



## Enhancing Speed, Agility and Heart rate optimization through HIIT: Insights from Female Rugby players

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### Abstract

Background: High-Intensity Interval Training (HIIT) is a form of interval training that involves alternating between short periods of high-intensity movements, elevating the heart rate to at least 80% of one's maximum, and brief intervals of lower-intensity activity. While there's a substantial body of evidence demonstrating the Psycho-physiological benefits of HIIT, there is indeed a recognized gap in research that specifically emphasizes HIIT's potential to induce sports-specific adaptations which leads to enhanced performance in chosen sports. By addressing the unique demands of the sport through targeted HIIT protocols, athletes may experience more transferable improvements in skills and fitness requirements. Closing this research gap is essential for providing athletes, coaches, and sports scientists with evidence-based insights into how HIIT can be optimized for specific sports training. As such, ongoing studies and future research endeavours focusing on sport-specific adaptations through HIIT are likely to contribute valuable insights to the field of sports science and conditioning.

Purpose: This study seeks to examine the impact of a brief tailor made High-Intensity Interval Training (HIIT) program on key performance indicators, specifically Speed, Agility and Resting Heart Rate (RHR) levels in female rugby players. Understanding how short-term HIIT interventions influence these parameters can provide valuable insights into the potential benefits of this training approach for female athletes in a rugby context.

Methods: 30 female rugby players (17-25 years of age) at the inter-collegiate level, representing various campuses of Calicut University, were chosen and randomly divided into two groups. The experimental group participated in an 8-week High-Intensity Interval Training (HIIT) program designed specifically for rugby players, whereas the control group did not undergo any training. Assessments of speed, Agility and Resting Heart Rate (RHR) levels were performed both before and after the completion of the HIIT training program. Assessments were done using 60 meters Sprint test for speed, RHR with the help of stethoscope and Agility by using Agility cone drill test.

Results: Following an 8-week intervention, all measured indices showed significant improvement in the HIIT group, while no significant changes were observed in the control group. Significantly different outcomes between the scores of HIIT and control groups were evident in Speed, Agility and Resting Heart Rate (RHR) levels both before and after the HIIT program.

Conclusion: The custom-designed High-Intensity Interval Training (HIIT) program implemented in the current study resulted in significant improvements in the speed, Agility, and resting heart rate levels, thereby enhancing the overall game performance of female rugby players. This underscores the efficacy of HIIT,

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| <b>CC License</b><br>CC-BY-NC-SA 4.0 | emphasizing its adaptability to be specifically tailored to replicate the intensity and duration of movements pertinent to a particular sport, such as rugby.<br><br><b>Key words:</b> <i>HIIT, Speed, Agility, Resting heart rate, Rugby.</i> |
|--------------------------------------|--|

## Introduction

High-Intensity Interval Training (HIIT) is a form of interval exercise that involves alternating between short periods of high-intensity movements, elevating the heart rate to at least 80% of one's maximum, and brief intervals of lower-intensity activity. Serving as an alternative to moderate or low-intensity continuous workouts, HIIT is effective in enhancing variables related to both endurance and anaerobic performance. Despite sessions lasting only 15–30 minutes due to their high intensity, HIIT provides comparable or superior benefits when compared to longer periods of moderate-intensity exercise. While there's a substantial body of evidence demonstrating the physiological benefits of HIIT, there is indeed a recognized gap in research that specifically emphasizes HIIT's potential to induce sports-specific adaptations which leads to enhanced performance in chosen sports. Tailoring HIIT protocols to closely mimic the demands of specific sports is crucial for optimizing performance in those activities. The concept of sport-specific adaptations involves designing training programs that replicate the movements, intensity, and energy systems utilized in a particular sport. By addressing the unique demands of the sport through targeted HIIT protocols, athletes may experience more transferable improvements in skills such as speed and agility. Closing this research gap is essential for providing athletes, coaches, and sports scientists with evidence-based insights into how HIIT can be optimized for specific sports training. This includes understanding the ideal work-to-rest ratios, exercise selection, and intensity levels that best align with the requirements of individual sports. Researchers and practitioners are increasingly recognizing the importance of tailoring training programs to the specific needs of athletes in various sports. As such, ongoing studies and future research endeavours focusing on sport-specific adaptations through HIIT are likely to contribute valuable insights to the field of sports science and conditioning.

Gregory Dupont and colleagues (2004) in their study on soccer players, observed significant enhancements in running performances following a 10-week High-Intensity Interval Training (HIIT) program. Similarly, Florian Azad Engel (2018) and his colleagues, in a review study, concluded that HIIT had a predominantly positive impact on running speed, oxygen consumption at various lactate- or ventilatory-based thresholds, and sprint running performance. Buchheit, M. (2009), and associates compared the effects of high-intensity interval training (HIT) with specific game-based handball training (HBT) on handball performance parameters. The study concluded that both HIT and HBT were effective training modes for adolescent handball players. However, HBT was recommended as the preferred method due to its higher game-based specificity. In a study led by Jaime Fernandez (2015) and colleagues, the effects of combining high-intensity training with sport-specific drill training were compared to sport-specific drill training alone in young tennis players. The research revealed significant improvements in VO<sub>2</sub>peak and VIFT after the training period, with no discernible differences between the two training protocols. Additionally, notable enhancements were observed in the agility Test, while no changes were reported in the sprint tests.

In another study led by C.B. Harrison and colleagues in 2015, the researchers compared the effects of specific sports-based training versus a combination of sports-based training and HIIT on physical performance characteristics. The study suggests that a mix of sports-based training and HIIT should be considered as the preferred method for improving aerobic power in young athletes. To date, there has been no comprehensive review specifically examining the diverse adaptations resulting from High-Intensity Interval Training (HIIT) exclusively in young athletes. This gap in research is significant because the responses to HIIT may differ in athletes compared to those in diseased or untrained children. A focused analysis through systematic reviews, investigating the specific adaptations, benefits, and potential considerations of HIIT in young athletes, is crucial. This exploration would provide essential insights into the unique physiological and performance effects of HIIT tailored to this specific demographic. Closing this research gap could have substantial implications for refining training protocols, injury prevention strategies, and overall performance optimization in young athletes.

## Methodology

**Subjects:** 30 Female Rugby players (17-25 years of age) belonged to different colleges under Calicut University were selected and randomly divided in to two groups: (i) Experimental group who received HIIT

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(N=15) and (ii) controlled group who received no training (N=15). 30 Rugby players in two groups had undergone a baseline assessment of the selected fitness components such as Speed, Agility and Resting Heart rate by using the tests selected appropriately. Experimental group was given HIIT programme for 8 weeks. Control group were not given any training. All participants received individual explanations about the study, and their signed informed consent was acquired. Participants were not provided with any incentives except for refreshments, and their involvement was entirely voluntary.

### Design and study setting

This study employs a two-group pretest-posttest design to assess the impact of a specifically crafted High-Intensity Interval Training (HIIT) program for rugby on selected physical fitness variables, namely speed, agility, and resting heart rate. The experiment was carried out in two colleges of Calicut University simultaneously. All participants were briefed about the study and provided with a thorough demonstration and explanation of how to execute the selected HIIT program. For the first two weeks of the programme they were given a set of foundation level exercises followed by strength conditioning for the next two weeks. Then 4-5 weeks training focused on speed and power development. For the last 12 days they underwent a rugby specific training. Post training assessment of selected fitness variables were done using the chosen tests. Participants were asked to fill a demographic data sheet to gather information on age, gender, height, weight, level of sport participation etc.

### Resting heart rate

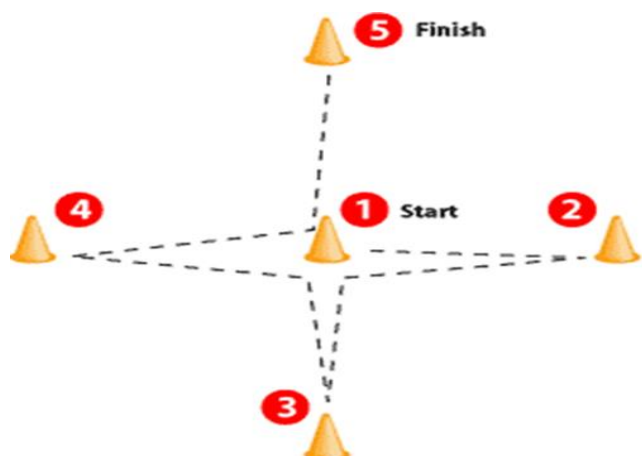
Resting heart rate, also known as pulse, refers to the number of heart beats per minute when the body is at rest, in a relaxed state, and either sitting or lying down. In adults, a typical resting heart rate falls within the range of 60 to 100 beats per minute. Generally, a lower resting heart rate is indicative of a more efficient and fit heart. For instance, an athlete may exhibit a resting heart rate as low as around 40 beats per minute. This was measured with the help of stethoscope for getting accurate results.

### Flying sprint test:

This test evaluates an individual's speed across a designated distance of 60 meters. Sprint tests can be conducted using different techniques, such as manual timing with a stopwatch or electronically with timing gates. These tests offer valuable insights into an individual's speed, acceleration, and power, serving as a means to identify strengths and weaknesses in an athlete's overall performance.

### Agility Cone or Compass Drill

The Agility Cone Drill, also known as the compass drill, assesses an athlete's agility, emphasizing body control and rapid changes of direction. The test involves a course set in various directions resembling points on a compass. It evaluates speed, explosive power, and the ability to maneuver with precision. To conduct the test, you need a stopwatch or timing gates, measuring tape or chalk, five marker cones, and a flat non-slip surface. The course consists of four outer cones forming a diamond shape, with one cone in the centre. The athlete starts behind the middle cone, touches designated cones sequentially, and completes the course. The timing starts when the hand leaves the centre cone and stops when the chest crosses the final cone's line. After a three-minute rest, the drill is repeated in the opposite direction. Scoring involves recording the time for each direction, with the final score being the average time from two trials.



| 8 WEEK RUGBY –SPECIFIC HIIT PROGRAMME   |                    |            |   |  |
|---|--------------------|------------|---|--|
|   | Frequency          | Duration   | Session 1   | Session 2  |
| Week 1-2<br>Foundation phase            | 2-3 sessions /week | 20 minutes | <b><u>Cardiovascular Endurance</u></b><br>1. 30 seconds sprinting (at maximum effort)<br>2. 30 seconds rest (light jogging or walking)<br>3. Repeat for 15 minutes              | <b><u>Basic Bodyweight Circuit</u></b><br>1. 40 seconds work (bodyweight squats, push-ups, lunges)<br>2. 20 seconds rest<br>3. Repeat for 15 minutes                     |
| Week 3-4<br>Strength and conditioning   | 3 sessions /week   | 25 minutes | <b><u>Interval Sprints and Agility</u></b><br>1. 20 seconds sprinting (maximum effort)<br>2. 40 seconds agility drills (e.g., ladder drills)<br>3. Repeat for 20 minutes        | <b><u>Strength Circuit</u></b><br>1. 30 seconds work (weighted squats, bench press, rows)<br>2. 30 seconds rest<br>3. Repeat for 20 minutes                              |
| Week 5-6<br>Power and speed development | 3-4 session/week   | 30 minutes | <b><u>Interval Sprints and Agility</u></b><br>1. 20 seconds sprinting (maximum effort)<br>2. 40 seconds agility drills (e.g., ladder drills)<br>3. Repeat for 20 minutes        | <b><u>Strength Circuit</u></b><br>1. 30 seconds work (weighted squats, bench press, rows)<br>2. 30 seconds rest<br>3. Repeat for 20 minutes                              |
| Week 7-8<br>Rugby-specific Training     | 4-5 session/week   | 35 minutes | <b><u>Rugby-Specific Drills</u></b><br>1. Incorporate movements specific to rugby (e.g., shuttle runs, tackle simulations, quick direction changes)<br>2. Repeat for 30 minutes | <b><u>Advanced Strength and Conditioning Circuit</u></b><br>1. 40 seconds work (dynamic movements, compound exercises)<br>2. 20 seconds rest<br>3. Repeat for 30 minutes |

### Statistical analysis

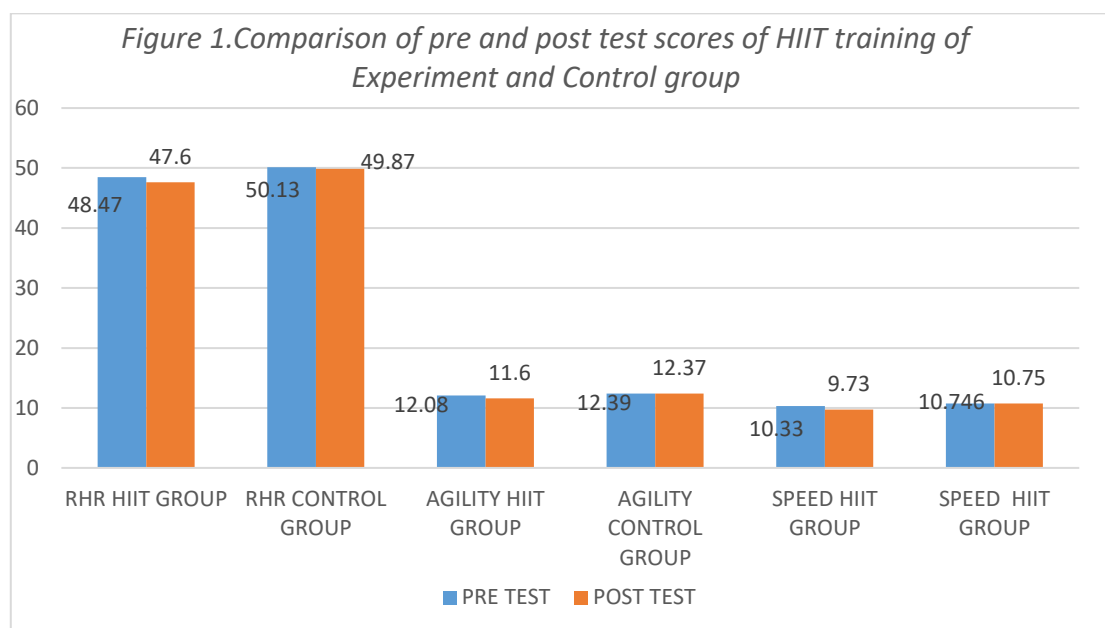
The statistical analysis involved basic statistics to calculate pre- and post-test means and standard deviations. A paired samples t-test was utilized to assess whether a significant change occurred in the measurements at the post-test stage. The data were analysed using the Statistical Package for Social Sciences (SPSS) Version 23, based in Chicago, IL, and statistical significance was set at  $P < 0.05$ .

### Results and Discussion

**Table 1** shows the mean and SD of each pair (pre and post) of the three variables (BMI, balance and core strength) for experimental as well as control group. In experimental group it is clear that for each pair, the mean scores of the post groups were better (lower score in RHR  $47.60 \pm 2.16$ ) and Agility (time taken to complete cone/ compass test) ( $11.60 \pm .95$ ) indicate an improved performance than the pre group, with uniformly lower values SD. In speed ability (time taken to complete 75 mts sprint) post groups mean scores ( $9.726 \pm .730$ ) are higher than the pre group ( $10.32 \pm .89$ ). In the case of control group there was not much differences between the pre and post test scores.

**TABLE 1** Descriptive statistics

| Physiological variables                  |           | HIIT training group (Experimental group)<br>N=15 |         | RUGBY Group<br>(Control group<br>N=15) |         |
|--|-----------|--|---------|--|---------|
|  |           | Mean   | SD      | MEAN                                   | SD      |
| RESTINGHEART RATE(RHR)                   | PRE TEST  | 48.4667  | 2.64215 | 50.1333                                | 2.44560 |
|  | POST TEST | 47.6000  | 2.16465 | 49.8667                                | 2.41622 |
|  | TEST      |  |         |  |         |
| AGILITY(Agility cone/compass drill Test) | PRE TEST  | 12.0807  | 1.01515 | 12.3934                                | .88183  |
|  | POST TEST | 11.6053  | .95397  | 12.3720                                | .78406  |
|  | TEST      |  |         |  |         |
| SPEED (time in seconds for 60 Mts dash)  | PRE TEST  | 10.3280  | .89359  | 10.7467                                | .74896  |
|  | POST TEST | 9.7260   | .73029  | 10.7480                                | .74957  |
|  | TEST      |  |         |  |         |



\*\*A lower score in RHR, Agility and Speed indicates improved performance

**Table 2** indicates the results of Paired T test conducted on the pre post test scores of HIIT training group and controlled group. It is seen that in the case of HIIT group there is significant difference ( $P < 0.01$ ) exist between the pre and post group indicating the positive effect of the training program. The score of control group shows no significant difference in any of the selected variables ( $P > 0.001$ ).

**Table 3. Paired sample T test of HIIT**

| Fitness components                      | HIIT Group N=15 |        |       |         | CONTROL GROUP N=15 |        |       |         |
|---|-----------------|--------|-------|---------|--------------------|--------|-------|---------|
|   | MEAN DIFFERENCE | SD     | t     | P VALUE | MEAN DIFFERENCE    | SD     | t     | P VALUE |
| RESTING HEART RATE (RHR)                | .86667          | .91548 | 3.666 | .003    | .26667             | .70373 | 1.468 | .164    |
| AGILITY (CONE/COMPASS Test)             | .47533          | .39172 | 4.700 | .000    | .02140             | .22803 | .363  | .722    |
| SPEED (Time in seconds for 50 mts dash) | .60200          | .28897 | 8.068 | .000    | -.00133            | .01922 | -.269 | .792    |

## Discussion

The current study's findings indicate that participants who underwent an 8-week High-Intensity Interval Training (HIIT) program experienced positive outcomes, including improvements in Resting Heart Rate (RHR), agility, and speed. These results are consistent with previous research that consistently demonstrates enhancements in various fitness components. For instance, a study by Gregory Dupont and colleagues (2004) on soccer players revealed significant improvements in running performances after a 10-week HIIT program. Additionally, a 2018 review study by Florian Azad Engel and colleagues concluded that HIIT had a predominantly positive impact on running speed, oxygen consumption at various thresholds, and sprint running performance. HIIT, characterized by alternating short bursts of intense exercise with periods of rest or lower-intensity activity, serves as a potent cardiovascular challenge. This structured interval format not only fortifies the cardiovascular system but also fosters efficiency in blood circulation and oxygen delivery, ultimately resulting in a lower resting heart rate over time. The cardiovascular adaptations induced by HIIT play a pivotal role in optimizing oxygen delivery to muscles, thereby enhancing their capacity to perform at heightened intensities and elevating overall speed and agility.

### **Limitations of the study**

The current study is subject to certain limitations. Firstly, the sample size was restricted, and a larger population might have yielded more comprehensive and impactful results. Secondly, the study focused exclusively on young, active female rugby players, and as such, the findings cannot be generalized to the non-athletic population.

### **Conclusion**

The results of the 8-week High-Intensity Interval Training (HIIT) program indicate that it effectively reinforces the body and complements overall fitness. This finding has practical implications for physical educators, coaches, and fitness trainers, providing them with a valuable tool to enhance physical performance. Implementing HIIT exercises in training programs is particularly beneficial for several compelling reasons. Firstly, HIIT exercises place a strong emphasis on speed, agility, and cardiovascular fitness, which are integral components in virtually all sports. The development of these abilities not only allows athletes to generate more speed and stamina but also helps in reducing the risk of injuries associated with physical activity. Moreover, the challenging nature of HIIT goes beyond physical improvements; it also plays a crucial role in fostering mental toughness and resilience. Athletes engaging in HIIT regularly develop the mental fortitude necessary to withstand the physical and mental demands of competitive sports. This mental resilience can contribute significantly to an athlete's ability to perform optimally under pressure. However, it's important to approach the incorporation of HIIT into an athlete's training regimen with careful consideration. Individual fitness levels, specific sport requirements, and overall training goals should be taken into account to design a tailored HIIT program that maximizes benefits while minimizing the risk of injury. Consulting with sports performance professionals or coaches is recommended to ensure that the HIIT program is well-suited to the athlete's needs and aligns with the demands of their sport.

### **Future Research Recommendations**

1. Investigate the psychological and cognitive benefits of HIIT, including its effects on mood, cognitive function, and mental well-being.
2. Examine the impact of HIIT on aging-related outcomes, such as muscle loss, bone density, cognitive decline, and overall quality of life in older adults.
3. Investigate the underlying physiological and molecular mechanisms responsible for the health benefits of HIIT.
4. Investigate the effects of HIIT on insulin sensitivity, glucose metabolism, and other markers of metabolic health.
5. Compare the effectiveness of HIIT with other forms of exercise across various health outcomes.

### **Credit authorship contribution statement**

All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of work.

### **Ethical statement**

Nil

### **Data availability**

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

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Nil

### **Conflicts of interest**

There are no conflicts of interest.

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