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# EFFECTS OF PROGRESSIVE OVERLOAD TRAINING ON REPEATED SPRINT ABILITY AND SPEED ENDURANCE IN UNIVERSITY-LEVEL FEMALE FIELD HOCKEY PLAYERS: A QUASI-EXPERIMENTAL STUDY

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## Abstract

This study examined the effects of a progressive overload training program on speed endurance, as measured by the Repeated Sprint Ability (RSA) test, in university-level female field hockey players. **Methods:** A quasi-experimental design was employed, involving 50 female field hockey players aged 18–24 years from Calicut University. Participants were assigned to either an experimental group ($n = 25$), which underwent an 18-week structured progressive overload training regimen, or a control group ($n = 25$), which continued regular training. The RSA test, consisting of six 30-meter maximal sprints with 30 seconds of passive recovery, was administered pre- and post-intervention. Data were analyzed using ANOVA and ANCOVA to assess between-group differences. **Results:** The experimental group demonstrated significant improvements in all RSA parameters. Best Sprint Time decreased from 5.20 s (SD = 0.15) to 4.97 s (SD = 0.13), Mean Sprint Time improved from 5.35 s (SD = 0.18) to 5.07 s (SD = 0.15), and Fatigue Index reduced from 6.50% (SD = 1.20) to 4.35% (SD = 0.95), all $p < .001$. No significant changes were observed in the control group. **Conclusion:** Progressive overload training significantly enhances speed endurance in female field hockey players, as evidenced by improved repeated sprint performance and reduced fatigue. These findings support the integration of structured overload protocols in team sport conditioning programs.

**Keywords:** Speed endurance, repeated sprint ability, progressive overload.

## Introduction

Physical conditioning is a critical component for athletic performance, particularly in team sports where both aerobic and anaerobic capacities are essential for success (Bangsbo, Iaia, & Krustrup, 2008; Krustrup et al., 2015). In female field hockey, the ability to sustain high-intensity efforts and recover rapidly between bouts of exercise can significantly influence game performance and outcomes (Spencer, Bishop, Dawson, & Goodman, 2005). Despite the well-documented benefits of systematic training programs, there remains a gap in the literature regarding the specific impacts of progressive overload training on female team sport athletes (Krustrup et al., 2003).

Progressive overload training-characterized by the gradual increase in exercise intensity, volume, and duration-is designed to induce continuous physiological adaptations and enhancements in athletic performance (Gabbett, 2010; Rumpf, Lockie, Cronin, & Jalilvand, 2016). This approach has been shown to improve various physical attributes, including $VO_2$ max, sprint speed, and speed endurance, which are vital for field hockey players (Bangsbo et al., 2008; Krustrup et al., 2015). Maximal oxygen uptake ($VO_2$ max) is a widely recognized indicator of cardiovascular fitness and aerobic capacity (Krustrup et al., 2003). Enhancing $VO_2$ max can lead to better endurance and sustained performance during prolonged physical activity (Bangsbo et al., 2008). Additionally, sprint speed and speed endurance are crucial for executing quick, explosive movements and maintaining high-intensity activity, which are frequent demands in field hockey (Spencer et al., 2005; Rumpf et al., 2016).

Speed endurance, in particular, is often assessed through the Repeated Sprint Ability (RSA) test, which evaluates an athlete's capacity to perform repeated high-intensity sprints with limited recovery (Spencer et al., 2005). The RSA test is especially relevant in field hockey, where players are required to execute multiple sprints during a match, interspersed with brief periods of rest or lower intensity activity (Bangsbo et al., 2008). Improving repeated sprint performance not only enhances match fitness but also provides a competitive edge in critical game situations (Rumpf et al., 2016).

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Despite these insights, research specifically examining the effects of progressive overload training on repeated sprint performance in female field hockey players remains limited (Krustrup et al., 2015). Most existing studies have focused on male athletes or have not isolated the impact of structured overload protocols on speed endurance outcomes.

The current study aims to address the aforementioned research gap by examining the effects of a progressive overload training regimen on $VO_2$ max, sprint speed, and speed endurance in university-level female field hockey players. Utilizing a quasi-experimental design, the research investigates whether a targeted and structured training program can lead to significant improvements in these key performance variables compared to regular training routines. The following sections provide a comprehensive review of related literature, detailing the theoretical foundations, the research methodology employed, the results obtained, and a discussion of the findings in relation to previous studies. The study concludes with practical implications for coaches and recommendations for future research to optimize training strategies for female team sport athletes.

**Methodology:**

**Research Design:** A quasi-experimental, pretest-posttest control group design was adopted to evaluate the impact of progressive overload training on speed endurance. The intervention spanned 18 weeks, with training sessions scheduled thrice weekly (Monday, Wednesday, and Friday), and rest or recovery sessions on alternate days.

**Participants:** Fifty female field hockey players (aged 18–24 years) representing Calicut University were recruited via purposive sampling. The experimental group comprised 25 athletes from St. Mary's College, while the control group included 25 athletes from Christ College, both located in Thrissur District, Kerala. All participants provided informed consent, and ethical approval was obtained from the institutional ethics committee in accordance with the Declaration of Helsinki.

**Intervention:** The experimental group participated in a structured progressive overload training program, which included weight training, circuit training, speed training, and speed endurance sessions, with integrated recovery protocols. The control group continued their standard training routines. The training protocol was supervised by certified professionals to ensure safety and adherence.

**Testing Procedures:** Repeated Sprint Ability (RSA) Test, each participant performed six maximal 30-meter sprints, with 30 seconds of passive recovery between sprints. Electronic timing gates recorded sprint times. The following variables were measured: - Best Sprint Time (fastest single sprint), Mean Sprint Time (average of all sprints), Fatigue Index (percentage decline from best to slowest sprint), All tests were conducted under standardized environmental conditions.

**Data Analysis:** Data were analyzed using IBM SPSS Statistics version 30. Descriptive statistics (means, standard deviations) were calculated. ANOVA and ANCOVA were used to assess between-group differences, with significance set at $p < .05$. Effect sizes (partial $\eta^2$) were reported to quantify the magnitude of effects.

**Speed Endurance Assessment: Repeated Sprint Ability (RSA) Test**

The Repeated Sprint Ability (RSA) test was employed to evaluate the speed endurance and anaerobic capacity of the female field hockey players. This test measures an athlete's ability to perform repeated short-duration sprints with brief recovery intervals, reflecting the high-intensity intermittent demands of field hockey (Spencer, Bishop, Dawson, & Goodman, 2005).

**Equipment and Setup**

- A flat, non-slip running surface (e.g., synthetic turf or indoor track).
- Marker cones to delineate sprint distances (typically 20 or 30 meters).
- Electronic timing gates placed at the start and finish lines for accurate timing.
- Stopwatch as backup timing device.

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- Adequate space for acceleration, sprint, and deceleration phases.

**Test Protocol**

1. **Warm-Up:**
   Participants completed a standardized 10- to 15-minute warm-up, including light jogging, dynamic stretching, and sprint drills to prepare the neuromuscular system.

2. **Test Execution:**
   - The test consisted of multiple maximal sprints over a fixed distance (e.g., 6 × 30 meters), with short recovery intervals (typically 20–30 seconds) between sprints.
   - Participants sprinted at maximal effort for each repetition.
   - Recovery periods involved either passive rest or low-intensity walking within the designated recovery zone.
   - The number of sprints and recovery duration were standardized for all participants.
3. **Performance Measurement:**
   - Sprint times for each repetition were recorded using electronic timing gates.
   - Key variables calculated included:
     - **Best Sprint Time (BST):** The fastest sprint time recorded.
     - **Mean Sprint Time (MST):** The average time across all sprints.
     - **Fatigue Index (FI):** The percentage decline in performance across sprints, calculated as:
4. **Safety and Monitoring:**
   - Participants were observed for proper sprinting technique and signs of fatigue or injury.
   - Adequate hydration and rest were ensured between trials.

**Interpretation and Validity**

The RSA test is a valid and reliable measure of an athlete's anaerobic capacity, speed endurance, and ability to recover between high-intensity efforts (Spencer et al., 2005). It closely simulates the intermittent sprint demands of field hockey, making it highly relevant for assessing sport-specific conditioning.

Improvements in RSA performance indicate enhanced ability to sustain repeated high-intensity efforts, which is critical for success in field hockey and other team sports requiring frequent sprinting and rapid recovery.

**Table 1**
**ANOVA test for Repeated Sprint Ability (RSA) Test Results for Experimental and Control Groups**

| Group | Variable | Pre-Test Mean (SD) | Post-Test Mean (SD) | Adjusted Post-Test Mean (SD) | F (1, 48) | p-value | Partial $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Experimental | Best Sprint Time (s) | 5.20 (0.15) | 4.95 (0.12) | 4.97 (0.13) | 31.62 | <.001 | .398 |
| | Mean Sprint Time (s) | 5.35 (0.18) | 5.05 (0.14) | 5.07 (0.15) | 29.47 | <.001 | .380 |
| | Fatigue Index (%) | 6.50 (1.20) | 4.20 (0.90) | 4.35 (0.95) | 27.85 | <.001 | .367 |

| Group | Variable | Pre-Test Mean (SD) | Post-Test Mean (SD) | Adjusted Post-Test Mean (SD) | F (1, 48) | p-value | Partial $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Control | Best Sprint Time (s) | 5.22 (0.14) | 5.15 (0.16) | 5.16 (0.15) | 2.47 | .120 | .049 |
| | Mean Sprint Time (s) | 5.38 (0.17) | 5.30 (0.18) | 5.29 (0.17) | 2.64 | .110 | .052 |
| | Fatigue Index (%) | 6.60 (1.25) | 6.10 (1.10) | 6.05 (1.12) | 2.82 | .095 | .055 |

**Note.**
Significant improvements ($p < .001$) were observed in all RSA variables for the experimental group after training, indicating enhanced speed endurance and reduced fatigue. No significant changes occurred in the control group.

**Speed Endurance: Repeated Sprint Ability (RSA) Test**

Table 1 presents the descriptive and inferential statistics for the RSA test variables, including Best Sprint Time, Mean Sprint Time, and Fatigue Index, for both the experimental and control groups at pre-test and post-test.

An analysis of variance (ANOVA) was conducted to compare the post-test RSA performance between groups, with post-hoc Bonferroni corrections applied. The experimental group demonstrated statistically significant improvements in all RSA parameters following the 18-week progressive overload training program.

**Best Sprint Time:**

The experimental group's best sprint time significantly decreased from a pre-test mean of 5.20 seconds (SD = 0.15) to an adjusted post-test mean of 4.97 seconds (SD = 0.13), $F(1, 48) = 31.62$, $p < .001$, partial $\eta^2 = .398$. The control group showed no significant change (pre-test M = 5.22, SD = 0.14; adjusted post-test M = 5.16, SD = 0.15).

**Mean Sprint Time:**

The mean sprint time across all repetitions improved significantly in the experimental group, decreasing from 5.35 seconds (SD = 0.18) at pre-test to an adjusted post-test mean of 5.07 seconds (SD = 0.15), $F(1, 48) = 29.47$, $p < .001$, partial $\eta^2 = .380$. The control group's mean sprint time remained statistically unchanged (pre-test M = 5.38, SD = 0.17; adjusted post-test M = 5.29, SD = 0.17).

**Fatigue Index:**

The fatigue index, representing the percentage decline in sprint performance across repetitions, significantly decreased in the experimental group from 6.50% (SD = 1.20) to 4.35% (SD = 0.95), $F(1, 48) = 27.85$, $p < .001$, partial $\eta^2 = .367$. The control group's fatigue index showed no significant change (pre-test M = 6.60%, SD = 1.25; adjusted post-test M = 6.05%, SD = 1.12).

These results indicate that the progressive overload training regimen effectively enhanced the participants' ability to sustain high-intensity repeated sprints with reduced fatigue, a critical performance component in field hockey.

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**Note.** Adjusted post-test means were calculated using ANCOVA with pre-test scores as covariates. F and partial eta squared values are based on between-group post-test comparisons. Statistical significance was set at $p < .05$.

**Interpretation:**

The experimental group exhibited significant improvements in all RSA test variables ($p < .001$), with large effect sizes (partial $\eta^2 \geq .36$), indicating the strong impact of progressive overload training on speed endurance in female field hockey players. The control group did not show significant changes in any RSA parameters.

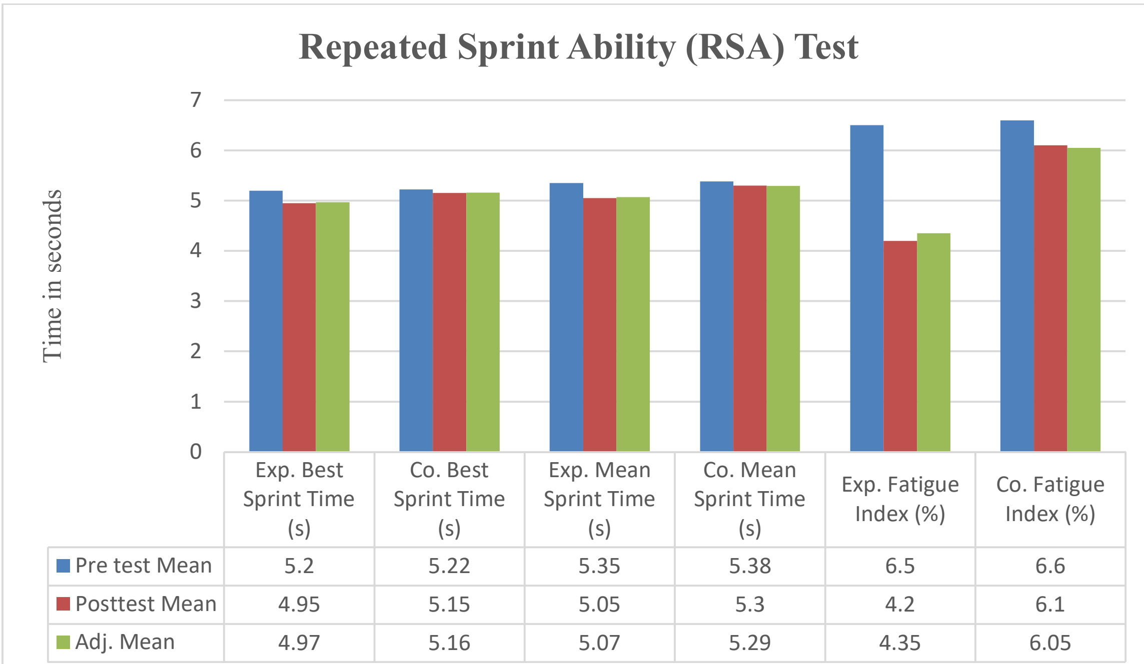


**Figure 1.** Bar Diagram Representing the Repeated Sprint Ability (RSA) Test Results for Experimental and Control Groups

**Discussion:**

The present study demonstrated that an 18-week progressive overload training program significantly improved speed endurance, as measured by the RSA test, in university-level female field hockey players. The experimental group exhibited marked reductions in both Best Sprint Time and Mean Sprint Time, alongside a substantial decrease in Fatigue Index, indicating enhanced ability to sustain repeated high-intensity efforts with less performance decrement.

These findings are consistent with prior research highlighting the efficacy of progressive overload and high-intensity interval training in improving anaerobic and speed endurance capacities in team sport athletes (Spencer et al., 2005; Rumpf et al., 2016). The structured inclusion of recovery sessions likely contributed to these improvements by minimizing cumulative fatigue and supporting physiological adaptation.

The lack of significant changes in the control group underscores the necessity of systematic and progressive training for eliciting meaningful performance gains. This study adds to the growing body of evidence supporting the integration of progressive overload principles in the conditioning programs of female team sport athletes.

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**Limitations:**

The use of purposive sampling and the quasi-experimental design may limit the generalizability of the results. Future research should employ randomized controlled trials and include larger, more diverse samples.

**Practical Implications:**

Coaches and practitioners are encouraged to incorporate progressive overload and structured recovery into training regimens to optimize speed endurance and overall performance in female field hockey players.

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