# EFFECT OF PLYOMETRIC TRAINING AND HIGH-INTENSITY INTERVAL TRAINING (HIIT) ON POWER AND AGILITY AMONG UNDER 23 CRICKET BATSMEN: A RANDOMIZED CONTROLLED TRIAL

Dissertation Submitted to the

**UTKAL UNIVERSITY, Bhubaneswar, Odisha**

**By**

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In partial fulfillment of the requirements for the degree of

**MASTER OF PHYSIOTHERAPY (M.P.T)**

In

**SPORTS PHYSIOTHERAPY**

Under the guidance of

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**Bhubaneswar, Odisha**

**2022-2024**

## DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "**EFFECT OF PLYOMETRIC TRAINING AND HIGH-INTENSITY INTERVAL TRAINING (HIIT) ON POWER AND AGILITY AMONG UNDER 23 CRICKET BATSMEN"** is a bonafide and genuine research work carried out by me under the guidance of Dr. Deepak Kumar Pradhan, Assistant professor, Abhinav Bindra Sports Medicine & Research Institute, Bhubaneswar, Odisha.

Date:

Place: Bhubaneswar, Odisha

Signature of the candidate

**Brijesh R. Vishwakarma**


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This is to certify that the dissertation entitled "**EFFECT OF PLYOMETRIC TRAINING AND HIGH-INTENSITY INTERVAL TRAINING (HIIT) ON POWER AND AGILITY AMONG UNDER 23 CRICKET BATSMEN"** is a bonafide work done by Brijesh R. Vishwakarma, in partial fulfillment of the requirement of the degree of Master Of Physiotherapy in Sports Medicine and rehabilitation.

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## LIST OF ABBREVATIONS

1. **1-MPT –** One-minute Push-ups Test
2. **ABSMARI** – Abhinav Bindra Sports Medicine and Research Institute
3. **ANOVA –** Analysis of Variance
4. **HIIT –** High-Intensity Interval Training
5. **IAT –** Illinois Agility Test
6. **MCID –** Minimal Clinically Important Difference
7. **PEC –** Parallel Elastic Component
8. **SEC –** Series Elastic Component
9. **SMBT –** Seated Medicine Ball Throw Test
10. **SPSS –** Statistical Package of Social Sciences

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## ABSTRACT

Background: This study aims to compare the effectiveness of plyometric vs high-intensity interval training, on selected fitness variables in cricket batsmen.

Methods: Thirty-six male subjects were assigned to: a plyometric group (n=12, 12 regular training sessions, 2 sessions per week, each lasting for 30 minutes); an HIIT group (n=12, 12 regular training sessions, 2 sessions per week, each lasting for 30 minutes). The outcome measures included tests were seated medicine ball throw test, Illinois agility test, and one-minute push-up test.

Results: The plyometric group showed an improvement in seated medicine ball throw ($p<0.05$, $\Delta=1.28$), Illinois agility test ($p<0.05$, $\Delta=5$), and one-minute push-up test ($p<0.05$, $\Delta=11$) after 12 sessions of training. The HIIT group showed an improvement in seated medicine ball throw ($p<0.05$, $\Delta=0.93$), Illinois agility test ($p<0.05$, $\Delta=4.47$), and one-minute push-up test ($p<0.05$, $\Delta=9.91$) after 12 sessions of training. The control group showed an improvement in seated medicine ball throw ($p<0.05$, $\Delta=0.008$), Illinois agility test ($p>0.05$, $\Delta=0.2$), and one-minute push-up test ($p<0.05$, $\Delta=5.08$) after 12 sessions of training.

Conclusion: The results of this study concluded that both the plyometric and HIIT groups were better than the control group but there is no statistically significant difference between plyometric and HIIT groups on improving power and agility.



Keywords: Batsman, Cricket Sport, High-Intensity Interval Training, Male, Plyometric Exercise, Seated medicine ball throw

# INTRODUCTION

Cricket is a non-contact sport, played in a twenty-two-yard pitch. During the play, players participate in a wide range of physical activities such as running, throwing, batting, bowling, catching, jumping, and diving. [1]

Internationally, three formats of cricket are played at the elite level: test, one-day and twenty20. All players bat and field, while only some players bowl and one person keeps wicket. [7]

Cricket is a well-liked team sport played across the globe. There are different game styles from lengthy multi-day tests to quick twenty20 matches. With varying physiological demands during each format, batsmen play a crucial part in all of the game types. Investigation of the physiological demands imposed during cricket batting has historically been neglected with much of the research focusing on bowling responses and batting technique. [6]

In cricket and its various formats, the actual physical demand has expanded, requiring the player to possess more agility, flexibility, and strength. [2] In this sport, the ability to change direction quickly, running between the wickets, and catching and tossing the ball requires agility. [2]

Cricket is a sport where agility is essential for a player to excel. Despite the widespread popularity of cricket, there is a limited amount of research that focuses on measuring the agility of cricketers. Agility in this context is also connected to other physical qualities that can be developed, such as strength, power, and balance. Good agility requires a complete mixture of speed, balance, power and co-ordination.[2]

In cricket, power is equally necessary, an increase in upper body strength is particularly important when executing powerful cricket strokes. Accurately timed and forceful cricket strokes offer batsmen the greatest likelihood of achieving boundaries. [3] The contractile component of the actin and myosin cross bridges with the sarcomere plays an important role in motor control and force development during plyometrics. Plyometric movements utilize the pre-stretch of the muscle-tendon unit, which aligns with the physiological length-tension curve, to enhance the muscle fibers' capacity for generating greater tension and force output. [4]

Biomechanically "priming" the muscle is supported by Elftman's research. Elftman's proposal suggests that muscle force production follows a predictable hierarchical pattern. This orderly format is that eccentric muscle contractions create the most force, followed by isometric contractions and then concentric contractions. [4]

Maximal eccentric muscle actions produce 10-40 percent more force compared to concentric contractions. The reason it generates more force is that during the eccentric muscle action, the SEC and PEC are being stretched which generates more force resulting in an increase in the power produced by the muscle. [4]

HIIT is a form of timed interval training that alternates periods (e.g., 20-seconds) of high-intensity effort with rest intervals (e.g., 10-second), repeated several times.[5]

HIIT is a type of interval training exercise. It involves multiple rounds alternating between several minutes of high-intensity exercises, which elevate

the heart rate to at least 80% of its maximum, and brief intervals of lower-intensity activity. The blood supply to the muscles increases as a result of increase in the heart rate, which provides more amount of oxygen to the muscles improving their ability to work more efficiently. Improved muscle efficacy provides better physical fitness. [9]

## NEED FOR STUDY

1. Evaluation of better training technique to improve the power and agility of batsmen.
2. Plyometrics and high-intensity interval training both being the most used training protocols in preparation for the competition in cricket yet there is no study done to know which between these two have greater effect. So this study will contribute in finding the most effective training protocol for cricket batsmen. [29]

## AIM

To compare the effectiveness of plyometric vs high-intensity interval training, on selected fitness variables in cricket batsmen.

## OBJECTIVES

1. To evaluate the effectiveness of plyometric training on the power and agility of cricket batsmen using illinois agility test, seated medicine ball throw test, and one minute push-up test.
2. To evaluate the effectiveness of high-intensity interval training on the power and agility of cricket batsmen using illinois agility test, seated medicine ball throw test, and one-minute push-up test.
3. To compare the effectiveness of plyometrics and high-intensity interval training on the power and agility of cricket batsmen using illinois agility test, seated medicine ball throw test, and one minute push-up test.

## HYPOTHESES

1. **Null hypothesis (H01):** There will be no significant difference between experimental and control groups on enhancing performance of a cricket batsmen in terms of power and agility.
2. **Null hypothesis (H02):** There will be no significant difference between both the experimental groups on enhancing performance of a cricket batsmen in terms of the power and agility.
3. **Alternate hypothesis (Ha1):** There will be significant difference between experimental and control groups on enhancing performance of a cricket batsmen in terms of power and agility.
4. **Alternate hypothesis (Ha2):** There will be significant difference between both the experimental groups on enhancing the performance of cricket batsmen in terms of power and agility.

## REVIEW OF LITERATURE

1. An observational study was done in 2016 by Kunvar Singh and Dr. Ratnesh Singh on an association of anthropometric and physical fitness variables of cricket players with the performance of running between the wickets. The objective of this study was to investigate the relationship between cricket players' performance in running between the wickets and selected anthropometric variables (height and arm length) as well as physical fitness variables (speed, agility, and flexibility). The findings of the study show that there are significant relationships of running between the wickets performance with selected anthropometric variables Heigh, Arm Length, and selected physical fitness variables Speed, Agility, and Flexibility.
2. A randomized clinical trial in 2022 was carried out by Anshul babul Sharma et. al on the effect of the cricFit intervention program on throwing and running performance in non-elite adolescent cricket players. The results indicated that the CricFit intervention program significantly enhanced throwing speed and running performance among non-elite adolescent cricket players. However, no statistically significant improvements were observed in throwing accuracy.
3. An observational pilot study was carried out in 2022 by Shloka Jayawant and Dr. Victoria Kuttan on Assessment And Comparison of Agility in Cricketers Depending on Their Playing Position. The objective of the study was to evaluate and compare the agility of cricket players depending on their playing position using Agility T-test. The agility differed significantly ($p$ value$<0.05$). The study revealed that agility timing scores among cricket players varied by position. Batsmen had the lowest times, followed by wicket-keepers, while bowlers had the highest times.
4. A co-relational study was done by Mogammad S. Taliep et al in 2010 on upper body muscle strength and batting performance in cricket batsmen. This study aimed to assess whether upper body muscle strength, measured by the repetition maximum bench press, was associated with cricket batting performance. A positive correlation was found between upper body muscle strength and maximum hitting distance ($p = 0.0052$).
5. A clinical commentary was carried out in 2015 by George Davies et. al on current concepts of plyometric exercise. Rehabilitation programs have drastically changed, especially in the terminal phases of rehabilitation, which include performance enhancement, the development of power, and a safe return to activity. Among the various types of exercise, plyometrics play a key role in developing power, which serves as a foundation for athletes to further hone their sport-specific skills. Therefore, the purpose of this clinical commentary is to provide an overview of plyometrics including its definition, phases, the physiological, mechanical, and neurophysiological basis of

plyometrics, and to describe clinical strategies and contraindications for executing plyometric programs.

6. An experimental study was conducted by M. Hammami et al. in 2021 on the Effects of high-intensity interval training and plyometric exercise on the physical fitness of junior male handball players. This study analyzed the effects of high intensity interval training (HIIT) combined with plyometric exercise on the physical fitness of junior male handball players. The combination of high-intensity interval training (HIIT) and plyometrics can enhance physical fitness attributes that are crucial for junior male handball players.
7. The study conducted by Yassine Negra et. al. aimed to assess the effectiveness and time course of improvements in explosive actions through resistance training (RT) vs. plyometric training (PT) in prepubertal soccer players. Thirty-four prepubertal soccer players were randomly assigned to a control group, an RT group, and a PT group. The RT group performed 5 regular soccer training sessions per week, while the PT group did 3 soccer training sessions and 2 RT sessions per week. The study measured outcomes like muscle strength, jump ability, linear speed, and change of direction. The results showed: The RT group showed improvements in half-squat and countermovement jump after 4 weeks, while improvements in sprinting, change of direction, and other jump tests were evident after 8 weeks. The PT group showed improvements in change of direction, standing long jump, countermovement jump, and squat jump after 8 weeks, with improvements in sprinting and multiple bounds seen only after 12 weeks. Both the RT and PT groups demonstrated improvements in sprint, change of direction, and jump tests compared to the control group.
8. The study conducted on the "Effect of plyometric exercises on physical fitness component speed in cricket players" by Dr. Awdhesh Kumar Shukla explores the impact of plyometric exercises on speed performance in cricket players. The study involved twenty male cricket players from Lucknow University, India, aged between 18 to 25 years. The participants were divided into two groups: an experimental group that underwent plyometric exercises four days a week for 10 weeks and a control group. The results indicated that the 10-week plyometric program significantly improved speed performance in the experimental group compared to the control group. The study highlights the effectiveness of plyometric training in enhancing speed performance among cricket players.

9. The study by E. Rey et. al. examined the effects of two different high-intensity interval training (HIIT) protocols, short-interval (SI) and long-interval (LI), on physical fitness measures in adult handball players during the preseason period.The 34 participants were randomly assigned to either the SI group (2 HIIT sessions per week) or the LI group (2 HIIT sessions per week). The training programs were conducted over 6 weeks in addition to the players'

regular handball training.The main findings were: Both the SI and LI groups showed significant improvements in repeated sprint ability (RSA) measures like average time, total time, and percentage of decrement from pre- to post-training. The SI group demonstrated greater improvements in RSA fastest time compared to the LI group. Both groups experienced significant increases in the velocity reached at the end of the 30-15 Intermittent Fitness Test (VIFT). There were no significant changes in countermovement jump height or 10-meter sprint time for either group. The authors concluded that both the SI and LI HIIT protocols were effective at improving aerobic fitness and RSA in adult handball players, with the SI protocol leading to greater enhancements in certain RSA measures.

# METHODOLOGY

## Participants:

A randomized control trial was performed on 36 cricket players selected from Jagruti cricket academy in Bhubaneswar. Ethical clearance was taken from the Institutional ethical committee of Abhinav Bindra Sports Medicine and Research Institute (ABSMARI), Pahal, Bhubaneswar prior to the commencement of the study. The protocol ID for approval was (ABS-IEC-2023-PHY-003). The participants selected were within the age group of 18-23 years and had at least 3 years of batting experience were included in the study. The purposive sampling method was used for sampling. The players having any kind of recent injury, female cricket batters, or PARQ score less than 7 were excluded from the study.

## Sample size calculation:

The sample size was calculated using G-Power software using A priori power analysis with effect size (0.65), alpha (0.05), power (0.90), of Illinois agility test. [6,16]

## MATERIALS USED

1. Stopwatch (Mobile Application)
2. Rope for rope training
3. Wooden box (40cm)
4. Kettlebell (6kg)
5. Marking cones
6. Measuring tape
7. Adjustable hurdles (40cm)
8. Medicine Ball (3kg)

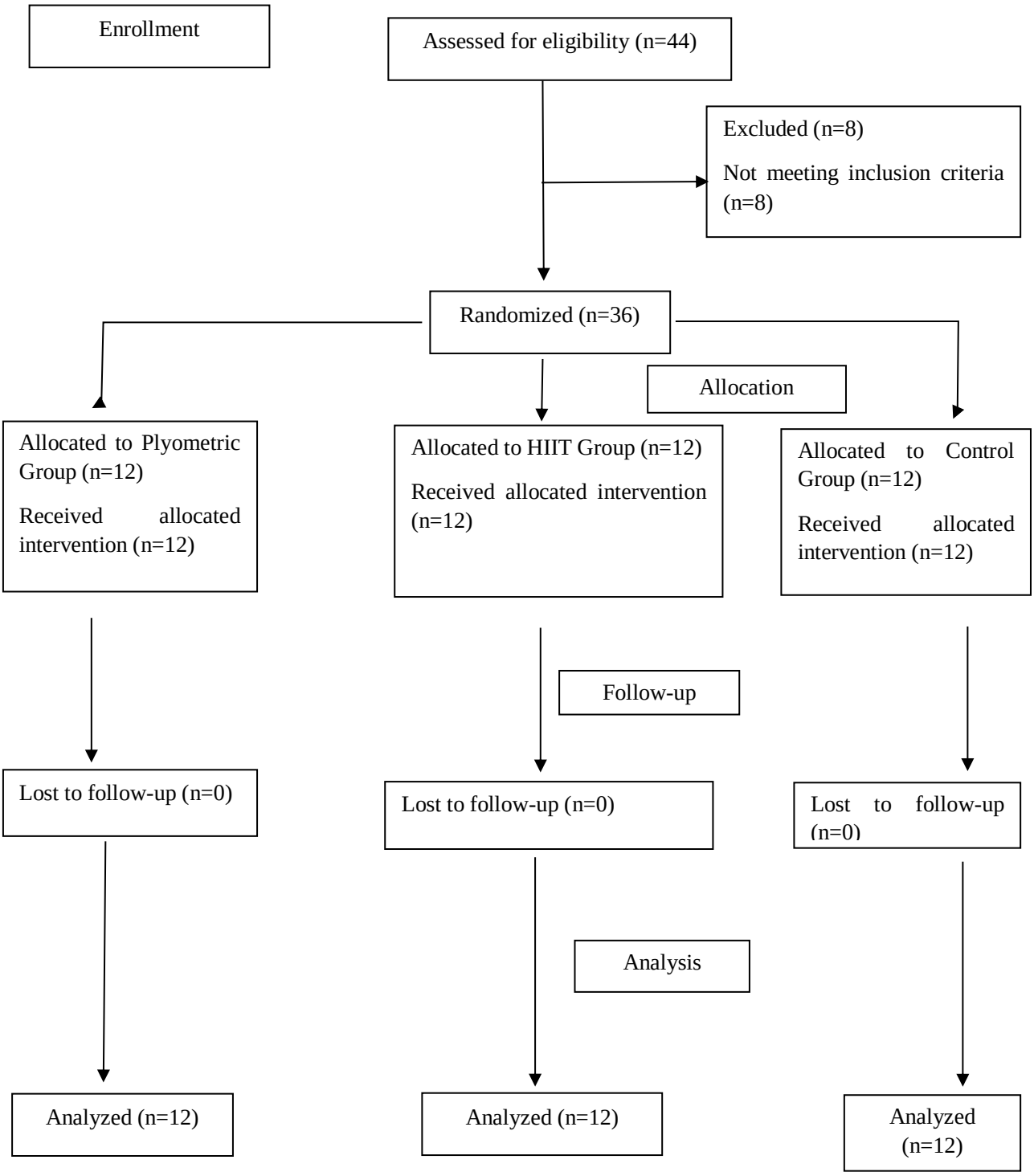



**FIGURE 1: CONSORT Flow Diagram**

## PROCEDURE

- An experimental study was undertaken at Jagruti Cricket Academy, Bhubaneswar. 36 participants were randomly included based on the inclusion and exclusion criteria mentioned earlier.
- A brief demographic data of all the participants was obtained, written consent was taken from all the participants, and the experimental protocol was explained with its benefits and harms. The study duration was 6 weeks which included 12 sessions of experimental protocol. 36 Participants, who cleared the Physical activity readiness questionnaire (PARQ), and the inclusion criteria were randomly divided to Plyometric Group, High Intensity Interval Group, and Control Group.
- Group A underwent plyometric exercises, Group B underwent High Intensity Interval Training (HIIT), twice a week for 6 consecutive weeks, with their regular training, and Group C (control group) did not undergo any additional training protocol apart from their regular training regime.
- Power and Agility were assessed for all the subjects using primary outcome measures, Seated Medicine Ball Throw Test (SMBT), Illinois Agility Test (IAT) respectively, and secondary outcome measure One-minute Push-ups Test (1-MPT) prior to the commencement of the training protocol and after 6 weeks.
- No adverse events were reported during the training sessions.

❖ **Plyometric Training (PT):**

- The plyometric training included 3 exercises which were performed prior to the cricketing drills, twice a week for 6 consecutive weeks. The exercise protocol is explained in the **TABLE 1**.

❖ **High Intensity Interval Training (HIIT):**

- The HIIT protocol also included 3 exercises which were performed prior to the cricketing drills, twice a week for 6 consecutive weeks. The exercise protocol is explained in the **TABLE 1**.

**Plyometric Training Protocol:**
40 cm - Box jump - 30 repetitions x 5 sets
Full arc arm rotation with elbow off the table - 10 repetitions x 5 sets with 6kg kettlebell
Two hand rotation from side - 10 repetitions x 5 sets with 6kg kettlebell

(Dosage: 6 weeks, 2 days/week, 30 minutes/day, 15-20 seconds rest in between sets, and 1-minute rest between exercises)

**High-Intensity Interval Training:**
Seated rope training - 15 seconds exercise and 5 seconds rest x 6 repetitions x 5 sets
Shuttle sprints - 10 seconds sprint and 5 seconds rest x 6 repetitions x 5 sets
40 cm Hurdle jumps - 6 jumps followed by 5 seconds sprint and 10 seconds rest x 5 sets

(Dosage: 6 weeks, 2 days/week, 30 minutes/day, 15-20 seconds rest between sets, and 1-minute rest between exercises)

**TABLE 1: Dosage and list of exercises**

**Outcome Measures:**

**<u>Primary Outcome Measures:</u>**

1. Seated Medicine Ball Throw Test: The seated medicine ball throw test **(ICC=0.96)** [30] is used to measure the power of the upper extremities with and

is performed with athlete sitting on floor with both the knees extended and back supported by the wall. Usually 3kg medicine ball is used for the test, but there are variations in this test which allow the examiner to use 1kg, 2kg, or 4kg medicine ball depending upon the targetted population. The ball is held with the hands by the side of the body and parallel to the ground. The athlete is asked to throw the ball as far as possible by keeping his back in constant touch with the wall. The distance from the wall to the dropping point of the ball is measured. (**FIGURE 2**)

**FIGURE 2: SMBT**

2. Illinois Agility Test: Illinois agility test **(ICC=0.96, SEM=0.19 seconds)** [31] is performed athletes assuming a prone position with their hands by their shoulders, they should face the starting line. Once the runner hears the command "Go," the stopwatch starts, and they must run as fast as they can to sprint 10 meters ahead, 10 meters back, and then up and down a four-cone slalom course. The timing is halted at the finishing cone when the athlete completes a final 10 meters of up and back running.

**Secondary Outcome Measure:**

1. One-minute push-up test: The aim of one-minute push-up test **(ICC=0.987)** [32] is to perform as many push-ups as athlete can in one minute. The starting

position is with the arms straight, elbows locked, body straight, hands placed slightly wider than shoulder-width apart with fingers pointing forward and both feet on the floor. From the starting position, on the command ‘go,’ start the push-up by bending elbows and lowering your body until the shoulders drop below the level of the elbows, then return to the starting position. (**FIGURE 3-a & b**)

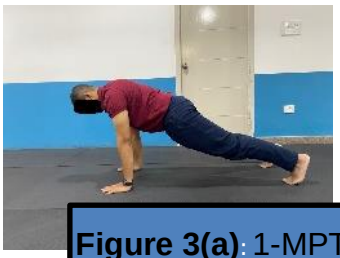


**Figure 3(a)**: 1-MPT starting position

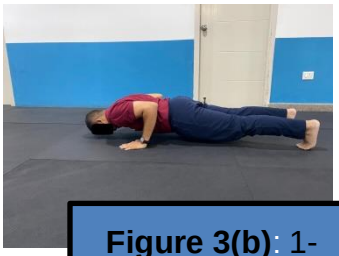


**Figure 3(b)**: 1-MPT end position

## STATISTICAL ANALYSIS

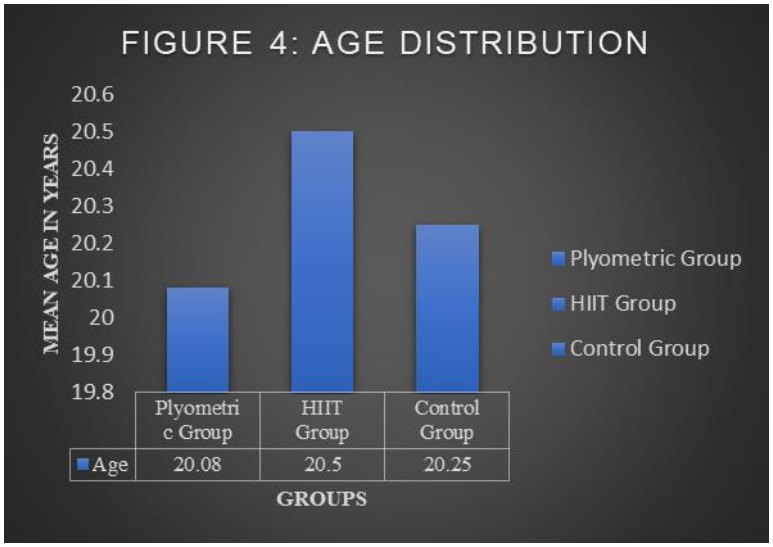
Statistical analysis was performed using IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Normality of the data was found using Shapiro-Wilk test. Descriptive analysis was done using mean and standard deviation while performing interferential statistics. The interferential statistics that is the Paired t-test was used for time factor analysis within the group and One-way ANOVA was used for the group factor analysis. The level of significance (p-value) kept at ≤0.05.

## RESULT

The current study included 36 participants aged 18 to 23 years. The baseline data are shown in **TABLE 2**. A comparison of the pre-intervention Seated Medicine Ball Throw Test (SMBT), Illinois Agility Test (IAT), and One-minute Push-ups Test (1-MPT) among the three groups revealed no statistically significant difference in the pre-intervention data (**p>0.05**). **FIGURE 4** illustrates the age distribution among groups.

| FACTORS | Plyometric Group | HIIT Group | Control Group | p Value |
|---|---|---|---|---|
| Age | 20.08 | 20.5 | 20.25 | p>0.05 |
| SMBT | 1.83 | 1.88 | 1.9 | p>0.05 |
| IAT | 22.49 | 22.11 | 22.74 | p>0.05 |
| 1-MPT | 26.5 | 27.25 | 27.08 | p>0.05 |

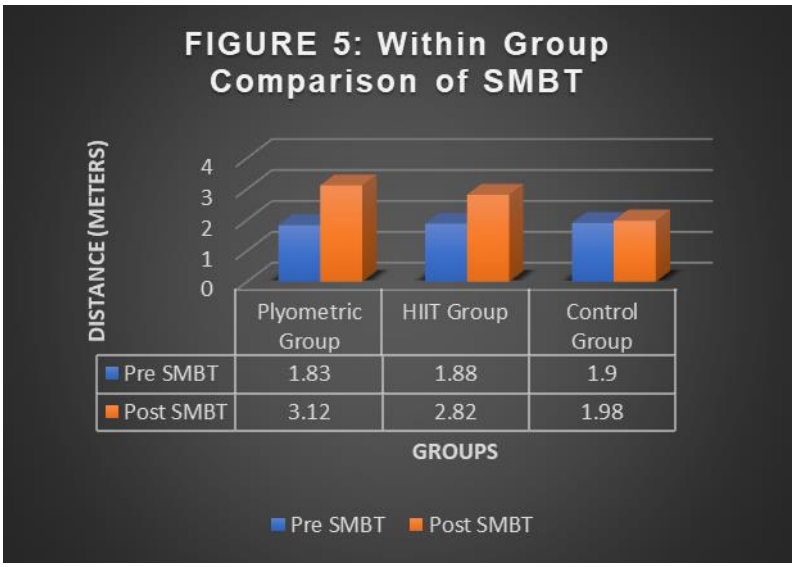
**TABLE 2: DEMOGRAPHIC & PRE-INTERVENTION DATA**




In a within-group comparison of the pre- and post-intervention of the Seated Medicine Ball Throw Test (SMBT), the plyometric, HIIT, and Control groups shown gains in power and agility with (**p<0.05**), (**TABLE 3** and **FIGURE 5**).

| Groups | Pre | Post | Mean Difference | p Value |
|---|---|---|---|---|
| Plyometric Group | 1.83 | 3.12 | 1.28 | p<0.05 |
| HIIT Group | 1.88 | 2.82 | 0.93 | p<0.05 |
| Control Group | 1.9 | 1.98 | 0.08 | p<0.05 |

**TABLE 3: Within Group Comparison of SMBT**




Within-group comparison of pre-and post-intervention of the Illinois Agility Test (IAT) in Group A, and Group B (**TABLE 4** and **FIGURE 6**) demonstrated improvement in the agility with the (**p<0.05**), which is statistically significant. Control group showed no statistically significant difference in the Illinois Agility Test with (**p>0.05**).

| Groups | Pre | Post | Mean Difference | p Value |
|---|---|---|---|---|
| Plyometric Group | 22.49 | 17.49 | 5 | p<0.05 |
| HIIT Group | 22.11 | 17.64 | 4.47 | p<0.05 |
| Control Group | 22.74 | 22.54 | 0.2 | p>0.05 |

**TABLE 4: Within Group Comparison of IAT**

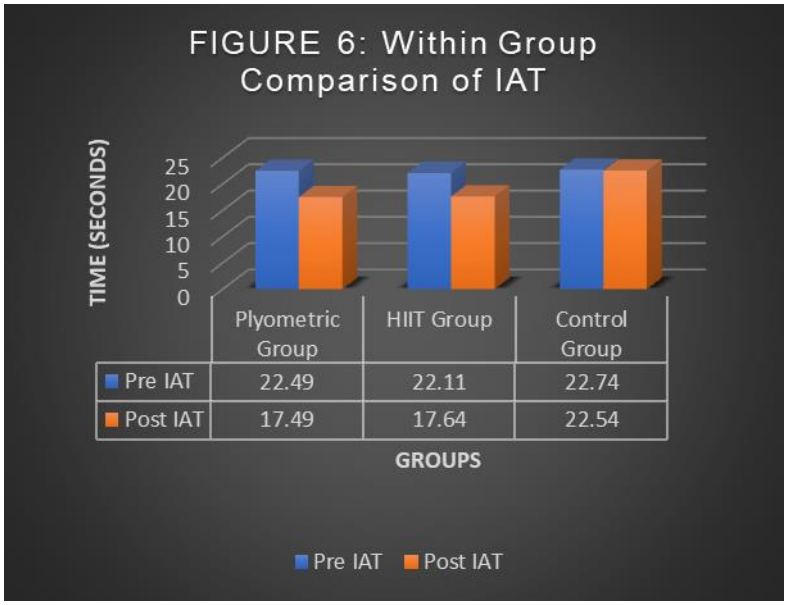
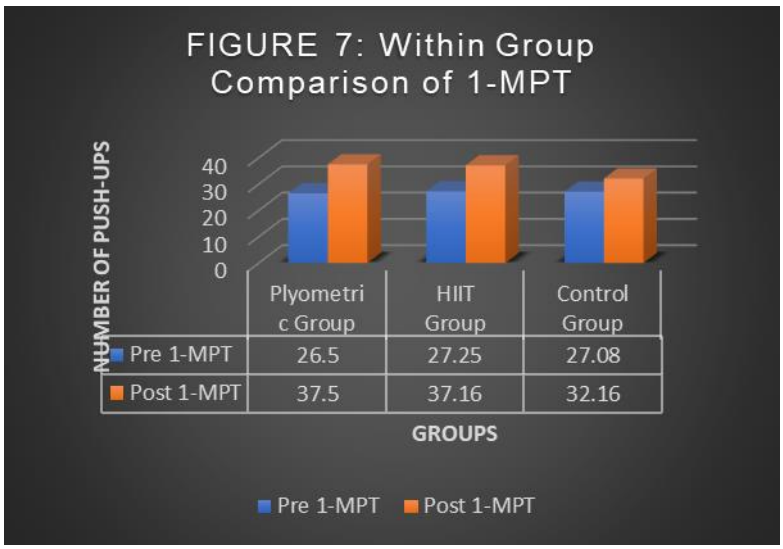



**TABLE 5** and **FIGURE 7** show that, there was a statistically significant improvement in power and agility within plyometric, HIIT, and Control groups when comparing their pre- and post-intervention scores on the One-minute Push-ups Test (1-MPT).

| Groups | Pre | Post | Mean Difference | p Value |
|---|---|---|---|---|
| Plyometric Group | 26.5 | 37.5 | 11 | p<0.05 |
| HIIT Group | 27.25 | 37.16 | 9.91 | p<0.05 |
| Control Group | 27.08 | 32.16 | 5.08 | p<0.05 |

**TABLE 5: Within Group Comparison of 1-MPT**



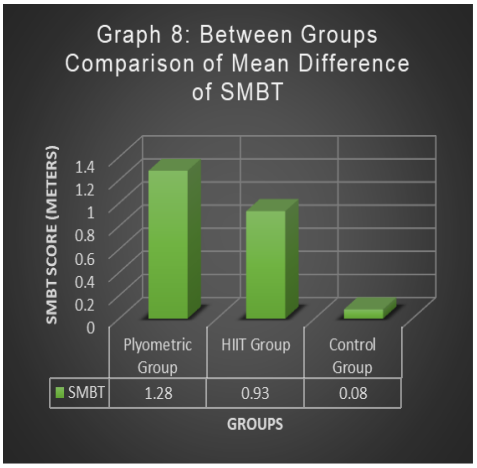
A comparison of the post-intervention Seated Medicine Ball Throw Test (SMBT), Illinois Agility Test (IAT), and One-minute Push-up Test (1-MPT), with (**p<0.05**), indicates that there is a statistically significant difference in the post-intervention data among the plyomeric, HIIT, and control groups.

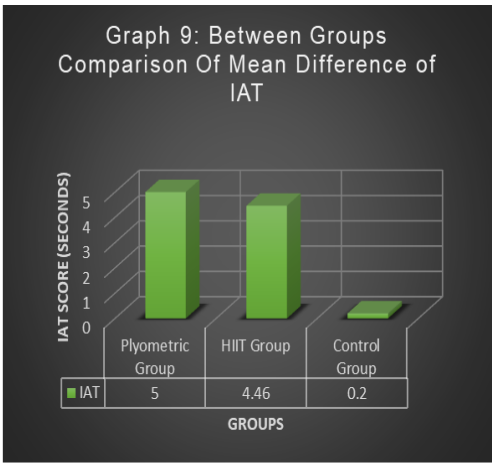
Comparison of means of Seated Medicine Ball Throw Test, Illinois Agility Test, and One-minute Push-ups Test among all the 3 groups, i.e plyometric, HIIT, and control groups demonstrated in **TABLE 6** and **FIGURE 8, FIGURE 9, and FIGURE 10** respectively.

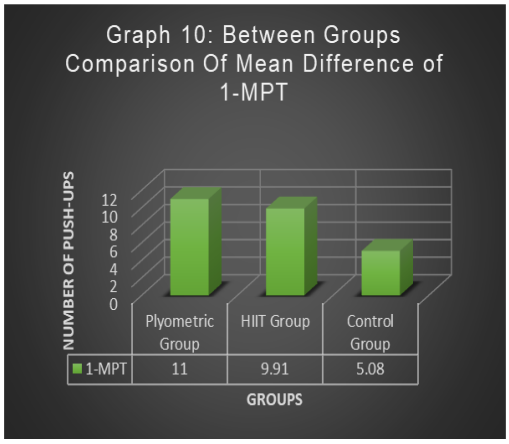
| Outcome Measure | Groups | Baseline Mean | Post Mean | Mean Difference | Between Group ANOVA | | MCID |
|---|---|---|---|---|---|---|---|
| | | | | | F Value | p Value | |
| Seated Medicine Ball Throw Test | Plyometric Group | 1.83 | 3.12* | 1.28* | 39.84 | p<0.05* | 0.41 |
| | HIIT Group | 1.88 | 2.82 | 0.93 | | | |
| | Control Group | 1.9 | 1.98 | 0.08 | | | |
| Illinois Agility Test | Plyometric Group | 22.49 | 17.49* | 5* | 67.95 | p<0.05* | |
| | HIIT Group | 22.11 | 17.64 | 4.47 | | | |
| | Control Group | 22.74 | 22.54 | 0.2 | | | |
| One-Minute Push-ups Test | Plyometric Group | 26.5 | 37.5* | 11* | 12.13 | p<0.05* | 2.5 |
| | HIIT Group | 27.25 | 37.16 | 9.91 | | | |
| | Control Group | 27.08 | 32.16 | 5.08 | | | |

**Table 6: Between Group Analysis Of Mean Differences**

***Indicates clinically as well as statistically significant change**




The pairwise comparison of seated medicine ball throw test, Illinois agility test, and one-minute push-up test between groups, shown in , **TABLE 7, TABLE 8, and TABLE 9** respectively, indicates that plyometric and HIIT training groups have improved the power and agility compared to the control group. These tables also indicate that there is no statistically significant difference between plyometric and HIIT groups on improving SMBT, IAT, and 1-MPT.

| For SMBT | PLYOMETRIC vs HIIT | HIIT vs CONTROL | PLYOMETRIC vs CONTROL |
|---|---|---|---|
| Mean Difference | 0.349 | 0.853 | 1.202 |
| Cohens D | 0.8647 | 2.3285 | 6.2385 |
| C.I | (-0.117 , 0.816) | (0.434 , 1.271) | (0.966 , 1.437) |
| p Value | p>0.05 | p<0.05 | p<0.05 |

**TABLE 7: PAIR-WISE COMPARISON OF SMBT**

| For IAT | PLYOMETRIC vs HIIT | HIIT vs CONTROL | PLYOMETRIC vs CONTROL |
|---|---|---|---|
| Mean Difference | 0.544 | 4.262 | 4.807 |
| Cohens D | 0.4065 | 4.0101 | 5.6084 |
| C.I | (-0.794 , 1.883) | (3.175 , 5.35) | (3.751 , 5.862) |
| p Value | p>0.05 | p<0.05 | p<0.05 |

**TABLE 8: PAIR-WISE COMPARISON OF IAT**

| For 1-MPT | PLYOMETRIC vs HIIT | HIIT vs CONTROL | PLYOMETRIC vs CONTROL |
|---|---|---|---|
| Mean Difference | 1.083 | 4.833 | 5.917 |
| Cohens D | 0.3121 | 1.5293 | 2.2064 |
| C.I | (-3.757 , 5.924) | (1.313 , 8.353) | (2.901 , 8.932) |
| p Value | p>0.05 | p<0.05 | p<0.05 |

**TABLE 9: PAIR-WISE COMPARISON OF 1-MPT**

Based on these within- and between-groups comparisons, all three groups showed improvement in the power and agility assessed by using the seated medicine ball throw test, the Illinois agility test, and the one-minute push-ups test, but plyometrics training resulted in greater improvements compared to the other 2 groups, which was clinically and statistically significant, and Group C did not show statistically significant improvement in the Illinois Agility Test for Agility.

## DISCUSSION

The aim of the current study was to compare the plyometric and high-intensity interval training on improving power and agility among cricket batsmen. The power and agility were measured using seated medicine ball throw test, Illinois agility test, and One-minute push-up test; pre- and post-intervention. The participants selected were within the age group of 18-23 years and had at least 3 years of batting experience.

The results of this study revealed that the power and agility measured using primary outcome measures- SMBT and IAT; and secondary outcome measure-1-MPT; improved in all 3 groups i.e plyometric, HIIT, and control groups, but statistically significant improvements were seen in plyometric training and HIIT groups. The control group did not show statistically significant improvements when compared to plyometric and HIIT groups.

Thus, from the results of this study it can be stated that power and agility can be improved by plyometric and high-intensity interval training in male cricket batsmen. The reason could be neural adaptations such as an increased nerve conduction velocity, improved intermuscular coordination, enhanced motor unit recruitment strategy, increased excitability of the Hoffman reflex, as well as changes in muscle size, architecture, or mechanical characteristics of the muscle-tendon complex, and changes in single-fiber mechanics. [27]

In a study, conducted in 2018 on effects of HIIT with various intervals on repeated sprint ability (RSA), counter movement jump (CMJ), and 10 meter sprint in elite handball players. It was found that the high intensity interval training improved the RSA, CMJ, and 10-m Sprint. The result of which

indicates that HIIT can improve power and agility. The rationale for the improvements was, boost in aerobic fitness and muscle buffer capacity that may promote faster rate of phosphocreatine re-synthesis. [26]

A study conducted by Harvard et al in 2020 on effects of plyometric training on change of direction in experienced soccer players. The conclusion of the study supported the current study in terms of improvement in change of direction followed by plyometric training, which was due to increased proprioceptive inputs and muscle power. [22]

A systematic review and meta-analysis was done in the year 2021 by Elena et al on effects on plyometric training on vertical jump, linear sprint, and change of direction in female soccer players which concluded that plyometric training was useful in improving the power and agility, which supports the current study. The rationale for improvement was improved stretch-shortening cycle of the muscle-fibres and increased strength and power production. [23]

Previous research indicates that plyometric training (PT) can improve sprinting performance due to its reliance on the stretch-shortening cycle (SSC). The benefits of PT for sprinting are closely related to the velocity of muscle actions used during training. Consequently, it is proposed that the most significant improvements in sprinting performance from PT are observed during the acceleration phase. [28]

Some researchers suggest that PT is more effective in improving performance due to the ability of subjects to use the elastic and neural benefits of the SSC. [28]

Overall, improvements in agility after PT can be attributed to neural adaptation, specifically to increased intermuscular coordination. [28]

Anaerobic glycolytic and ATP-PCr systems, which are responsible for performing brief activities (2–15 seconds), such as throwing and sprinting, are trained throughout the training protocol in both the HIIT and plyometric groups. This is the reason for the improvement in power and agility outcomes following the training period in both plyometric and HIIT group. [28]

The results of the current study indicate that there was no statistically significant difference (**p>0.05**) in SMBT between the plyometric and HIIT groups, with a Cohen's d effect size of **0.8647**. However, statistically significant differences were observed (**p<0.05**) in SMBT between the HIIT and control groups, as well as between the plyometric and control groups, with effect sizes of **2.3285** and **6.2385**, respectively.

According to the findings of the current study, there was no statistically significant distinction (**p>0.05**) in IAT between the plyometric and HIIT groups, accompanied by a Cohen's d effect size of **0.4065**. Nevertheless, notable differences were evident (**p<0.05**) in IAT between the HIIT and control groups, as well as between the plyometric and control groups, demonstrating effect sizes of **4.0101** and **5.6084**, respectively.

Based on the results of the current study, there was no statistically significant difference (**p>0.05**) in 1-MPT between the plyometric and HIIT groups, with a Cohen's d effect size of **0.3121**. However, significant differences were observed (**p<0.05**) in 1-MPT between the HIIT and control groups, as well as between the plyometric and control groups, with effect sizes of **1.5293** and **2.2064**, respectively.

Thus, based on the findings and statistical analyses of this study, significant improvements (**p<0.05**) in power and agility were observed in both the

plyometric and HIIT groups compared to the control group. However, there was no statistically significant difference (**p>0.05**) detected between the plyometric and HIIT groups when compared to each other.

## LIMITATIONS

1. The study exclusively involved male cricket batsmen to control for physiological differences between genders.
2. The training interventions were applied over a defined period, but long-term research could provide insights into how sustained power and agility improvements persist over extended seasons or years.
3. With a sample size of 36 male participants, the findings may not be generalizable to larger populations or to female cricketers.

## FUTURE SCOPE

1. Conduct longitudinal studies to assess the sustainability of gains in power and agility over an extended period following the cessation of training programs.
2. Investigate the potential synergistic effects of combining plyometric and HIIT training protocols on cricket-specific performance metrics.
3. Extend similar studies to include female cricketers to understand gender-specific responses to plyometric and HIIT training.

## CONCLUSION

In conclusion, this study assessed the effectiveness of plyometric training and high-intensity interval training (HIIT) on enhancing power and agility in cricket batsmen. It involved 36 male participants aged 18-23, who were randomly assigned to either a Plyometric, HIIT, or Control group, with 12 participants per group. The Plyometric and HIIT groups underwent a regimen of 12 sessions over six weeks, while the Control group continued their standard training. Power and agility were evaluated using the Seated Medicine Ball Throw Test (SMBT), Illinois Agility Test (IAT), and One-minute Push-ups Test (1-MPT) before and after the intervention.

## SUMMARY

Both plyometric and HIIT training led to significant improvements in power and agility compared to the Control group. However, no significant difference was observed between the Plyometric and HIIT groups in terms of the extent of improvement. Thus, both training methods were found to be equally effective. Coaches and trainers can choose either approach based on their preferences or other practical considerations, as both are effective in enhancing physical performance in cricket.

## DATA AVAILABILITY STATEMENT

The datasets produced and/or analyzed in this study are not publicly accessible due to privacy and confidentiality concerns but can be obtained from the corresponding author upon reasonable request. The detailed original data underlying the findings of this study, including raw measurements and analysis files, are securely stored and can be accessed upon request for research and verification purposes.

## KEY POINTS

1. Both Plyometric and HIIT training significantly improved the power and agility of cricket batsmen, as measured by the Seated Medicine Ball Throw Test (SMBT), Illinois Agility Test (IAT), and One-minute Push-ups Test (1-MPT).
2. The study demonstrated that both Plyometric and HIIT training methods are effective in enhancing the physical performance of cricket batsmen, particularly in areas crucial to cricket performance, such as power and agility.
3. Participants in the Plyometric and HIIT groups showed significantly greater improvements in power and agility compared to those in the Control group, who did not receive any additional training beyond their regular routines.
4. When comparing the Plyometric and HIIT groups directly, there was no statistically significant difference in the degree of improvement in power and agility, suggesting that both training methods are equally effective.
5. The findings suggest that cricket coaches and trainers can utilize either Plyometric or HIIT training to enhance the power and agility of their athletes, offering flexibility in training approaches without compromising the effectiveness of the outcomes.

## CONFLICT OF INTEREST

The authors state that the research was carried out without any commercial or financial ties that could be interpreted as a potential conflict of interest.

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**ANNEXURE:1**

**CONSENT FORM**

I _____, aged ___ years, confirm that I have understood about plyometric and high intensity interval training procedure and its potential benefits on athletes as explained by mst. Brijesh R. Vishwakarma and is as mentioned in his study which is taking place under the guidance of Dr. Deepak K Pradhan, assistant professor, abhinav bindra sports medicine and research institute (ABSMARI).

I understand that my participation is voluntary and i'm free to withdraw at any time, without giving any reason.

I understand that confidentiality will be maintained.

I voluntarily agree to and give my consent to be a part of the above mentioned study.

Signature Date

## ANNEXURE:2

## ASSESSMENT FORM

NAME: AGE/GENDER:

### PRE-AND POST-INTERVENTION DATA:

1. SEATED MEDICINE BALL THROW TEST:

| Trials | Pre | Post |
|---|---|---|
| Trial 1 | | |
| Trial 2 | | |
| Trial 3 | | |
| Final (Highest) | | |

2. ILLINOIS AGILITY TEST:

| | Pre | Post |
|---|---|---|
| Time (in seconds) | | |

3. ONE-MINUTE PUSH-UP TEST:

| | Pre | Post |
|---|---|---|
| No. of Push-ups | | |

### PHYSICAL ACTIVITY READINESS QUESTIONNAIRE:

**The Physical Activity Readiness Questionnaire for Everyone**

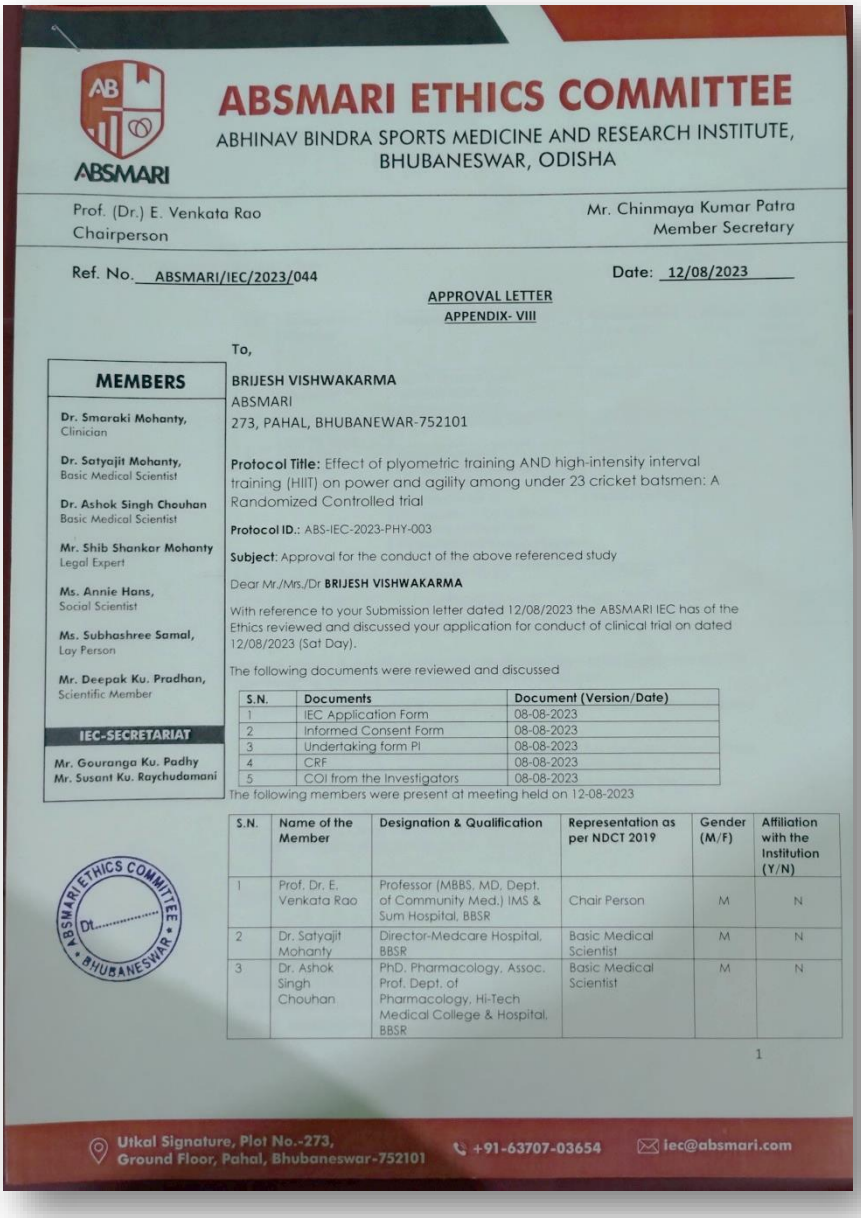
The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

**GENERAL HEALTH QUESTIONS**

| **Please read the 7 questions below carefully and answer each one honestly: check YES or NO.** | YES | NO |
|---|---|---|
| 1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐? | ☐ | ☐ |
| 2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity? | ☐ | ☐ |
| 3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise). | ☐ | ☐ |
| 4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** _____ | ☐ | ☐ |
| 5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** _____ | ☐ | ☐ |
| 6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** _____ | ☐ | ☐ |
| 7) Has your doctor ever said that you should only do medically supervised physical activity? | ☐ | ☐ |

## ANNEXURE: 3

## IEC- APPROVAL CERTIFICATE



# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

ABSMARI

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/044

Date: 12/08/2023

**APPROVAL LETTER**
**APPENDIX- VIII**

**MEMBERS**

- **Dr. Smaraki Mohanty,** Clinician
- **Dr. Satyajit Mohanty,** Basic Medical Scientist
- **Dr. Ashok Singh Chouhan** Basic Medical Scientist
- **Mr. Shib Shankar Mohanty** Legal Expert
- **Ms. Annie Hans,** Social Scientist
- **Ms. Subhashree Samal,** Lay Person
- **Mr. Deepak Ku. Pradhan,** Scientific Member

**IEC-SECRETARIAT**

**Mr. Gouranga Ku. Padhy**
**Mr. Susant Ku. Raychudamani**

To,

**BRIJESH VISHWAKARMA**
ABSMARI
273, PAHAL, BHUBANEWAR-752101

**Protocol Title:** Effect of plyometric training AND high-intensity interval training (HIIT) on power and agility among under 23 cricket batsmen: A Randomized Controlled trial

**Protocol ID.:** ABS-IEC-2023-PHY-003

**Subject:** Approval for the conduct of the above referenced study

Dear Mr./Mrs./Dr **BRIJESH VISHWAKARMA**

With reference to your Submission letter dated 12/08/2023 the ABSMARI IEC has of the Ethics reviewed and discussed your application for conduct of clinical trial on dated 12/08/2023 (Sat Day).

The following documents were reviewed and discussed

| S.N. | Documents | Document (Version/Date) |
|---|---|---|
| 1 | IEC Application Form | 08-08-2023 |
| 2 | Informed Consent Form | 08-08-2023 |
| 3 | Undertaking form PI | 08-08-2023 |
| 4 | CRF | 08-08-2023 |
| 5 | COI from the Investigators | 08-08-2023 |

The following members were present at meeting held on 12-08-2023

| S.N. | Name of the Member | Designation & Qualification | Representation as per NDCT 2019 | Gender (M/F) | Affiliation with the Institution (Y/N) |
|---|---|---|---|---|---|
| 1 | Prof. Dr. E. Venkata Rao | Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR | Chair Person | M | N |
| 2 | Dr. Satyajit Mohanty | Director-Medcare Hospital, BBSR | Basic Medical Scientist | M | N |
| 3 | Dr. Ashok Singh Chouhan | PhD, Pharmacology, Assoc. Prof, Dept. of Pharmacology, Hi-Tech Medical College & Hospital, BBSR | Basic Medical Scientist | M | N |

ABSMARI ETHICS COMMITTEE Dt. BHUBANESWAR

1

Utkal Signature, Plot No.-273,
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iec@absmari.com

# ANNEXURE:4
# MASTERCHART

| Sr. no. | Name | Age (Years) | SMBT (Meters) | | IAT (seconds) | | 1-MPT | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pre | Post | Pre | Post | Pre | Post | |
| 1 | Ashok Patnaik | 21 | 1.72 | 2.89 | 20.76 | 17.67 | 25 | 37 | |
| 2 | Bijay Mohanty | 18 | 2.14 | 3.56 | 21.34 | 16.98 | 22 | 30 | |
| 3 | Chandan Sahu | 22 | 1.39 | 3.14 | 21.91 | 16.52 | 30 | 44 | |
| 4 | Durga Charan Das | 20 | 1.95 | 3.27 | 22.89 | 18.17 | 28 | 33 | |
| 5 | Ganesh Mishra | 19 | 2.31 | 3.83 | 24.03 | 18.43 | 24 | 36 | |
| 6 | Harihara Behera | 23 | 1.87 | 2.72 | 24.57 | 17.89 | 21 | 31 | PT |
| 7 | Ishwar Pradhan | 18 | 2.03 | 3.41 | 20.45 | 17.24 | 29 | 39 | |
| 8 | Jagan Prusty | 21 | 1.56 | 2.45 | 24.21 | 17.46 | 23 | 38 | |
| 9 | Kailash Jena | 22 | 1.28 | 2.33 | 22.18 | 17.03 | 31 | 39 | |
| 10 | Laxman Panda | 19 | 1.73 | 3.02 | 23.64 | 17.61 | 27 | 42 | |
| 11 | Madan Samal | 20 | 2.47 | 3.74 | 20.89 | 16.29 | 32 | 45 | |
| 12 | Niranjan Nayak | 18 | 1.62 | 3.11 | 23.12 | 18.61 | 26 | 36 | |

| Sr. no. | Name | Age (Years) | SMBT (Meters) | | IAT (seconds) | | 1-MPT | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pre | Post | Pre | Post | Pre | Post | |
| 1 | Omkar Sahu | 23 | 2.14 | 2.19 | 20.29 | 17.12 | 34 | 40 | |
| 2 | Prakash Barik | 19 | 1.82 | 2.96 | 21.57 | 18.05 | 33 | 46 | |
| 3 | Ramesh Mohapatra | 22 | 2.42 | 2.68 | 24.46 | 18.76 | 20 | 28 | |
| 4 | Santosh Dash | 20 | 1.35 | 2.23 | 22.76 | 18.22 | 31 | 38 | |
| 5 | Tarakanta Das | 18 | 1.97 | 3.62 | 23.33 | 16.95 | 24 | 35 | HIIT |
| 6 | Udaya Swain | 21 | 2.24 | 2.85 | 24.89 | 18.38 | 23 | 39 | |
| 7 | Vikram Rout | 23 | 1.49 | 2.13 | 23.01 | 16.58 | 33 | 41 | |
| 8 | Yudhisthir Behera | 19 | 1.81 | 2.51 | 21.23 | 16.32 | 21 | 27 | |
| 9 | Abhinash Patra | 20 | 2.22 | 3.95 | 20.62 | 17.54 | 32 | 47 | |
| 10 | Biranchi Sethi | 22 | 1.66 | 3.07 | 19.76 | 16.84 | 22 | 28 | |
| 11 | Debashish Mohanty | 18 | 1.39 | 2.36 | 22.45 | 18.74 | 28 | 36 | |
| 12 | Gopal Panigrahi | 21 | 2.12 | 3.29 | 20.98 | 18.29 | 26 | 41 | |

| Sr. no. | Name | Age (Years) | SMBT (Meters) | | IAT (Seconds | | 1-MPT | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pre | Post | Pre | Post | Pre | Post | |
| 1 | Himanshu Mishra | 23 | 1.54 | 1.6 | 23.87 | 23.82 | 32 | 34 | |
| 2 | Jagannath Pradhan | 19 | 2.33 | 2.4 | 21.09 | 21.02 | 20 | 25 | |
| 3 | Kanhu Sahu | 20 | 1.78 | 1.8 | 22.34 | 22.32 | 21 | 26 | |
| 4 | Lokanath Das | 18 | 1.21 | 1.23 | 24.34 | 24.28 | 34 | 38 | |
| 5 | Manoj Behera | 22 | 1.96 | 2.01 | 23.56 | 23.51 | 25 | 31 | CG |
| 6 | Narayan Mohanty | 21 | 2.05 | 2.12 | 21.68 | 21.12 | 22 | 28 | |
| 7 | Pramod Jena | 19 | 1.68 | 1.69 | 19.98 | 18.89 | 29 | 36 | |
| 8 | Rajendra Sahoo | 23 | 2.48 | 2.57 | 22.67 | 22.61 | 29 | 31 | |
| 9 | Satish Mohapatra | 18 | 2.17 | 2.26 | 20.12 | 19.87 | 35 | 42 | |
| 10 | Trilochan Barik | 22 | 1.42 | 1.46 | 25.31 | 25.3 | 20 | 29 | |
| 11 | Uttam Sahu | 20 | 1.89 | 2.23 | 23.23 | 23.09 | 28 | 34 | |
| 12 | Vishal Panda | 18 | 2.29 | 2.41 | 24.78 | 24.73 | 30 | 32 | |