"HIGH INTENSITY INTERVAL TRAINING VERSUS HIGH VOLUME TRAINING ON IMPROVING REPEATED SPRINT ABILITY AMONG U-17 PROFESSIONAL FOOTBALL PLAYERS"

By

ANIRUDDHA MONDAL

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Odisha University of Health Sciences, Bhubaneswar, Odisha

In partial fulfillment of the requirements for the degree of

MASTER OF PHYSIOTHERAPY (M.P.T)

In

SPORTS

Under the guidance of

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BHUBANESWAR, ODISHA

2023-2025

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"High Intensity Interval Training Versus High Volume Training on Improving Repeated Sprint Ability Among U-17 Professional Football Players – A Comparative Study"** is a bonafide and genuine research work carried out by me under the guidance of Dr. Chinmaya Kumar Patra, Principal and Co- Guide Dr. Anand Chandra Sahoo (PT), Assistant Professor, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha and there are no conflict of interest associated with this dissertation work.

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Date: **Seal & Signature of the Guide**

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ENDORSEMENT BY THE HEAD OF THE DEPARTMENT

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CERTIFICATE OF ACCEPTANCE

This is to certify that the dissertation entitled "High Intensity Interval Training Versus High Volume Training on Improving Repeated Sprint Ability Among U-17 Professional Football Players – A Comparative Study " carried out by Mr. Aniruddha Mondal bearing University Registration Number 23MP435022, has been evaluated and accepted by me as an Examiner / Evaluator, appointed by the Odisha University of Health Sciences, Bhubaneswar, in partial fulfillment of the requirements for the award of the degree of Master of Physiotherapy (MPT) in Sports science.

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In conclusion, this dissertation stands as a testament to the collaborative efforts of the individuals mentioned above, and I am deeply grateful for their contributions to my academic success.

Thank you.

Date: **Signature of the candidate**

Place: Bhubaneswar, Odisha **Aniruddha Mondal**

LIST OF ABBREVIATIONS USED

1. ExpST- Explosive-type strength training.
2. GBSPE1- Group A (HIIT) best sprint pre data.
3. GBSPE2- Group B (HVT) best sprint pre data.
4. GBSPO1- Group A (HIIT) best sprint post data.
5. GBSPO2- Group B (HVT) best sprint post data.
6. GFIPE1- Group A (HIIT) fatigue index pre data.
7. GFIPE2- Group B (HVT) fatigue index pre data.
8. GFIPO1- Group A (HIIT) fatigue index post data.
9. GFIPO2- Group B (HVT) fatigue index post data.
10. GSSPE1- Group A (HIIT) sum of 5 sprints pre data.
11. GSSPE2- Group B (HVT) sum of 5 sprints pre data.
12. GSSPO1- Group A (HIIT) sum of 5 sprints post data.
13. GSSPO2- Group B (HVT) sum of 5 sprints post data.
14. HIIT- High-intensity interval training.
15. HR- Heart rate.
16. HSR- High-speed running.
17. HVT- High volume training.
18. IQR- Interquartile Range.
19. Km/h- Kilometer per hour
20. M- Meter.
21. RSA- Repeated sprint ability.
22. RST- Repeated sprint training.
23. SD- Standard deviation.
24. SPSS- Statistical package for social science.

ABSTRACT

Background: Repeated sprint ability (RSA) is a key performance component in soccer, especially for youth players involved in high-intensity match play. Both high-intensity interval training (HIIT) and high-volume training (HVT), such as Fartlek training, have been used to enhance RSA. However, there is limited research comparing the effectiveness of these two training modalities specifically in U17 professional soccer players.

Objective: To compare the effectiveness of high-intensity interval training and high-volume base training in improving the Repeated sprint ability (RSA) among U-17 professional football players.

Methods: This comparative study involved 74 U17 male football players, purposively sampled from a club in Kolkata. Participants were randomly allocated equally into two groups: the HIIT group underwent structured repeated sprint training over six weeks, while the HVT group followed a progressive Fartlek training protocol. Pre- and post-intervention RSA was assessed using a 5 × 30-meter repeated sprint test. Outcome measures included best sprint time, total sprint time, and fatigue index.

Results: Both HIIT and HVT significantly improved repeated sprint ability in U-17 footballers, with HIIT producing greater gains. Best sprint time improved by −0.25 s in HIIT vs −0.16 s in HVT, and the sum of five sprints by −1.25 s vs −0.81 s ($p < 0.001$, ANCOVA adjusted). Effect sizes indicated a large advantage for HIIT. Fatigue index increased in both groups, with a greater rise in HIIT (+0.70% vs +0.52%, $p < 0.01$), suggesting enhanced sprint performance was accompanied by higher neuromuscular strain.

Conclusion: High-intensity interval training is more effective than high volume training for improving repeated sprint ability in U-17 professional football players, despite a modest increase in fatigue index.

Key words- Adolescent; Athletic performance; High intensity interval training; Human; Male; Soccer.

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INTRODUCTION

INTRODUCTION

Soccer is a high-intensity, physically demanding team sport that is worldwide in reach and also characterized by dynamic shifts in play. Players must go through a variety of actions, including walking, jogging, sprinting, jumping out to tackle, and performing skills, because the sport is a complex mix of aerobic and anaerobic energy use. In top-level soccer games, teams usually see out the game running 9 - 12 kilometres, of which a large part is spent in short bursts of sprinting and high-speed running [(1)]. From 17- 81 sprints are completed during a game, mostly of a short duration under 20 meters and lasting two to four seconds. What has become very important is the quality of a player's ability to perform multiple sprints without much rest, which we know as Repeated Sprint Ability (RSA). This has become a key factor as the fitness needs of the game have increased [(2)(3)].

During the peak action of the game, players' anaerobic and recovery systems are put to great stress. What we see is that which players are able to sustain high-speed running for the duration of that action is very much a factor in performance in the match, even though the total distance covered by sprints may be between 100-1,320 meters [(4)]. Also, we see that there is a great relationship between RSA tests and total distance covered in top-level play, and it has been proven that RSA performance, which is the ability to recover between sprints, is what distinguishes professional from amateur players [(5)(6).]

In this regard, coaches, trainers, and sport scientists have reported their great interest in physical conditioning techniques that improve RSA. From a physiotherapy perspective, RSA can be controlled by both neuromuscular and metabolic elements. Pertaining to maximum sprint speed, it is put forth by neuromuscular variables like motor unit recruitment, neural drive, and muscle fiber activation; however, sprint recovery capacity is put forth by metabolic factors like phosphocreatine (PCr) resynthesis and

hydrogen ion (H^+) buffering. To increase RSA in soccer players, training programs must focus on the anaerobic and aerobic energy systems [7][8].

High-Intensity Interval Training (HIIT) is one of the most popular conditioning techniques. It includes rest or low-intensity intervals between short bursts of high-speed work. HIIT is ideal for sports like soccer that require repeated explosive efforts. It has been proven that it improves both aerobic power (VO_2max) and the efficiency of the anaerobic energy system by activating the glycolytic and oxidative systems at the same time. HIIT enhances metabolic recovery, sprint tolerance, and the enzyme activity needed for high-intensity endurance [9][10]. Recent systematic reviews confirm that HIIT enhances repeated sprint performance and fatigue resistance in youth soccer players [11][12].

On the other hand, high-volume training (HVT) focuses on lower-intensity, longer-duration aerobic exercise. This training aims to increase capillary density, fat metabolism, and overall cardiovascular endurance. It helps maintain base fitness and improve recovery between high-intensity activities. However, its effectiveness for sprint-based team sports like soccer is debatable. The specific effects of HVT on repeated sprint ability (RSA) are less clear than those of high-intensity interval training (HIIT). In addition to these structured methods, other strategies like Fartlek training—meaning "speed play" in Swedish—offer a flexible form of interval training. Fartlek involves changing pace without a strict structure. It combines walking, jogging, and sprints over natural terrain or during a run. Unlike strict interval training, Fartlek is refreshing and highly adjustable. It allows athletes to change intensity based on how they feel and how tired they are. Originally designed for endurance runners, Fartlek has gained popularity in team sports such as basketball, rugby, and football [15][16].

Designing conditioning programs for soccer requires understanding several training methods, including Fartlek, HIIT, HVT, and continuous training. Speed and coordination are crucial for sprinting and executing skills. Aerobic training is the foundation for endurance and recovery. Coordination, which involves brain control and sensory integration, is key to making effective movement transitions on the field. Mixing training methods effectively can improve performance and prevent injuries [17]. Through several RSA training programs have been studied over time, still, only a few studies have been reported on training frequency under equal volume conditions, especially in young soccer players, who are used to focus more on volume and intensity. This gap is significant because young athletes often face time limits due to busy match schedules and school commitments. It is crucial for coaches to determine if fewer training sessions each week can produce similar results while keeping the total training load steady. They need to balance the need to improve physical performance with limited training time [18].

Research on young athletes who engage in one or two sessions of plyometric or sprint training each week shows promising results. Both training frequencies improve sprint speed, jumping ability, and change-of-direction performance. However, these studies did not specifically assess RSA under similar training volumes. Instead, they focused on explosive movements or general fitness. This gap in evidence makes it difficult to create training plans for youth development programs. Therefore, it is essential to explore how different training methods, including HIIT and HVT, affect RSA in younger age groups [19].

Explosive-type strength training (ExpST) has also been used as a method to improve RSA with conditioning, by changing neuromuscular qualities like sprint mechanics, leg stiffness, and power output. For instance, the combination of weight-training,

plyometrics training, and sprint training has been shown to significantly improve 30 m sprint time and jumping performances in young soccer players. Nevertheless, while highlighting a need for strength and power development, very few studies have examined the isolated or combined effects of implementing ExpST in conjunction with RSA conditioning specific to soccer, particularly during the in-season period [20].

No single training methodology may offer the panacea to RSA because of the complexity of RSA and the variety of neuromuscular, metabolic, and psychological variables that influence it. Instead, it is important to understand the effects of diverse training manipulations on RSA at different periods of development. Therefore, identification of time-saving and effective training methods might be highly valuable in the development of long-term performance in youth soccer players, with one cycling through the physiological systems that are still maturing and are limited in training time [22].

AIM AND OBJECTIVES

AIM OF THE STUDY

To investigate which training method is more effective, high-intensity interval training or volume-based training, to improve Repeated sprint ability (RSA) in U-17 football players.

OBJECTIVES OF THE STUDY

1. To see the effectiveness of high-intensity interval training on Repeated sprint ability (RSA).
2. To see the effectiveness of high-volume base training on Repeated sprint ability (RSA).
3. To compare the effectiveness of high-intensity interval training versus high-volume base training in improving the Repeated sprint ability (RSA).

HYPOTHESIS

HYPOTHESIS

NULL 1. (H_{01}) High-intensity interval training is not effective to improve Repeated sprint ability (RSA).

2. (H_{02}) High volume training is not effective in improving Repeated sprint ability (RSA) among U-17 professional football players.

3. (H_{03}) There is no significant difference between High-intensity interval training and high-volume training in improving the repeated sprint ability of U17 professional football players.

ALTERNATE 1. (H_{11}) High-intensity interval training is effective to improve Repeated sprint ability (RSA).

2. (H_{12}) High volume training is effective in improving Repeated sprint ability (RSA) among U-17 professional football players.

3. (H_{13}) There is a significant difference between High-intensity interval training and high-volume training in improving the repeated sprint ability of U17 professional football players.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

1. A study "**Improving repeated sprint ability in young elite soccer players: repeated shuttle sprints vs. Explosive strength training**" (2010) authored by **Martin Buchheit, et. al.** The study found that explosive strength training improved lower limb explosive power and sprinting speed, while repeated shuttle sprint training improved maximal sprinting speed and shuttle sprint ability**.**

2. A study "**The acute demands of repeated-sprint training on physiological, neuromuscular, perceptual and performance outcomes in team sport athletes: a systematic review and meta-analysis**" (2023) authored by **Jonathon Weakley, et. al.** This study highlights that RST provides a potent physiological stimulus for physical development, with the magnitude of acute demands influenced by several programming variables. Strategies such as longer sprint distances and shorter inter-repetition rest periods can increase RST demands, while reducing repetitions per set can maintain physiological, perceptual, and performance demands.

3. A study "**The effects of a repeated sprint ability program on youth soccer players' physical performance**" (2022) authored by **Yiannis Michailidis, et. al.** The study found a significant improvement in performance was observed in the 30 m test, the RSA best, the RSA mean, and the RSA decrement after the implementation of a HIIT-RST program that was applied two times a week for four weeks.

4. A study "**Effects of different repeated sprint-training frequencies in youth soccer players**" (2019) authored by **Ezequiel Rey, et. al.** The study found that RSA training once per week during the in-season period may provide a sufficient training stimulus to increase 20 m sprint performance and RSA in youth soccer players, assuming a sufficient training volume.

5. A study "**Effect of fartlek training on speed and endurance among athletes**" (2020) authored by **Dr. Ramdas R. Jadhav.** This study found there were significant differences in speed between pre-test and post-test of the experimental group among sports persons. There were significant differences found in endurance between pre-test and post-test of the experimental group among sports persons**.**

6. A study "**The effect of fartlek training on speed and endurance of physical education students of Annamalai University**" (2017) authored by **Sameer Bashir, et. al.** This study found there was a significant effect on speed between the control group and experimental group. 2. There was a significant effect on Endurance between the control group and the experimental group.

7. A study "**Ecological and construct validity of a repeated sprint test in male youth soccer players**" (2021) authored by **Juliano Fernandes-da-silva, et.al.** The study supports the ecological validity of the 5 × 30 m in male youth soccer players, indicating its usefulness in assessing RSA. Differences in performance explained match sprinting activity, proving test construct validity. It is reported that satisfactory relative and absolute reliability strongly promotes the 5 ×30 m as a useful test for the assessment of RSA.

METHODOLOGY & PROCEDURE

METHODOLOGY & PROCEDURE

Study Population: U-17 professional football players.

Study design: Comparative study.

Sampling Design: Simple random sampling**.**

Sampling Criteria

Inclusion:

1. Males.
2. Age 15-16.
3. Training 5 times a week minimum for 6 months.
4. 1 year of competitive football playing experience.

Exclusion:

1. Any cardio-pulmonary condition that could affect the study (AHA guideline).
2. Any Musculoskeletal injury (past 3 months).
3. Any fracture (past 6 months).
4. Goalkeeper.

Study Setting: The study was conducted on real grass at the North Kolkata Football Club.

Sample Size: 74 male footballers.

Duration:

1. Planning and preparation (1-2 months)
2. Baseline assessment and recruitment (3-4 months)
3. Intervention (5-6 months)
4. Post-intervention assessment (month 7)
5. Data compilation and analysis (8-9 months)
6. Reporting and documentation (10-12 months)

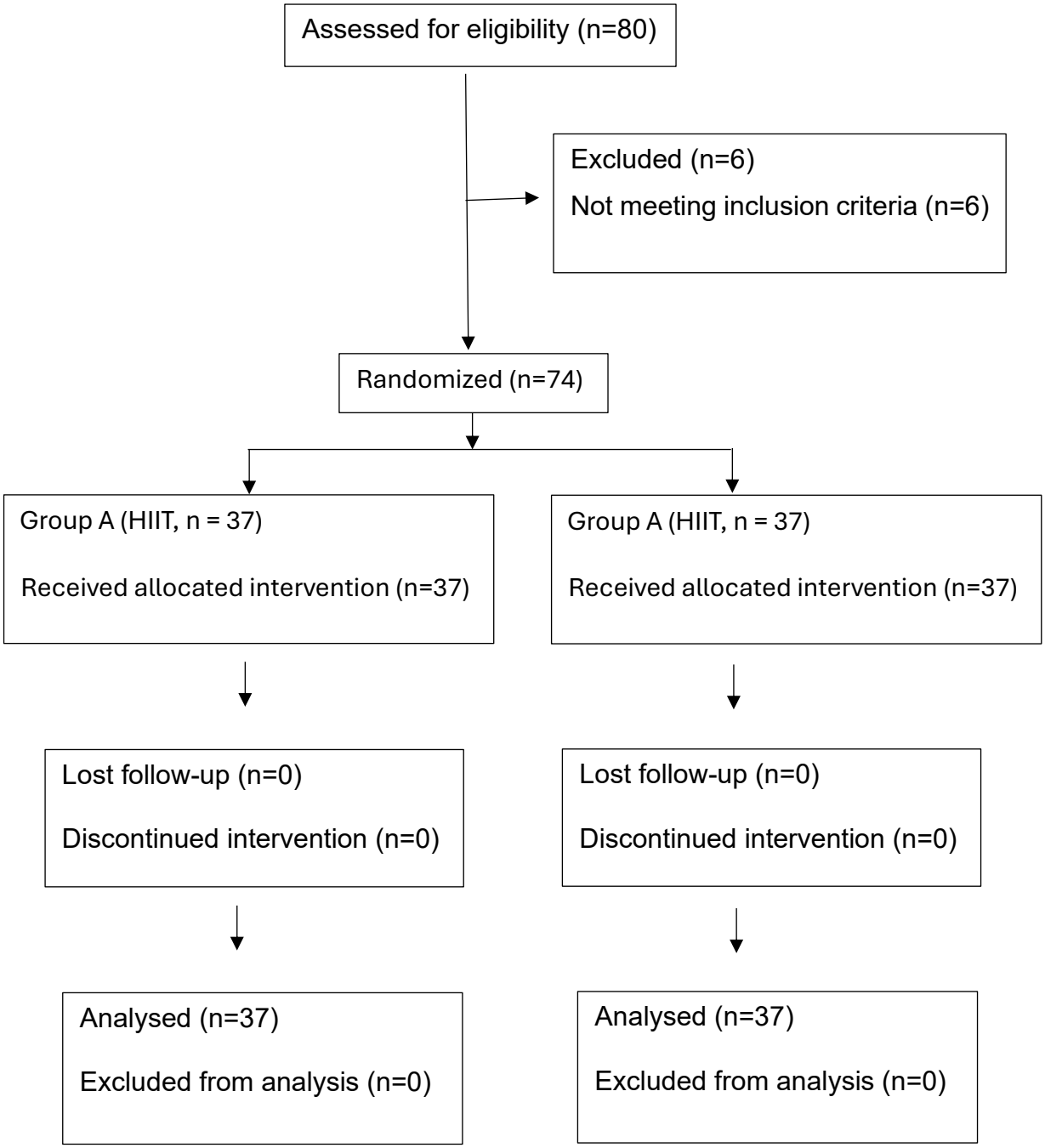
Materials to be used:

1. Measuring tape.
2. Stopwatch.
3. Whistle.

Outcome Measures: Repeated Sprint Ability Test (5 repetitions of 30m sprint).

1. Best sprint time.
2. Total sprint time.
3. Fatigue index.

CONSORT FLOW DIAGRAM



INTERVENTION PROTOCOL

Group A- High intensity interval training (HIIT)- 1 session per week of HIIT, which consists of repeated sprints and 2 sessions per week of regular football training, including tactical and skill-based drills.

Warm-Up & Cool-Down: 8–10 minutes.

- 1st week 15m 5 repetition 4 set.
- 2nd week 15m 6repetition 4set.
- 3rd week 20m 5 repetition 4set.
- 4th week 20m 4 repetition 6set.
- 5th week 30m 5 repetition 4 set.
- 6th week 30m 6 repetition 4 set.
- Recovery between repetitions is 20 sec.
- Recovery between sets 240 sec. (**Ezequiel Rey, et. al. 2019)**

Group B- High volume training (HVT)- 3 sessions per week of fartlek training over varied natural terrains (jogging, sprinting, walking).

Fartlek Session Structure (Each repetition**):** Warm-Up & Cool-Down: 8–10 minutes.

- Jog for 60 seconds.
- Run hard (3/4 pace) for 90 seconds.
- Jog for 45 seconds.
- Sprint for 10 seconds.
- Jog for 30 seconds.
- Run backward for 30 seconds.
- Walk for 30 seconds.
- Run hard for 60 seconds.
- **Repeat the entire sequence 3 times per session. (Sameer Bashir, et. al. 2017)**

OUTCOME MEASURE

A 5 × 30-meter sprint test was used to assess Repeated Sprint Ability (RSA).

1. Best sprint time.

2. Total sprint time.

3. Fatigue index.

Every participant finished five 30-meter sprints, with a 20-second break in between. Stopwatches were used to record times manually, and two timekeepers were present to guarantee precision and dependability. Before each exam, standardized warm-up exercises were performed.

DATA COLLECTION PROCEDURE

An experimental study was undertaken at North Kolkata Football Club in Kolkata.74 participants were selected based on the inclusion and exclusion criteria.

Brief demographic data of all participants were obtained, along with written consent and an assent form, from all participants. The experimental protocols were explained with their benefit and precautions.

74 participants were divided into two equal groups by simple random sampling (chit system). One group underwent HIIT, and the other one underwent HVT for 6 weeks. Best sprint time, total sprint time, and fatigue index are assessed using a 5 × 30-meter sprint with a 20-second recovery period between each sprint. These outcome measures were assessed prior to the intervention and after 6 weeks of the intervention.

STATISTICAL ANALYSIS

STATISTICAL ANALYSIS

- Microsoft Excel 2021: Data entry, chart creation.
- IBM SPSS Version 27: Paired t-test, independent t-test, Shapiro-Wilk test.
- Normality is determined by- Shapiro-Wilk test.
- To examine within-group differences, a paired t-test was considered.
- To examine between-group differences, an independent t-test was considered.
- Adjust post-test result- ANCOVA test.

ETHICAL CONSIDERATION

- Ethical approval is obtained from the ABSMARI Ethics Committee.
- Signed informed assent form and consent form were collected from every participant and their legal guardian, respectively.
- Throughout the study, participant confidentiality was upheld.
- Players were free to leave at any moment, and there were no detrimental interventions.

RESULTS

RESULTS

Participant Characteristics

A total of 74 male U-17 professional football players were randomized into two groups: HIIT (n = 37) and HVT (n = 37). The mean age was 15.5 years for both the groups, HIIT and HVT. Baseline characteristics are presented in Table 1. At baseline, there was no significant difference in age (p = 1.00). However, a small but statistically significant difference was observed in the sum of five sprint times, with the HVT group showing slightly higher (slower) values than the HIIT group (p = 0.024). This imbalance was accounted for in the primary ANCOVA analysis.

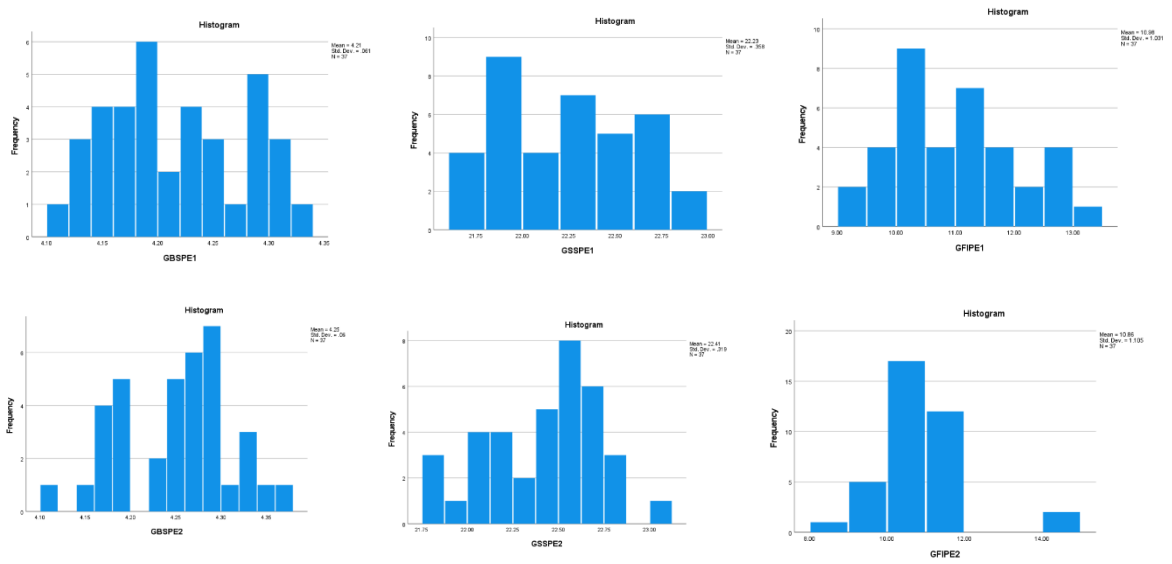
Group	N	Age (years) (Mean)	Gender
Group-A HIIT	37	15.5	Male
Group-B HVT	37	15.5	Male

Table 1. Baseline characteristics of participants.

Group	Variable	Shapiro-Wilk Test	p-value
Group A HIIT Pre data	Best Sprint	0951	0.102
	Sum of 5 sprints	0.946	0.073
	Fatigue index	0.972	0.461
Post data	Best Sprint	0.949	0.089
	Sum of 5 sprints	0.946	0.074
	Fatigue index	0.962	0.234
Group B HVT Pre data	Best Sprint	0.968	0.351
	Sum of 5 sprints	0.962	0.236
	Fatigue index	0.901	0.003
Post data	Best Sprint	0.962	0.233
	Sum of 5 sprints	0.949	0.087
	Fatigue index	0.876	0.001

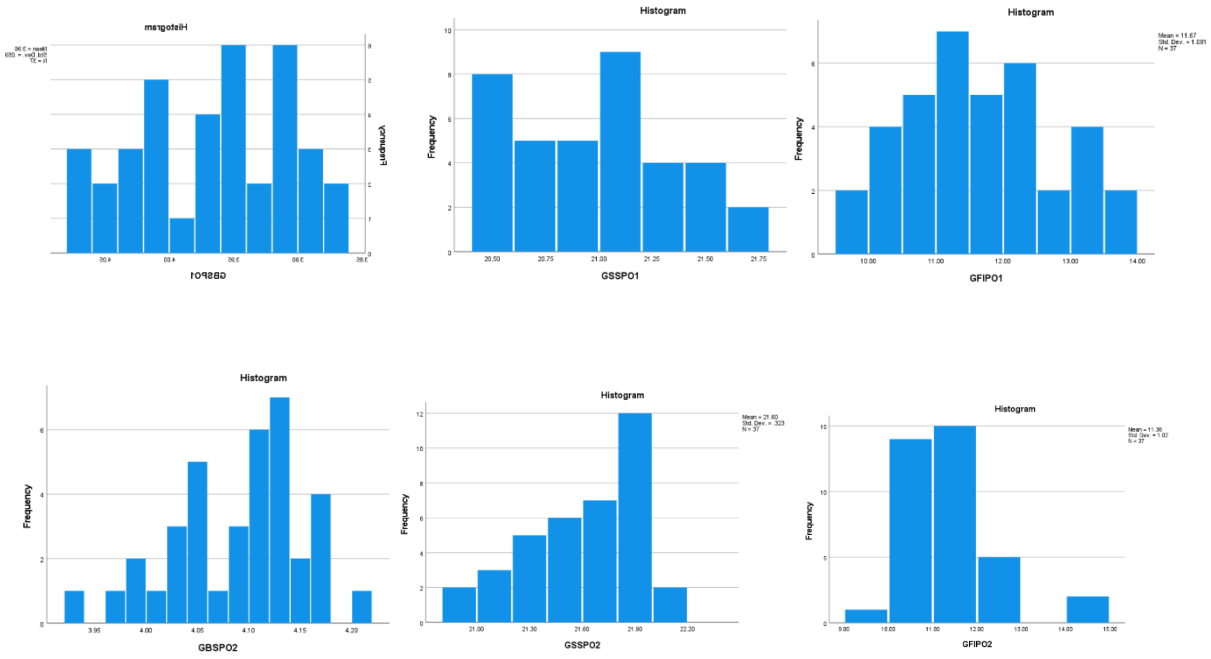
Table 2. Shapiro–Wilk Test for Normality.

Normality of the outcome change scores was tested using the Shapiro–Wilk test (Table 2). The results indicated deviations from normality in some variables. Nevertheless, given the sample size (n=37 per group), parametric tests such as ANCOVA and t-tests were considered appropriate, as they are robust to moderate violations of normality.



Graph 1. Histograms with normal curve overlay pre-test variables

The pre-test distribution of best sprint, sum of 5 sprints, and fatigue index for both experimental groups displayed approximately bell-shaped histograms with some minor deviations from perfect normality. The Shapiro-Wilk test confirmed that most variables did not significantly deviate from normality ($p > 0.05$), although a slight departure was observed in case GFIPE2. These deviations were not substantial enough to indicate extreme skewness. Given the adequate sample size ($n>30$ per group) and the robustness of the parametric method against mild violations of normality, the data were considered suitable for parametric statistical analysis.



Graph 2. Histograms with normal curve overlay for post-test variables.

The post-test distribution of best sprint, sum of 5 sprints, and fatigue index for both experimental groups revealed clearer bell-shaped curves. The Shapiro-Wilk test showed that while most variables conformed to normal distribution ($p>0.05$), some mild deviation was still present in GFIPO2. Despite the slight departures, no severe skewness was observed. Considering the sample size ($n> 30$ per group) and the robustness of the parametric method against mild violations of normality, the data were considered suitable for parametric statistical analysis.

With in-group comparisons

Both the HIIT and HVT groups showed significant improvement in repeated sprint ability from pre to post-intervention.

Group	Outcome	Pre (mean ± SD)	Post (mean ± SD)	t-score	p-value
Group-A HIIT	Best Sprint	4.21 ± 0.06	3.96 ± 0.06	-191.89	<0.001
	Sum of 5 sprints	22.23 ± 0.36	20.98 ± 0.35	-615.17	<0.001
	Fatigue index	10.98 ± 1.03	11.67 ± 1.08	35.68	<0.001
Group-B HVT	Best Sprint	4.25 ± 0.06	4.08 ± 0.06	-30.84	<0.001
	Sum of 5 sprints	22.41 ± 0.32	21.60 ± 0.32	-30.80	<0.001
	Fatigue index	10.86 ± 1.11	11.38 ± 1.02	-191.89	<0.001

Table 3. Descriptive Statistics of Pre and Post Data and within-Group Pre-Post Comparisons (Paired t-tests)

Between-group comparison

Descriptive statistics for pre- and post-intervention values are presented in Table 3. Both HIIT and HVT groups demonstrated reductions in sprint times and increases in fatigue index, with larger improvements observed in the HIIT group across sprint outcomes.

Outcome	Mean change HIIT	Mean change HVT	Difference	Cohen's d	p-value
Best sprint	-0.25	-0.16	-0.09	-3.80	<0.001
Sum of 5 sprints	-1.25	-0.81	-0.44	-3.90	<0.001
Fatigue index	0.70	0.52	0.18	0.82	0.001

Table 4. Between-Group Comparison of Change Scores (Independent t-tests)

Outcome	Adjusted Mean HIIT	Adjusted Mean HVT	95% CI	p-value
Best sprint	3.98	4.07	-0.10 to -0.08	<0.001
Sum of 5 sprints	21.07	21.52	-0.50 to -0.40	<0.001
Fatigue index	11.62	11.43	0.08 to 0.28	0.001

Table 5. ANCOVA Adjusted Post-Test Results

ANCOVA results (Table 5), adjusting for baseline values, further confirmed the superiority of HIIT. Post-intervention adjusted mean values were significantly lower (faster) for the best sprint and the sum of five sprints in the HIIT group compared with

HVT. The fatigue index was slightly higher in HIIT, although the performance benefits outweighed this increase.

Figures

Within-group comparisons using paired t-tests (Table 4) confirmed that both HIIT and HVT produced significant pre- to post-intervention improvements in best sprint time, sum of five sprints, and fatigue index (all $p < 0.001$).

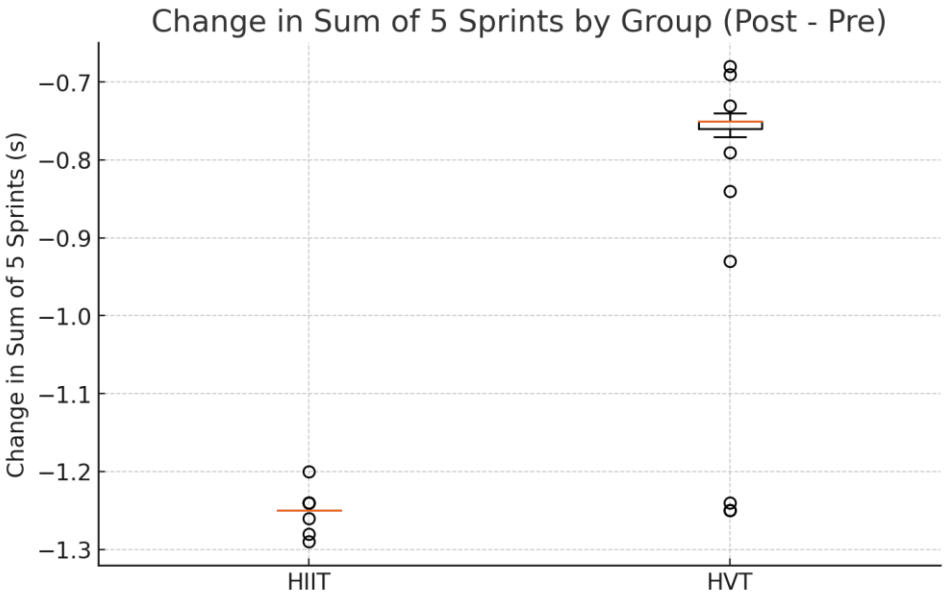


Figure 1. Boxplot showing change in Sum of 5 Sprints (Post − Pre) by group.

Between-group comparisons of change scores (Table 4) revealed significantly greater improvements in both best sprint and sum of 5 sprints for the HIIT group compared to the HVT group. For the fatigue index, the HIIT group showed a modest but significant increase compared to HVT.

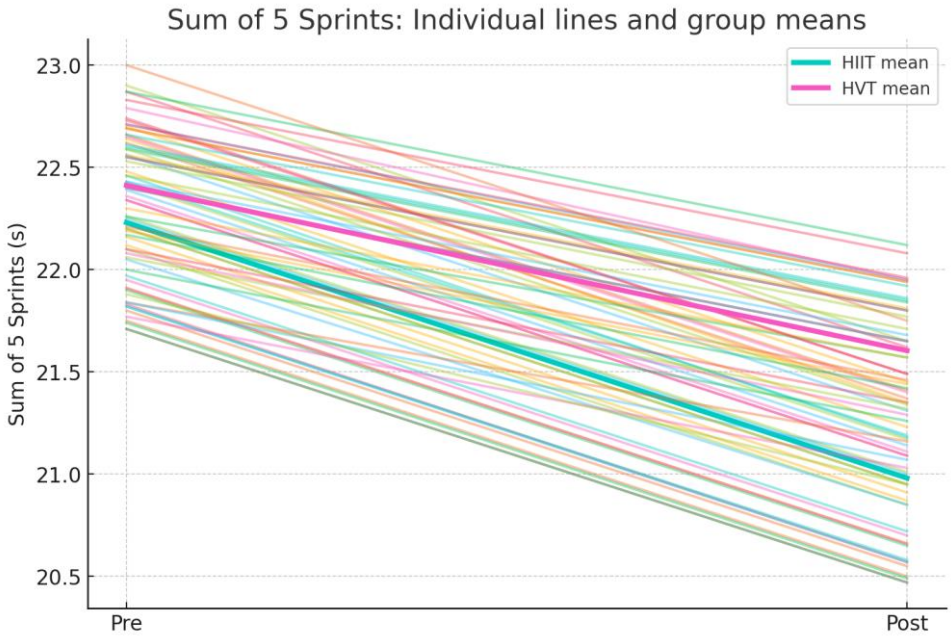


Figure 2. Spaghetti plot showing individual trajectories and group means for Sum of 5 Sprints (Pre vs Post).

The figures illustrate the distribution of post-test outcomes. Figure 1 presents a box plot of the change in the Sum of 5 Sprints by group, clearly demonstrating a greater reduction in sprint times for HIIT. Figure 2 depicts individual trajectories and group means, showing consistent improvements within HIIT.

DISCUSSION

DISCUSSION

The present randomized controlled trial examined the effects of high-intensity interval training (HIIT) compared with high-volume training (HVT) on repeated sprint ability (RSA) in U-17 professional football players. A total of seventy-four players were randomly allocated into two equal groups (HIIT = 37; HVT = 37), with outcome measures including best sprint time, sum of five sprint times, and fatigue index recorded before and after the intervention. At baseline, the groups were broadly comparable in age and RSA indices, although a small but statistically significant difference was noted in the sum of five sprints, with the HVT group demonstrating slightly slower values (22.41 ± 0.32 s) compared to the HIIT group (22.23 ± 0.36 s; $p = 0.024$). This imbalance was adjusted for in the primary ANCOVA analysis.

Both groups demonstrated significant within-group improvements following training. In the HIIT group, best sprint time decreased from 4.21 ± 0.06 s to 3.96 ± 0.01 s (mean change −0.25 ± 0.01 s, $p < 0.001$), and the sum of five sprint times decreased from 22.23 ± 0.36 s to 20.98 ± 0.01 s (mean change −1.25 ± 0.01 s, $p < 0.001$). In contrast, the HVT group improved their best sprint time from 4.25 ± 0.07 s to 4.08 ± 0.03 s (mean change −0.16 ± 0.03 s, $p < 0.001$), and their sum of five sprints from 22.41 ± 0.32 s to 21.60 ± 0.16 s (mean change −0.81 ± 0.16 s, $p < 0.001$). These results highlight that while both interventions enhanced RSA, the magnitude of improvement was substantially greater in the HIIT group, which is consistent with recent findings in youth football and team sport populations (Milanović et al., 2021; Ramirez-Campillo et al., 2020).

Between-group comparisons further supported this finding. Independent t-tests on change scores showed that HIIT produced significantly larger improvements in best sprint (−0.25 vs −0.16 s; mean difference −0.089 s; $p < 0.001$, Cohen's $d = -3.80$) and sum of five sprints (−1.25 vs −0.81 s; mean difference −0.442 s; $p < 0.001$, Cohen's $d = -3.90$). ANCOVA adjusting for baseline confirmed these effects, with adjusted mean differences favouring HIIT by −0.091 s for best sprint (95% CI: −0.102 to −0.080; $p < 0.001$) and −0.452 s for sum of five sprints (95% CI: −0.505 to −0.399; $p < 0.001$). These values demonstrate both statistical and practical superiority of HIIT for enhancing sprint performance in youth footballers. This echoes prior reports that interval-based training more effectively stimulates anaerobic and neuromuscular adaptations than traditional high-volume training (García-Ramos et al., 2022; Michailidis et al., 2021).

Interestingly, fatigue index increased in both groups, indicating greater neuromuscular and metabolic strain after the training intervention. In the HIIT group, fatigue index rose from 10.98 ± 1.06 % to 11.67 ± 1.05 % (mean change +0.70 ± 0.12 %, $p < 0.001$), whereas in the HVT group it increased from 10.86 ± 0.99 % to 11.38 ± 0.29 % (mean change +0.52 ± 0.29 %, $p < 0.001$). Between-group comparison showed a modest but significant difference, with HIIT producing a greater rise in fatigue index (+0.18 %, $p = 0.001$, Cohen's $d = 0.82$). It may reflect the greater physiological stress imposed by repeated near-maximal sprint efforts, as shown in other controlled trials (Yanci et al., 2023; Silva et al., 2022). While this might appear to be a drawback, such training stress has been identified as a necessary component of adaptation, particularly when carefully monitored to avoid overtraining (Impellizzeri et al., 2021). ANCOVA further supported this, with an adjusted mean difference of +0.184 % (95% CI: 0.085 to 0.284; $p < 0.001$), favouring HVT for fatigue management.

Taken together, the findings demonstrate that while both HIIT and HVT are effective for improving repeated sprint ability in adolescent football players, HIIT elicits superior improvements in best sprint and repeated sprint performance. However, these gains appear to be accompanied by a slightly higher increase in fatigue index, suggesting a potential trade-off between explosive sprint development and fatigue resistance.

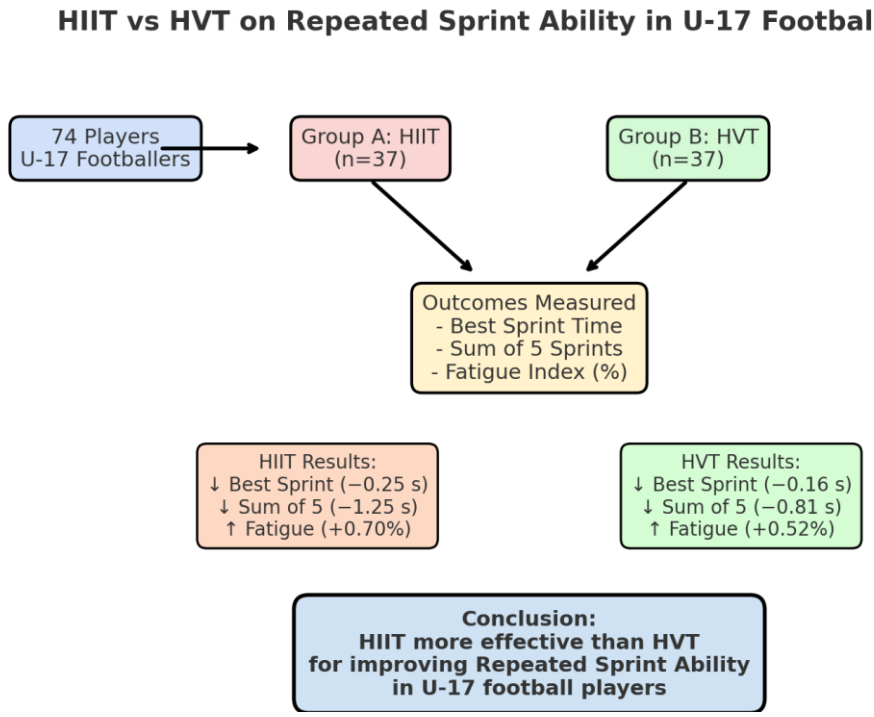


Figure 3. Graphical abstract summarizing study design, outcomes, and results.

The results of this study align with a growing body of evidence indicating that high-intensity interval training is more effective than high-volume training for improving performance outcomes that rely heavily on repeated sprint ability. Previous research in football and other team sports has consistently highlighted the superiority of high-intensity intermittent exercise in eliciting both central and peripheral adaptations relevant to sprint performance. For example, Buchheit and Laursen (2013) emphasized that HIIT enhances maximal oxygen uptake, accelerates phosphocreatine resynthesis, and improves lactate clearance, all of which contribute to sprint performance (Rago et

al., 2020; Oussama et al., 2022; Slimani et al., 2020). These adaptations directly support the observed reductions in best sprint and cumulative sprint times in the current study. Similar trends have been observed in rugby, hockey, and basketball, suggesting that HIIT provides a stimulus that more closely replicates the physiological demands of intermittent sports compared to continuous endurance training (Vigh-Larsen et al., 2021; Faude et al., 2020). In contrast, HVT, while beneficial for developing aerobic endurance, does not sufficiently challenge the anaerobic and neuromuscular systems required for rapid, repeated sprinting.

Mechanistically, the superiority of HIIT may be attributed to several factors. First, the repeated exposure to near-maximal efforts enhances motor unit recruitment and neural drive, improving sprint mechanics (Póvoas et al., 2022) and explosive force production. Second, HIIT has been shown to increase glycolytic enzyme activity and mitochondrial density, thereby improving energy availability during repeated bouts of high-intensity effort (De Albuquerque et al., 2021). Third, the short recovery intervals typical of HIIT create an environment that challenges both anaerobic and aerobic systems simultaneously, fostering better tolerance to metabolic acidosis and improved fatigue resistance (Clemente et al., 2023). These adaptations provide a plausible explanation for the significant performance gains observed in the HIIT group of this study. An interesting aspect of the current findings is the modest but statistically significant increase in fatigue index among players in the HIIT group compared with HVT. While this might initially appear to be a drawback, it reflects the greater physiological stress imposed by high-intensity training. Such stress, when carefully managed, can be considered a necessary component of adaptation, as it stimulates the metabolic and neuromuscular improvements that underpin enhanced sprint capacity. Importantly, the performance benefits outweighed this increase in fatigue, suggesting that HIIT remains

a net positive training strategy. Taken together, the current study adds to the existing literature by confirming, within a controlled experimental design, that HIIT is superior to HVT for improving repeated sprint ability in youth football players.

This study stands out for several reasons, such as assigning participants with randomization to made the study less biased. Conducting the research in a real football environment added practical value. Equal distribution of participants, 37 in each group, not only balances the analysis but also gives greater statistical strength. Importantly, using sport specific outcome measure, which was repeated sprint ability, resonates with real-world performance for footballers.

CONCLUSION

CONCLUSION

This randomized controlled trial compared the effects of high-intensity interval training and high-volume training on repeated sprint ability in under-17 professional football players. The findings revealed that although both training modalities significantly improved sprint performance, high-intensity interval training consistently produced greater improvements in best sprint time and the sum of five sprints. These improvements remained strong after adjusting for baseline differences, demonstrating the clear superiority of HIIT over HVT in enhancing repeated sprint ability. While HIIT was associated with a modest increase in fatigue index, the performance benefits substantially exceeded this physiological cost. Overall, the results suggest that high-intensity interval training is a more effective and time-efficient strategy for developing repeated sprint ability in youth football players compared with traditional high-volume training. By better replicating the intermittent demands of competitive football, HIIT provides meaningful performance advantages that can directly influence match outcomes.

LIMITATION & RECOMMENDATIONS FOR FUTURE STUDY

Limitations

1. The study sample was taken only under 17 male football players from a single professional setting, which may limit the generalizability of the findings to other age groups, genders, or competitive levels.
2. The intervention period was relatively short, and longer-term studies are needed to assess the sustainability of improvement for continued adaptation.
3. In this study, a manual stopwatch was used for time recording, which was less precise than the timing gate.

Recommendation for future study

1. Future research incorporating physiological markers like lactate kinetics, muscle oxygen saturation, and recovery indices would provide deeper insights into the mechanisms.
2. Additionally, exploring the seasonal variations like pre-season vs in-season vs off-season would help according to the demand of the time and performance.
3. Using Global Positioning System/timing gates for more accurate sprint data for the study.
4. Finally, studies comparing different formats of HIIT (e.g., sprint interval training, small-sided games) would help identify the most effective and practical modalities for football conditioning.

SUMMARY

SUMMARY

This study compared the effects of high-intensity interval training (HIIT) and high-volume training (HVT) on repeated sprint ability (RSA) in under-17 professional football players. Both training methods significantly improved the best sprint, total sprint time, and fatigue index, but the magnitude of improvement was greater with HIIT. After adjusting for baseline values, HIIT demonstrated superior reductions in sprint times, with players achieving faster best sprint and sum of five sprint performances compared with HVT. Although HIIT produced a slightly higher fatigue index, the increase was small relative to the performance benefits. Overall, the findings indicate that HIIT is a more effective and time-efficient approach for developing RSA in youth football players, offering meaningful performance gains that align with the intermittent demands of match play.

STATEMENT OF FUNDING

STATEMENT OF FUNDING

Source of funding: “No funding sources.”

Nature of funding: This research was conducted without any external financial support.

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BIBLIOGRAPHY

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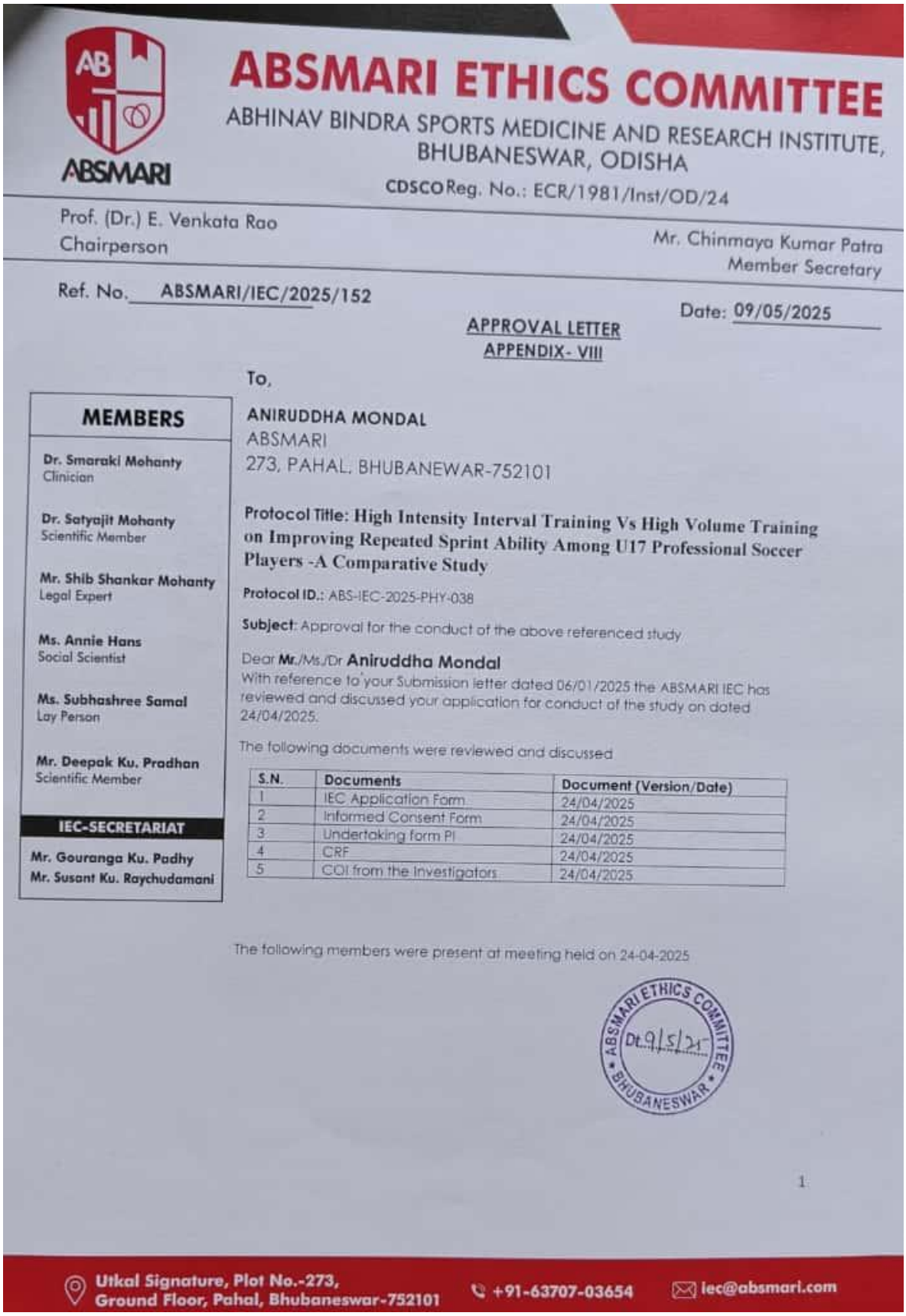
ANNEXURES

Annexure 1



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/152

Date: 09/05/2025

APPROVAL LETTER
APPENDIX- VIII

To,

ANIRUDDHA MONDAL
ABSMARI
273, PAHAL, BHUBANEWAR-752101

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

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

Protocol Title: High Intensity Interval Training Vs High Volume Training on Improving Repeated Sprint Ability Among U17 Professional Soccer Players -A Comparative Study

Protocol ID.: ABS-IEC-2025-PHY-038

Subject: Approval for the conduct of the above referenced study

Dear **Mr.**/Ms./Dr **Aniruddha Mondal**
With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 24/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	24/04/2025
2	Informed Consent Form	24/04/2025
3	Undertaking form PI	24/04/2025
4	CRF	24/04/2025
5	COI from the Investigators	24/04/2025

The following members were present at meeting held on 24-04-2025

ABSMARI ETHICS COMMITTEE Dt. 9/5/25 BHUBANESWAR

1

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/152

Date: 09/05/2025

MEMBERS

Dr. Smaraki Mohanty
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Legal Expert

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Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

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

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. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
4	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
5	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
6	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occuring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely,

Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee
Pahal, Bhubaneswar

Member Secretary
ABSMARI ETHICS COMMITTEE

ABSMARI ETHICS COMMITTEE
09/5/25
BHUBANESWAR

2

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+91-63707-03654
iec@absmari.com

Annexure 2

NORTH KOLKATA FOOTBALL CLUB

Shobhabazar Kolkata-700005

Ref no: NKFC/EB13/2025/13

Date: 08/05/2025

TO WHOMESOEVER IT MAY CONCERN

To

Dr. Aniruddha Mondal (PT)

This is to formally grant permission to Mr. Aniruddha Mondal, a postgraduate student (Roll No. 23MP435022) at the Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha, to conduct his research titled:

"High-Intensity Interval Training vs. High-Volume Training on Repeated Sprint Ability in U17 Football Players – A Comparative Study."

We support Mr. Mondal's research and grant him permission to:

- Collect baseline and post-intervention data
- Conduct training interventions with our U17 players
- Monitor performance over the intervention period

This approval is subject to the following conditions:

1. All study procedures will be conducted in a safe, ethical, and professional manner.
2. Participation will be voluntary, with informed assent from players and consent from their guardians.
3. The research shall not interfere with the team's training or competitive calendar.
4. Confidentiality of all collected data will be strictly maintained and used solely for academic purposes.
5. A summary of the findings will be shared with the club upon the completion of the study.

We appreciate your interest in conducting ethical and meaningful research and wish you success in your work. Should you require further support or clarification, please feel free to contact us.

Yours Sincerely

NORTH KOLKATA FOOTBALL CLUB COACH

Sayan Koley(Assistant Coach)

North Kolkata Football Club

Email: sayankoley119@gmail.com

Annexure 3

INFORMED CONSENT

Informed Consent form to participate in a clinical trial

Study Title: **HIGH INTENSITY INTERVAL TRAINING VS HIGH VOLUME TRAINING ON IMPROVING REPEATED SPRINT ABILITY AMONG U17 PROFESSIONAL SOCCER PLAYERS -A COMPARATIVE STUDY**

Study Number:

Subject 's Name: _____

Date of Birth / Age: _____

Address of the Subject_____

Qualification _____

(i) I confirm that I have read and understood the information sheet dated _____[ ] for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am [ ] free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that the Sponsor of the clinical trial, others working on the [ ] Sponsor 's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this [ ] study provided such a use is only for scientific purposes.

(v) I agree to take part in the above study. [ ]

Guardians signature _____

Signature of the Investigator: _____

Study Investigator 's Name: Aniruddha Mondal

Signature of the Witness: _____

Date: _____/ _____/ _____

Name of the Witness: _____

Annexure 4

ASSENT FORM

(Supplement to informed consent form-for children 12-18 years of age)

Study Title: Title of the Study: **HIGH INTENSITY INTERVAL TRAINING VS HIGH VOLUME TRAINING ON IMPROVING REPEATED SPRINT ABILITY AMONG U17 PROFESSIONAL SOCCER PLAYERS - A COMPARATIVE STUDY**

Study Number:

Investigator's Name: Aniruddha Mondal

Details of the participant subject -

Subject's Name:

Date of Birth/Age:

Address of the Subject:

Qualification:

Part 1: Introduction

I am going to give you information and invite you to be part of a research study. You can choose whether you want to participate. We have discussed this research with your parent(s)/legal guardian, and they know that we are also asking you for your agreement. If you are going to participate in the research, your parent(s)/guardian also must agree. But if you do not wish to take part in the research, you do not have to, even if your parents have agreed. You may discuss anything in this form with your parents or friends or anyone else you feel comfortable talking to. You can decide whether to participate or not after you have talked it over. You do not have to decide immediately. There may be some words you don't understand or things that you want me to explain more about because you are interested or concerned. Please ask me to stop at any time and I will take time to explain.

2.Purpose of the study: This study aims to compare the effects of two different types of training—High-Intensity Interval Training (HIIT) and High-Volume Training (HVT)—on improving repeated sprint ability in U17 soccer players.

3.Choice of participants: You have been invited to participate in this study because you are a registered U17 professional soccer player who fits the criteria for this research.

4.Participation is voluntary: Taking part in this study is your choice.

5.Procedure: You will be asked to participate in either a HIIT or HVT program over 6 weeks.
- Your sprint performance will be measured before and after the training.
- The training sessions will be part of your normal training routine and supervised by qualified coaches or staff.

7.Discomforts: You may feel tired or sore from the exercises. All precautions will be taken to ensure your safety.

8.Benefits: You may improve your sprint performance and overall fitness.

9.Reimbursements: You will not receive any payment for taking part in this study. However, if you incur any reasonable expenses (such as travel or meals) as a result of participating in this study, you may be reimbursed.

10.Confidentiality: All the information collected about you during the study will be kept private. Your name will not be used in any reports or publications.

11.Compensation details: All necessary precautions will be taken to ensure your safety during the training. However, in the unlikely event that you are injured during the study, immediate first aid will be provided, and you will be referred to appropriate medical care.

12.Sharing the Findings: After the study is completed and the results are analyzed, a summary of the findings will be shared with all participants and their guardians.

13.Right to Refuse or Withdraw: Taking part in this study is your choice. You may stop at any time, and you will not be punished or lose any benefits if you decide not to participate.

14.Whom to Contact: If you have any questions about the study or your child's rights as a participant, please contact: Name-Aniruddha Mondal

Phone Number-8961871082

Email- mondalaniruddha294@gmail.com

Name of Person who explained form: Aniruddha Mondal

Signature of Person who explained this form:

Part 2: Certificate of Assent

1/my parent or legal guardian has read the previous page(s)of the consent form, and the investigator has explained the details of the study. I/my parent or legal guardian understands that I am free to ask additional questions. I/my parent or guardian understands that participation in this study is voluntary I/my parent or legal guardian may refuse to participate or may discontinue participation at any time without penalty, loss of benefits, or prejudice to the quality of care which I will receive. I/my parent or legal guardian, acknowledge that no guarantees have been made to me regarding the results of the treatment involved in this study, and I agree to participate in the study and have been given a copy of this form.

Statement by the Child

Name of child:

Signature of child:

Date:

Parent's or legal guardian's Name:

Signature of Parent or legal guardian:

Statement by the researcher/person taking assent

I confirm that the child and respective parents or legal guardian were given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that they have not been coerced into giving assent, and the assent has been given freely and voluntarily.

A copy of this assent form has been provided to the participant.

Name of Researcher/person taking the assent- Aniruddha Mondal

Signature of Researcher /person taking the assent-

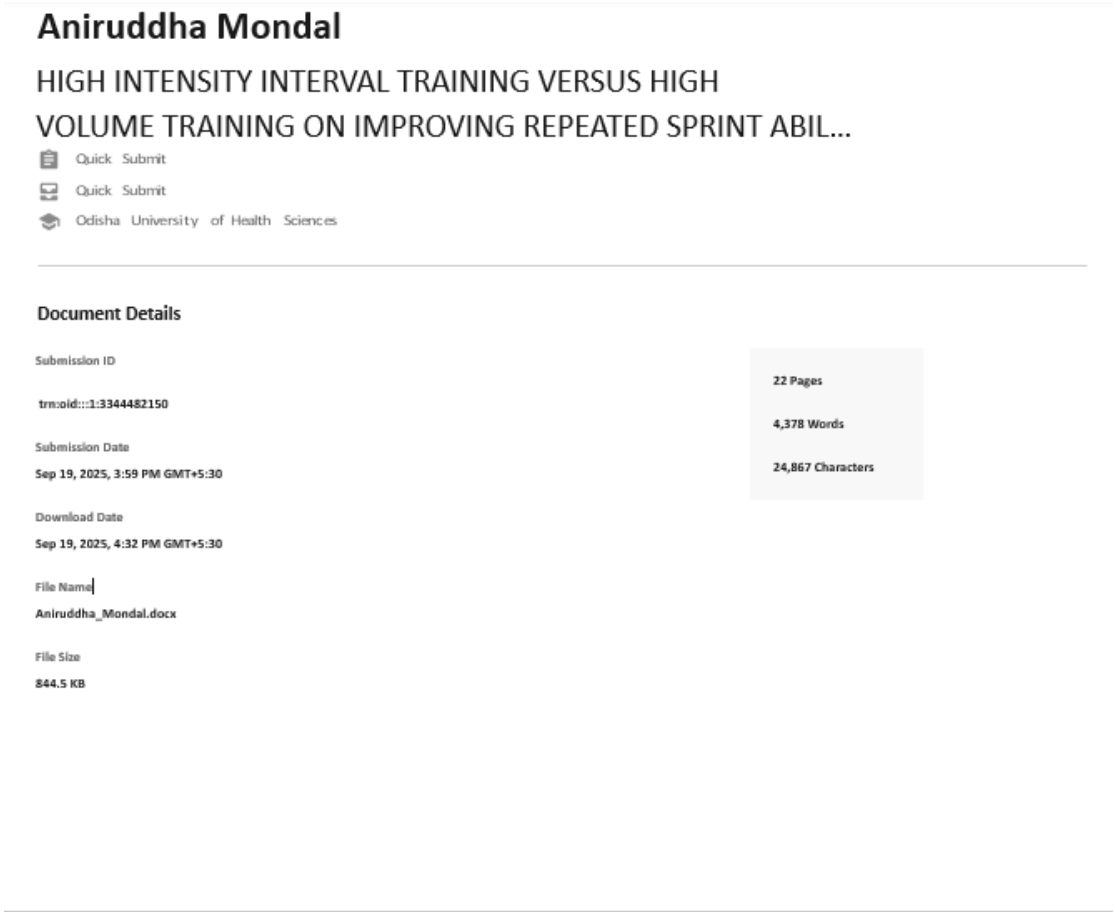
Annexure 5

Fig 1 RSA Pre testing.

Fig 2 RSA Post testing.

	GBSPE1	GSSPE1	GFIPE1	GBSPO1	GSSPO1	GFIPO1	AGE1	GBSPE2	GSSPE2	GFIPE2	GBSPO2	GSSPO2	GFIPO2	AGE2
1	4.31	22.64	10.20	4.05	21.35	11.11	16.00	4.25	22.26	9.41	4.10	21.57	10.98	16.00
2	4.16	21.80	10.09	3.91	20.55	10.74	16.00	4.29	22.46	10.25	4.14	21.71	10.63	16.00
3	4.18	21.83	9.09	3.92	20.57	9.95	15.00	4.27	22.30	9.36	4.12	21.57	10.19	16.00
4	4.22	22.36	11.37	3.97	21.11	12.09	16.00	4.19	21.84	8.35	4.04	21.16	9.16	15.00
5	4.17	21.82	10.07	3.92	20.57	10.71	16.00	4.35	22.83	10.11	4.20	22.08	10.48	15.00
6	4.21	22.46	13.06	3.95	21.18	13.92	16.00	4.26	22.40	10.56	4.11	21.65	10.95	16.00
7	4.14	21.90	12.56	3.89	20.65	13.37	16.00	4.32	22.71	10.18	4.16	21.95	10.82	16.00
8	4.31	22.90	12.52	4.06	21.65	13.30	15.00	4.22	22.60	14.21	4.07	21.85	14.74	15.00
9	4.19	22.12	10.26	3.94	20.87	10.91	15.00	4.11	22.00	14.11	3.97	21.26	14.37	15.00
10	4.29	22.62	10.48	4.00	21.37	11.14	15.00	4.17	22.06	11.27	4.02	21.32	11.94	15.00
11	4.11	21.71	10.70	3.87	20.47	11.13	16.00	4.29	22.69	10.95	4.14	21.94	11.35	16.00
12	4.32	22.65	9.72	4.07	21.40	10.33	15.00	4.25	22.40	10.35	4.10	21.65	10.73	16.00
13	4.22	22.25	10.90	3.97	21.00	11.59	15.00	4.19	22.10	10.26	4.04	21.35	10.64	15.00
14	4.24	22.43	11.32	4.00	21.19	11.75	16.00	4.14	21.77	10.38	4.00	21.03	10.50	16.00
15	4.13	21.71	9.92	3.88	20.47	10.82	15.00	4.16	21.84	9.85	3.99	21.07	10.78	16.00
16	4.23	22.26	10.40	3.98	21.01	11.06	15.00	4.28	22.66	10.98	4.13	21.92	11.62	16.00
17	4.28	22.70	11.68	4.03	21.45	12.42	15.00	4.19	22.17	10.97	4.04	21.42	11.38	16.00
18	4.16	21.75	9.37	3.91	20.50	9.97	16.00	4.17	21.88	9.59	3.98	20.95	10.55	16.00
19	4.26	22.34	9.62	4.01	21.09	10.22	16.00	4.28	22.56	10.98	4.13	21.81	11.37	16.00
20	4.19	21.95	9.78	3.94	20.70	10.40	16.00	4.23	22.21	9.92	4.08	21.46	10.29	15.00
21	4.28	22.56	10.51	4.03	21.31	11.17	16.00	4.31	22.71	10.44	4.16	21.96	10.82	15.00
22	4.15	21.82	10.12	3.91	20.58	10.48	16.00	4.32	22.79	10.41	4.17	21.95	11.03	16.00
23	4.19	22.20	11.69	3.94	20.95	12.44	16.00	4.24	22.43	11.55	4.09	21.68	12.00	16.00
24	4.25	22.42	11.05	4.00	21.17	11.75	15.00	4.27	22.55	10.77	4.12	21.80	11.17	16.00
25	4.19	22.16	10.26	3.94	20.91	10.91	15.00	4.27	22.59	11.47	4.12	21.84	11.89	16.00
26	4.28	22.66	10.74	4.03	21.41	11.42	16.00	4.26	22.53	11.03	4.11	21.77	11.43	15.00
27	4.31	22.87	11.83	4.06	21.62	12.56	16.00	4.19	22.19	10.97	4.04	21.44	11.39	15.00
28	4.16	21.91	11.53	3.91	20.66	12.27	16.00	4.28	22.69	11.68	4.13	21.94	12.10	15.00
29	4.22	22.39	11.37	3.97	21.14	12.09	15.00	4.25	22.55	11.29	4.10	21.80	11.71	16.00
30	4.15	21.97	12.04	3.90	20.72	12.82	15.00	4.17	22.08	11.99	4.02	21.29	11.72	16.00
31	4.13	21.74	10.41	3.88	20.49	11.09	15.00	4.24	22.40	11.08	4.09	21.65	11.49	16.00
32	4.19	22.10	11.45	3.94	20.85	12.18	15.00	4.28	22.61	10.98	4.13	21.86	11.37	15.00
33	4.25	22.48	11.05	4.00	21.23	11.75	16.00	4.32	22.87	11.57	4.17	22.12	12.00	16.00
34	4.12	21.91	12.86	3.87	20.66	13.69	16.00	4.27	22.59	11.24	4.02	21.34	11.94	15.00
35	4.29	22.74	11.18	4.04	21.49	11.88	16.00	4.18	22.20	11.72	3.93	20.95	12.47	15.00
36	4.21	22.34	12.35	3.96	21.09	13.13	16.00	4.36	23.00	10.32	4.11	21.75	10.95	15.00
37	4.15	22.05	12.53	3.91	20.85	13.29	15.00	4.29	22.73	11.42	4.04	21.49	12.13	15.00

Annexure 7



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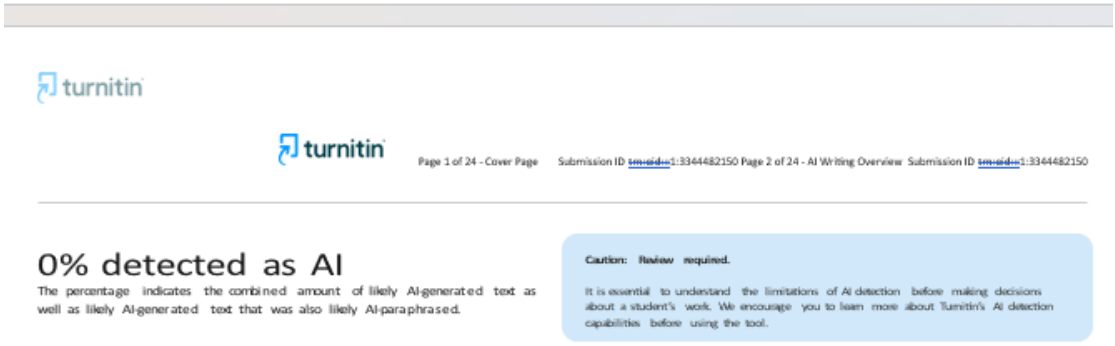

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Annexure 8

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