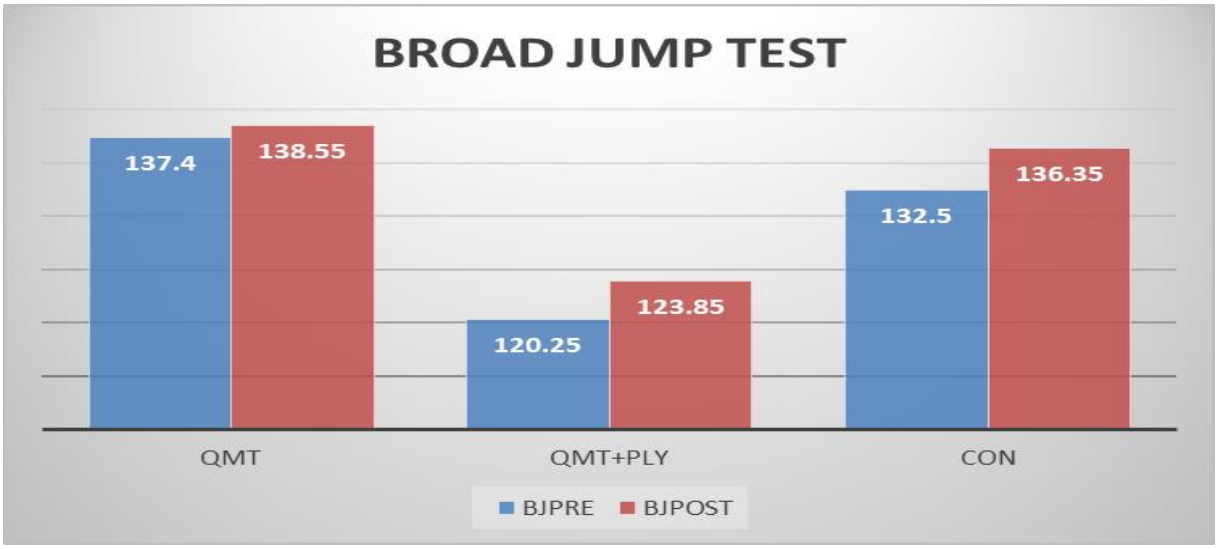


FIG 7.6 Graphical presentation of within group analysis of Broad jump test

TABLE 7.7 VERTICAL JUMP TEST WITHIN GROUP ANALYSIS

	PRE	POST	P VALUE	MEAN DIFFERENCE
QMT	38.3±15.4	38.9±15.4	0.001	0.6
QMT+PLYO	32.75±10.2	35.95±10.5	0.001	3.2
CON	35±11.4	38.15±11.5	0.001	3.15

Vertical jump analysis with paired t test indicates statistically significant difference within the group in QMT group (p <0.05), QMT+PLYO group

(p<0.05), CON group (p<0.05) The difference in mean value was reported was as follows, CON group> QMT+PLYO group>QMT group.

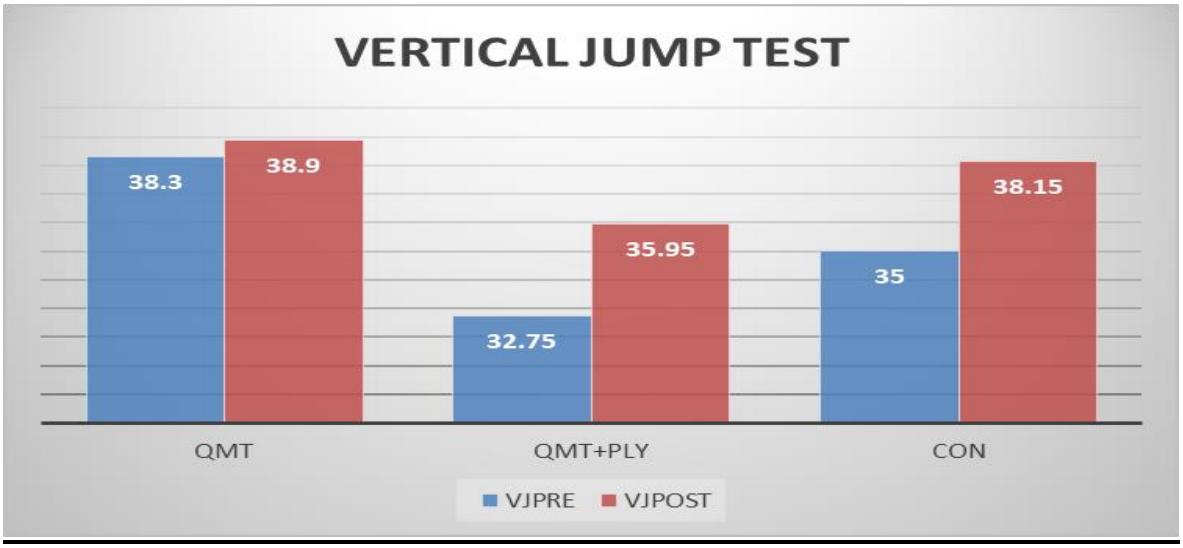


FIG 7.7 Graphical presentation of within group analysis of Vertical jump test

TABLE 7.8 Between Group Analysis summary

OUTCOME	GROUPS		MEAN DIFFERENCE BETWEEN GROUPS	P VALUE	EFFECT SIZE
Y BALANCE TEST LEFT	QMT vs QMT+PLY	2.55 vs 6.1	3.55	<0.001	4.80
	QMT vs CON	2.55 vs 5.3	2.75	<0.001	2.64
	QMT+PLY vs CON	6.1 vs 5.3	0.80	0.029	0.74
Y BALANCE TEST RIGHT	QMT vs QMT+PLY	2.75 vs 5.55	2.80	<0.001	4.80

	QMT vs CON	2.75 vs 5.95	3.20	<0.001	2.64
	QMT+PLY vs CON	5.55 vs 5.95	0.40	0.685	0.74
MODIFIED T TEST	QMT vs QMT+PLY	0.5 vs 2.85	2.35	<0.001	4.80
	QMT vs CON	0.5 vs 3.01	2.50	<0.001	2.64
	QMT+PLY vs CON	2.85 vs 3.01	0.15	0.756	0.74
BROAD JUMP TEST	QMT vs QMT+PLY	1.15 vs 3.6	2.45	<0.001	4.80
	QMT vs CON	1.15 vs 3.85	2.70	<0.001	2.64
	QMT+PLY vs CON	3.6 vs 3.85	0.25	0.666	0.74
VERTICAL JUMP TEST	QMT vs QMT+PLY	0.6 vs 3.2	2.60	<0.001	4.80
	QMT vs CON	0.6 vs 3.15	2.55	<0.001	2.64
	QMT+PLY vs CON	3.2 vs 3.15	0.05	0.986	0.74

Between group analysis by one way ANOVA followed by Tukey post hoc test indicates statistically significant difference between QMT vs QMT+PLYO , QMT vs CON group ($p<0.05$) and no statistically significant difference between QMT + PLYO vs CON ($p>0.05$) on Y balance test left and right, modified T test, Broad jump and Vertical jump. In effect size calculation using cohen's d method QMT versus QMT +PLYO and QMT vesus control showed a large effect size where QMT + PLYO versus control showed a medium effect size.

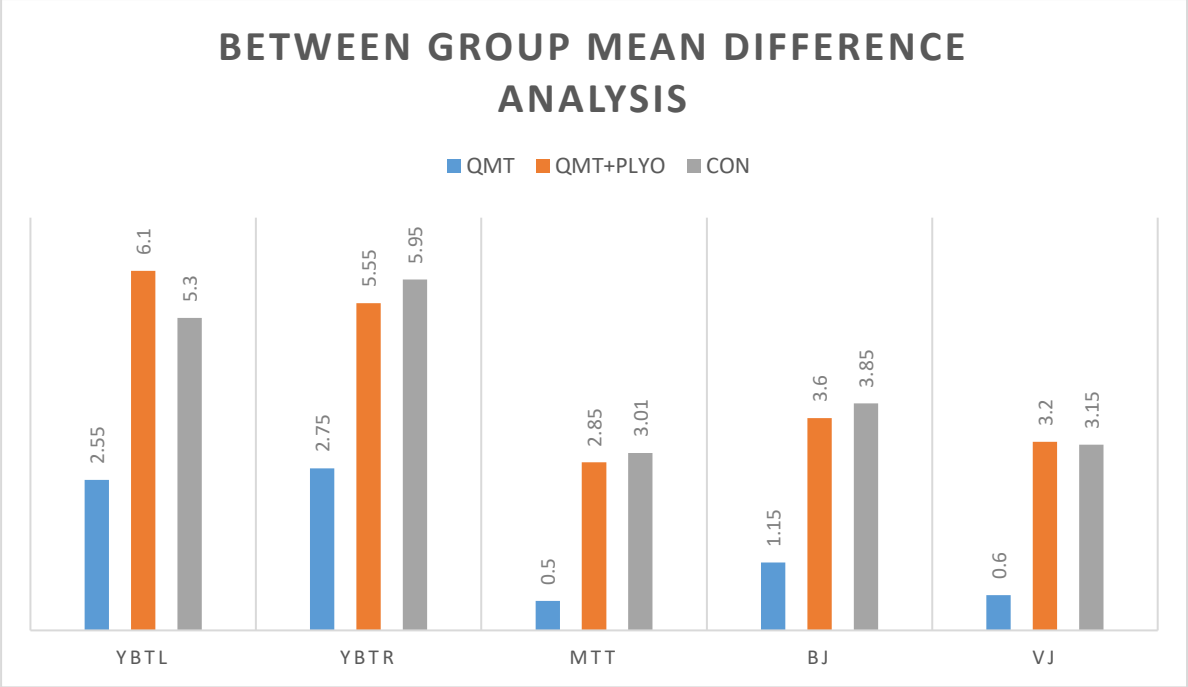


FIG 7.8 Graphical presentation of Between group mean difference analysis of outcome measures

DISCUSSION

The present study investigated the effect of novel Quadrupedal movement training on dynamic balance, agility, and jump performance. The results of this study reveal an important component in the complementation of the QMT compared to the QMT+PLYO and control regarding balance, agility, and jump performance in collegiate jumpers as a result of the implementation of the training program. The findings presented in this study fill a knowledge gap regarding this specific concept of QMT training's role in fitness parameters.

Dynamic Balance

The 4-week intervention of QMT, QMT combined with plyometric and control group training produced significant changes in pre and post-value of dynamic balance in collegiate jumpers but there was no significant effect between the 3 groups .QMT program imposed primarily close kinetic demand on the core which we can hypothesize would lead to significant improvement of dynamic balance mainly anterior stability (20). Previous studies also prove that the CKC training did involve more coordination and co-contraction of antigravity muscles. Therefore the benefits of CKC exercises may have accrued from a combination of more muscles being strengthened and those muscles being trained to co-contract together. Because both exercise devices strengthened muscles that act primarily in the sagittal plane (knee and hip extensors) the balance parameter that would be expected to show the greatest improvement from strength gains is the anterior-posterior displacement(21). Traveling form of trunk exercise helps to improve hip and knee extensor muscle strength which shows improvement in dynamic balance(22). Trunk stability is a controlled

closed kinetic exercise that helps to improve dynamic balance to derive the optimal effect of physical training basic principles such as specific adaptation to imposed demand must be followed (20).CKC placed unilateral stress on the muscle involved in hip extension in resemblance to stress in the posterolateral and posteromedial direction, improving dynamic balance(20).Plyometric training helps to improve lower body stability . This training develops proper landing techniques and improves dynamic control over the center of mass, drastically improving neuromuscular adaptability(23) . Myer et al showed that female high-school volleyball players decreased their medio-lateral center of pressure after seven weeks of plyometric training (23). Majeed et al reported a significant difference in the dynamic balance of male badminton players after six weeks of plyometric training (24). Cherni et al observed that eight weeks of in-season plyometric training by top-level female basketball players reduced the risk of falls and injuries by improving dynamic postural control(25).Zadi Kazi Qasim et al showed applying core and plyometric training along with general training improves dynamic balance but there is no significant difference between both groups(26). QMT group alone was not that much effective as compare to combined and control group.

Agility

The 4-week intervention of QMT, QMT combined with plyometric and control group training produce significant changes in pre and post-value of agility in collegiate jumpers but there is no significant effect between the 3 groups.QMT program is mainly related to a traveling form of trunk exercise where more activation of the muscles like hip extensor, knee extensor, and plantar flexor

as compared to the static form of quadrupedal training (22). A previous study by Takuya et al showed a relationship between hip extensor strength training with agility in badminton players because more squatting position helps to activate these muscles, the players with greater ankle plantar flexion can perform fast side-step and efficiently change direction; therefore, this score may be correlated to ankle plantar flexion strength(27). Afyon et al showed that there is a significant improvement in agility and speed after 8 weeks of core training (28). Asuthosh et al (2018), and Moreira et al (2017) showed proprioceptive training improves the neuromuscular system for complex activity(29,30). While performing a dynamic activity like agility, proprioceptors located in the muscle (muscle spindle) and facilitates quick and faster movements and maintains a balanced position against particular stimulus from peripheral receptors through afferent- efferent pathway regarding movements of the body in a particular direction to change quickly (31). A recent study confirmed that agility is significantly correlated with speed in both genders, with power in women, and with balance in men (32). Balance improvement after Proprioceptive Training can further impact complex movements and could result in improved agility(31).Plyometric training improves times in the agility test measures because of either better motor recruitment or neural adaptations (33). Potteiger et al showed plyometric training improves agility and that improvements were a result of enhanced motor unit requirement pattern (34). Craig et al showed neural adaptation usually occurs when athletes react due to improved coordination between CNS signals and proprioceptive feedback(34). Plyometric training programs can decrease ground reaction test times because of an increase in muscular power and movement efficiency(35).Amarinder

Singh et al conduct a comparative study on 8 months of core training versus plyometrics on agility which showed there is significant improvement within the group but there is no significant difference between the groups(36).QMT group alone was not that much effective as compare to combined and control group.

Jump Performance

The 4-week intervention of QMT, QMT combined with plyometric and control group training produced significant changes in pre and post-value of agility in collegiate jumpers but there is no significant effect between the 3 groups.Trunk stability exercises had low muscular loading and were designed to increase the overall awareness and control of trunk and pelvic position (37). Bayrakdar et al found that trunk stability training increased vertical jumping ability and that there was no association between trunk stability score and vertical height (38). Liton Sarkae et al showed core training programs were designed to improve lower limb explosiveness by improving lower limb strength (39). The core muscles are considered the kinetic link between the lower and upper limbs and they are essential in effectively transferring force throughout the body. Efficient control of the core muscles ensures efficient acceleration, deceleration, and stabilization because all movements originate in, or are conducted through, the trunk. Therefore, a Core stabilization program could improve athletes' explosive strength (40). Ates and Atesoglu conducted a study on 16-18 age group soccer players in which they implemented a training twice a week for 10 weeks program in addition to their soccer training; and found significant differences in vertical jump parameter (41).Simek –salaj showed proprioceptive training helps to improve explosive power in the leg(42). Plyometric training enhances hip and

thigh muscle power which was projected by the vertical jump(43) .Vertical and horizontal plyometric training have a significant effect on long jump performance (3), which indicated an improvement in hamstring muscle peak power, torque, and hamstring quadriceps ratio after a period of plyometric training(44). Jump training is a powerful effective way to improve strength and speed in the long jump which allows the nervous system to activate the largest number of muscle fiber, so in explosive training variation of jump was added informs of vertical and horizontal plyometric exercise(3). Amarinder Singh et al conduct a comparative study on 8 months of core training versus plyometric on jump performance which showed there is significant improvement within the group but there is no significant difference between the groups(36). QMT group alone was not that much effective as compare to combined and control group. The major limitation of this study was there is only 4 week protocol for QMT and follow up was not assessed after post intervention. Future research addressing a long term protocol will be used to measure the same fitness parameter and other fitness parameter with a follow up. In addition future research investigating comparison between QMT and other training protocol for short term improvement of fitness.

CONCLUSION-

Collegiate long jumpers require significant dynamic balance, agility, Broad jump and vertical jump as a fitness component for a satisfactory performance. The results of these study demonstrate that a 4 week training programme of QMT along with plyometric and plyometric alone showed a better improvement than QMT alone on dynamic balance, agility and jump performance in collegiate long jumpers. Hence combined training can be used as unique fitness training protocol for long jumpers. Which turns to improve fitness of long jumpers and helps to improve their performance as well.

REFERENCE

1. Enoki S, Nagao M, Ishimatsu S, Shimizu T, Kuramochi R. Injuries in Collegiate Track and Field Jumping: A 2-Year Prospective Surveillance Study. Orthop J Sports Med. 2021 Jan;9(1):2325967120973397.

2. Istenič N, Orlič D, Samardžija Pavletič M. CORRELATION BETWEEN STATIC BALANCE AND DROP JUMP AMONG ARTISTIC GYMNASTS. In: 3rd INTERNATIONAL SCIENTIFIC CONGRESS SLOVENIAN GYMNASTICS FEDERATION. p. 69.

3. Singh D, Singh S. Effects of vertical, horizontal, and combination depth jump training on long jump performance. Biomed Hum Kinet. 2012;4(2012):107–11.

4. Seiler S, Taylor M, Diana R, Layes J, Newton P, Brown B. Assessing anaerobic power in collegiate football players. J Appl Sport Sci Res. 1990;4(1):9–15.

5. Buxton JD, Prins PJ, Miller MG, Moreno A, Welton GL, Atwell AD, et al. The Effects of a Novel Quadrupedal Movement Training Program on Functional Movement, Range of Motion, Muscular Strength, and Endurance. J Strength Cond Res. 2022 Aug 1;36(8):2186–93.

6. Matthews MJ, Yusuf M, Doyle C, Thompson C. Quadrupedal movement training improves markers of cognition and joint repositioning. Hum Mov Sci. 2016 Jun;47:70–80.

7. Bedoya AA, Miltenberger MR, Lopez RM. Plyometric Training Effects on Athletic Performance in Youth Soccer Athletes: A Systematic Review. J Strength Cond Res. 2015 Aug;29(8):2351–60.

8. Davies G, Riemann BL, Manske R. CURRENT CONCEPTS OF PLYOMETRIC EXERCISE. Int J Sports Phys Ther. 2015 Nov;10(6):760–86.

9. Myer GD, Ford KR, McLean SG, Hewett TE. The effects of plyometric versus dynamic stabilization and balance training on lower extremity biomechanics. Am J Sports Med. 2006 Mar;34(3):445–55.

10. Silva AF, Clemente FM, Lima R, Nikolaidis PT, Rosemann T, Knechtle B. The Effect of Plyometric Training in Volleyball Players: A Systematic Review. Int J Environ Res Public Health. 2019 Aug 17;16(16):2960.

11. Takahashi K, Wakahara T. Association between trunk and gluteus muscle size and long jump performance. PloS One. 2019;14(11):e0225413.

12. Marzouki H, Ouergui I, Dridi R, Selmi O, Mbarki R, Mjadri N, et al. Effects of Four Weeks of Plyometric Training Performed in Different Training Surfaces on Physical Performances in School Children: Age and Sex Comparisons. Child Basel Switz. 2022 Dec 7;9(12):1914.

13. Buxton JD, Sherman SA, Sterrett MT, Kannel KD, Blanchflower ME, Jancay KT, et al. A comparison of the energy demands of quadrupedal movement training to walking. Front Sports Act Living. 2022;4:992687.

14. Joy EA, Pescatello LS. Pre-exercise screening: role of the primary care physician. Isr J Health Policy Res. 2016;5:29.

15. Tam CWC, Lam LCW. Cognitive function, functional performance and severity of depression in Chinese older persons with late-onset depression. East Asian Arch Psychiatry Off J Hong Kong Coll Psychiatr Dong Ya Jing Shen Ke Xue Zhi Xianggang Jing Shen Ke Yi Xue Yuan Qi Kan. 2012 Mar;22(1):12–7.

16. Powden CJ, Dodds TK, Gabriel EH. THE RELIABILITY OF THE STAR EXCURSION BALANCE TEST AND LOWER QUARTER Y-BALANCE TEST IN HEALTHY ADULTS: A SYSTEMATIC REVIEW. Int J Sports Phys Ther. 2019 Sep;14(5):683–94.

17. Sassi RH, Dardouri W, Yahmed MH, Gmada N, Mahfoudhi ME, Gharbi Z. Relative and absolute reliability of a modified agility T-test and its relationship with vertical jump and straight sprint. J Strength Cond Res. 2009;23(6):1644–51.

18. Ab Rahman Z, Kamal AA, Noor MAM, Geok SK, others. Reliability, Validity, and Norm References of Standing Broad Jump. Rev Geintec-Gestao Inovacao E Tecnol. 2021;11(3):1340–54.

19. Maulder P, Cronin J. Horizontal and vertical jump assessment: reliability, symmetry, discriminative and predictive ability. Phys Ther Sport. 2005;6(2):74–82.

20. Kwon YJ, Park SJ, Jefferson J, Kim K. The effect of open and closed kinetic chain exercises on dynamic balance ability of normal healthy adults. J Phys Ther Sci. 2013 Jun;25(6):671–4.

21. Lee KE, Baik SM, Yi CH, Kwon OY, Cynn HS. Electromyographic Analysis of Hip and Trunk Muscle Activity During Side Bridge Exercises in Subjects With Gluteus Medius Weakness. J Sport Rehabil. 2021 Dec 30;30(5):754–9.

22. Pyka DT. Effects of static, stationary, and traveling trunk exercises on muscle activation. California State University, Fullerton; 2017.

23. Alikhani R, Shahrjerdi S, Golpaigany M, Kazemi M. The effect of a six-week plyometric training on dynamic balance and knee proprioception in female badminton players. J Can Chiropr Assoc. 2019 Dec;63(3):144–53.

24. Majeed KNA, Latheef MNA. EFFECTS OF PLYOMETRIC TRAINING ON AGILITY AND DYNAMIC POSTURAL CONTROL IN BADMINTON PLAYERS. Int J Sports Sci Fit. 2016;6(2).

25. Cherni Y, Jlid MC, Mehrez H, Shephard RJ, Paillard T, Chelly MS, et al. Eight weeks of plyometric training improves ability to change direction and dynamic postural control in female basketball players. Front Physiol. 2019;10:726.

26. Gasim ZK, Cengizel E, Günay M. Core vs Plyometric Training Effects on Dynamic Balance in Young Male Soccer Players. Rev Bras Med Esporte. 2022;28:326–30.

27. Sonoda T, Tashiro Y, Suzuki Y, Kajiwara Y, Zeidan H, Yokota Y, et al. Relationship between agility and lower limb muscle strength, targeting university badminton players. J Phys Ther Sci. 2018;30(2):320–3.

28. Belli G, Marini S, Mauro M, Maietta Latessa P, Toselli S. Effects of Eight-Week Circuit Training with Core Exercises on Performance in Adult Male Soccer Players. Eur J Investig Health Psychol Educ. 2022;12(9):1244–56.

29. Salot C, Sathya P. Effects of Proprioceptive Training on Agility Performance in Male Football Players. Indian J Physiother Occup Ther Print-ISSN 0973-5666 Electron 0973-5674. 2020;14(1):68–72.

30. Moreira NB, Alves RC, Ferandes DY, Prestes LF, Cassimiro V, Da Silva VS, et al. Effect of proprioceptive training and central stabilization in physical fitness in young soccer players. J Phys Educ Sport. 2017;17(2):810.

31. Gidu DV, Badau D, Stoica M, Aron A, Focan G, Monea D, et al. The effects of proprioceptive training on balance, strength, agility and dribbling in adolescent Male soccer players. Int J Environ Res Public Health. 2022;19(4):2028.

32. Zwierko M, Jedziniak W, Popowczak M, Rokita A. Reactive Agility in Competitive Young Volleyball Players: A Gender Comparison of Perceptual-Cognitive and Motor Determinants. J Hum Kinet. 2022;85(1):87–96.

33. van de Hoef PA, Brauers JJ, van Smeden M, Backx FJ, Brink MS. The effects of lower-extremity plyometric training on soccer-specific outcomes in adult male soccer players: a systematic review and meta-analysis. Int J Sports Physiol Perform. 2020;15(1):3–17.

34. Kumaravelu P. THE EFFECT OF PLYOMETRIC TRAINING PROGRAM ON AGILITY, POWER AND RESTING HEART RATE OF ADOLESCENT BOYS.

35. Villalba MM, Eltz GD, Fujita RA, Panhan AC, Cardozo AC, Gonçalves M. Effects of six weeks of plyometric training on the ground vs on a mini-trampoline on strength, jump performance, and balance in male basketball players—randomized clinical trial. Sport Sci Health. 2022;1–11.

36. Singh A, Patel D, Shenoy S, Sandhu JS, others. Comparative analysis of plyometrics and core training on performance indices of Indian handball players. BLDE Univ J Health Sci. 2022;7(1):104.

37. Sinha S, Mili A. The effectiveness of core stability to improve motor skills among football players. 2021;

38. Bayrakdar A, BOZ HK, IŞILDAR Ö. The investigation of the effect of static and dynamic core training on performance on football players. Turk J Sport Exerc. 2020;22(1):87–95.

39. Sarkar L, Datta U. Impact of core muscle training on explosive strength for school going state level participants. 2019;

40. Dinç N, Ergin E. The Effect of 8-Week Core Training on Balance, Agility and Explosive Force Performance. Univers J Educ Res. 2019;7(2):550–5.

41. Özdemir M, Kayantaş İ. Effect of plyometric training on vertical jump performance (a meta-analysis study). Int J Appl Exerc Physiol. 2020;9(7):90–100.

42. Šalaj SŠ, Milanović D, Jukić I. The effects of proprioceptive training on jumping and agility performance. Kinesiology. 2007;39(2):131–41.

43. Sabillah MI, Nasrulloh A, Yuniana R, others. The effect of plyometric exercise and leg muscle strength on the power limb of wrestling athletes. J Phys Educ Sport. 2022;22(6):1403–11.

44. Singh A, Boyat A, Sandhu JS. Effect of a 6 week plyometric training program on agility, vertical jump height and peak torque ratio of Indian Taekwondo players. Sport Exerc Med Open J. 2015;1(2):42–6.

ANNEXURES.1

CONSENT FORM

CONSENT FORM

TITLE OF THE STUDY-

THE EFFECTIVENESS OF NOVEL QUADRUPEDAL MOVEMENT TRAINING ON BALANCE, AGILITY AND JUMP PERFORMANCE IN COLLEGIATE JUMPERS – A RANDOMIZED CONTROLLED TRIAL

I have been informed by Miss Charuhasini Mahapatra; pursuing MPT (sports) conducting the above-mentioned study under the guidance of Prof. Joseph Oliver Raj, Dean, department of physiotherapy, ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE (ABSMARI), BHUBANESWAR.

I have no objection and will be a part of that group. I also understand that the study does not have any negative implication on my health. I understand that the information produced by the study will become a part of the institute's record and will be utilized, as per confidentiality regulations of the institute. I am also aware that the data might be used for medical literature and teaching purposes, but all my personal details will be kept confidential.

I am well informed to ask as many questions as I can to Miss Charuhasini Mahapatra either during the study or later. I wish to discuss my participation and concerns regarding these study with a person not directly involved.

I understand that my assent is voluntary and I reserve the right to withdraw or discontinue the participation from the study at any point of time during the study.

I have explained to MR/MISS/MRS the purpose of the research, the procedure required in the language he/she could understand to the best of my ability.

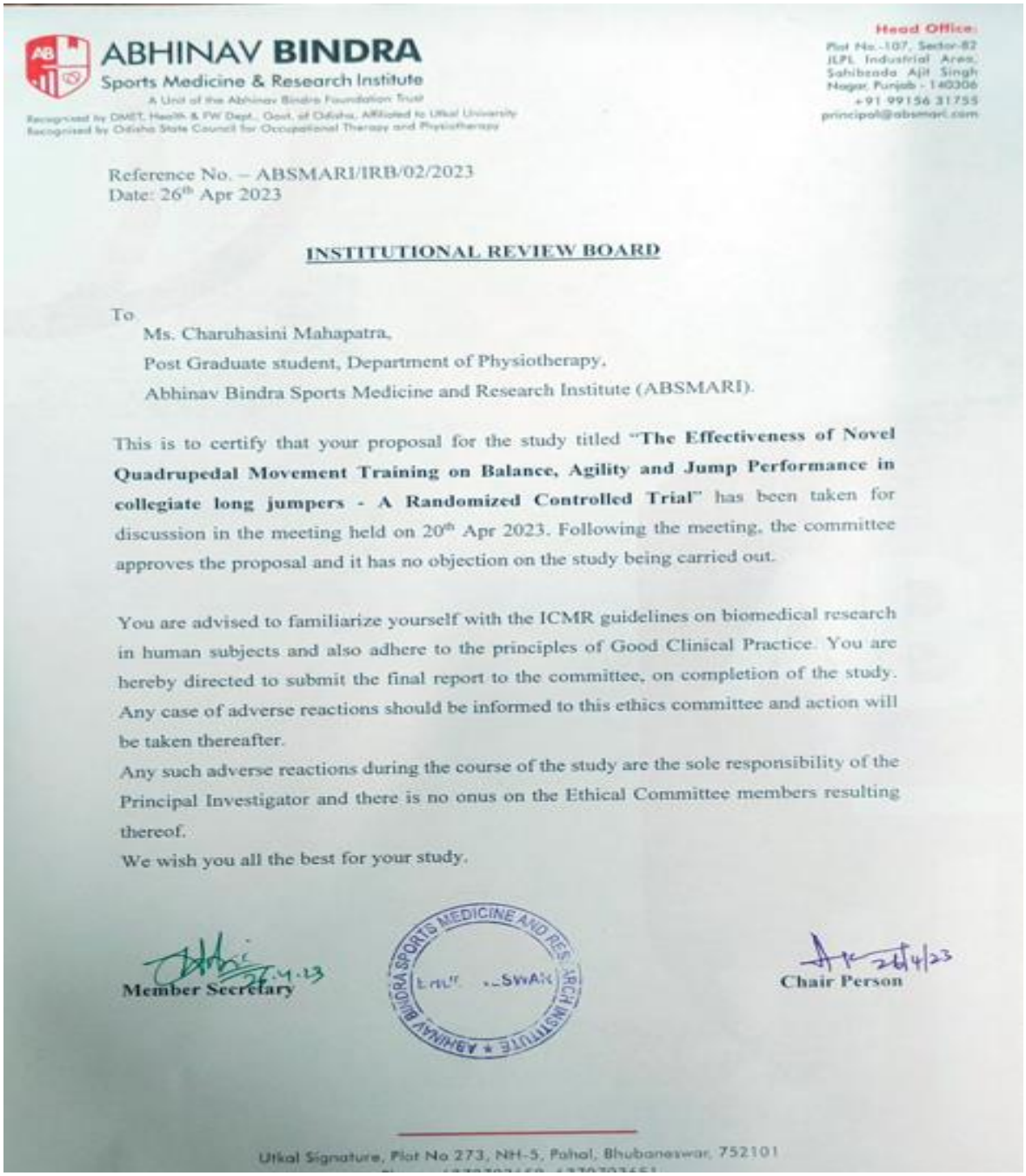
(Investigator) (Date)

I confirm that Miss Charuhasini Mahapatra (investigator) has explained to me in the language I can understand, the purpose of the study and the procedure. Therefore, I agree to give my assent for the participation as a subject in this study and I will be accountable for the decisions.

(Signature) (Date)

ANNEXURES.2

ETHICAL COMMITTEE CLEARANCE CERTIFICATE



ABHINAV BINDRA
Sports Medicine & Research Institute
A Unit of the Abhinav Bindra Foundation Trust
Recognised by DMET, Health & FW Dept., Govt. of Odisha, Affiliated to Utkal University
Recognised by Odisha State Council for Occupational Therapy and Physiotherapy

Head Office:
Plot No.-107, Sector-82
JLPL Industrial Area,
Sahibzada Ajit Singh
Nagar, Punjab - 140306
+91 99156 31755
principal@absmari.com

Reference No. – ABSMARI/IRB/02/2023
Date: 26th Apr 2023

INSTITUTIONAL REVIEW BOARD

To
Ms. Charuhasini Mahapatra,
Post Graduate student, Department of Physiotherapy,
Abhinav Bindra Sports Medicine and Research Institute (ABSMARI).

This is to certify that your proposal for the study titled "**The Effectiveness of Novel Quadrupedal Movement Training on Balance, Agility and Jump Performance in collegiate long jumpers - A Randomized Controlled Trial**" has been taken for discussion in the meeting held on 20th Apr 2023. Following the meeting, the committee approves the proposal and it has no objection on the study being carried out.

You are advised to familiarize yourself with the ICMR guidelines on biomedical research in human subjects and also adhere to the principles of Good Clinical Practice. You are hereby directed to submit the final report to the committee, on completion of the study. Any case of adverse reactions should be informed to this ethics committee and action will be taken thereafter.
Any such adverse reactions during the course of the study are the sole responsibility of the Principal Investigator and there is no onus on the Ethical Committee members resulting thereof.
We wish you all the best for your study.

Member Secretary

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE

Chair Person

Utkal Signature, Plot No 273, NH-5, Pahal, Bhubaneswar, 752101

ANNEXURES.3

ASSESMENT FORM

ASSESMENT FORM:

DEMOGRAPHIC DATA:

Name-

Age-

Gender-

Address-

Phone number-

Height –

Weight-

Date of examination-

- Pretest-
- Posttest –

GROUP -

COMPONENT	PRE INTEVENTION SCORE	POST INTRVENTION SCORE
DYNAMIC BALANCE		
AGILITY		
BROAD JUMP		
VERTICAL JUMP		

ANNEXURES.4

MASTER CHART

1	SUBJEC'	AGE	GENDER	HEIGHT	WEIGHT	BMI	GROUP	Y BALANCE TEST				MODIFIED T TEST		BROAD JUMP TES		VERTICAL JUMP TEST	
2								LEFT		RIGHT		PRETES	POSTTE	PRE TES	POST TE	PRE TES	POST TEST
3								PRE TES	POST TE	PRE TES	POST TEST						
4	1	25	M	158	56	22.4	A	87	85	85	87	9.2	8.69	185	184	48	48
5	2	24	M	176	65	21	A	78	88	78	79	9.78	9.49	191	191	48	41
6	3	28	M	174	96	31.7	A	79	75	69	72	7.82	6.86	240	242	42	42
7	4	28	M	179	92	28.7	A	98	101	99	95	7.8	7.1	295	297	51	51
8	5	29	M	165	75	27.5	A	81	84	78	81	11	10.58	158	152	38	39
9	6	18	M	171	75	25.6	A	86	89	84	86	8.9	7.6	184	184	48	42
10	7	19	M	189	106	29.7	A	104	106	92	94	10.54	9.76	172	174	78	79
11	8	19	M	171	78	26.9	A	85	86	86	87	8.2	7.69	158	151	55	55
12	9	18	M	171	98	38.8	A	85	92	81	84	7.9	7.26	188	188	52	52
13	10	18	M	178	85	26.8	A	82	84	77	79	8.5	7.99	188	182	55	55
14	11	24	F	168	72	28.1	A	64	66	63	65	12.94	11.9	188	189	15	16
15	12	29	F	157	62	25.2	A	62	66	60	65	10.99	9.92	126	127	52	54
16	13	21	F	158	62	24.8	A	78	79	65	69	8.5	8	115	117	25	25
17	14	28	F	162	49	18.7	A	68	78	79	76	10.44	10	138	148	26	27
18	15	29	F	154	47	19.8	A	61	63	62	66	10.2	10	188	188	31	32
19	16	24	F	149	39	17.6	A	88	84	64	67	11.81	11.81	69	71	24	24
20	17	22	F	159	69	24.9	A	60	69	62	64	12.99	12	74	76	26	27
21	18	26	F	162	61	29.2	A	67	69	56	59	13	12.27	96	97	24	25
22	19	26	F	159	66	28.2	A	72	74	78	81	13.11	12.65	44	45	26	26
23	20	19	F	158	52	28.8	A	89	91	91	94	11.9	11.49	74	74	26	26
24	21	25	M	179	77	25.7	B	89	95	79	85	10.11	7.24	194	196	45	49
25	22	24	M	172	69	29.9	B	84	98	84	91	12.18	9.9	127	198	24	27
26	23	26	M	163	98	34.9	B	91	96	84	98	12	8	188	194	49	59
27	24	18	M	185	84	24.5	B	75	81	78	77	9.98	7.26	288	289	99	97
28	25	21	M	165	66	24.2	B	87	99	86	92	10.56	8.2	78	74	25	29
29	26	26	M	154	58	24.5	B	81	87	88	85	11.9	9.5	196	198	94	98
30	27	24	M	169	67	23.5	B	78	89	75	82	19	18.65	122	124	98	99
31	28	29	M	168	76	26.7	B	69	75	68	79	15	11.12	67	78	24	28
32	29	22	M	153	68	26.9	B	74	81	72	79	13.45	9.95	97	101	28	31
33	30	18	M	156	54	22.2	B	88	99	85	91	9.92	7.26	89	92	91	99
34	31	30	F	158	65	26	B	82	89	79	84	15.99	12.57	99	97	26	28
35	32	19	F	157	54	21.9	B	81	87	76	88	11	9.29	119	129	29	31
36	33	19	F	161	52	20.1	B	89	89	77	89	14.9	11.28	107	111	92	95
37	34	18	F	152	58	24.6	B	78	77	69	69	19.89	11.29	115	119	25	27
38	35	18	F	162	65	24.8	B	66	71	68	79	11.66	9.47	162	165	65	69
39	36	28	F	153	72	30.8	B	53	65	53	64	19.78	18.61	107	118	22	25
40	37	18	F	159	61	24.1	B	58	64	48	52	15.66	11.95	68	65	38	34
41	38	19	F	164	48	18.5	B	82	98	77	81	11.99	9.81	162	166	97	48
42	39	19	F	154	52	21.9	B	79	79	58	69	12.16	9.52	185	189	94	97
43	40	18	F	155	55	22.9	B	57	64	65	78	19.65	11.42	85	98	92	95
44	41	24	M	168	78	27.6	C	74	88	84	91	11.9	9.99	178	182	49	45
45	42	24	M	166	52	18.9	C	92	97	89	99	12	9.99	149	146	92	96
46	43	28	M	178	64	22.1	C	82	88	84	89	18	7	188	191	47	51
47	44	19	M	161	59	28.4	C	69	79	76	82	19.55	9	149	147	42	44
48	45	26	M	179	87	29.1	C	84	91	86	94	9.89	7.71	59	64	94	97
49	46	26	M	166	89	32.9	C	95	102	91	99	11.56	9.82	59	69	95	98
50	47	19	M	167	76	27.9	C	74	78	78	76	18.78	7.66	207	211	45	49
51	48	18	M	178	62	19.6	C	84	88	78	91	11.94	8.26	224	228	54	59
52	49	18	M	175	77	25.1	C	69	75	78	74	9.82	7.89	167	171	59	59
53	50	19	M	144	54	26	C	69	79	76	79	18.29	8.42	168	179	48	44
54	51	27	F	162	52	19.8	C	97	109	94	108	14.21	11	181	184	29	27
55	52	25	F	164	52	19.3	C	72	77	72	75	10	7.9	164	169	52	56
56	53	28	F	159	68	26.6	C	72	75	79	78	14.92	10.87	182	186	26	29
57	54	18	F	159	45	19.2	C	67	72	59	66	11.99	9.79	118	121	94	98
58	55	19	F	168	57	22.9	C	59	66	59	64	15	10.46	94	97	26	98
59	56	18	F	162	66	25.1	C	68	79	75	79	14.19	10.15	185	111	29	25
60	57	19	F	163	64	24.1	C	65	69	61	67	15.8	11.96	88	85	18	21
61	58	18	F	192	89	22.4	C	82	88	78	75	19.77	18.41	156	159	26	29
62	59	18	F	156	62	25.5	C	79	82	89	89	16.2	12.1	188	184	29	26
63	60	19	F	159	54	21.4	C	79	85	89	91	19.86	18.56	118	115	24	26
64																	