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Investigating the Effects of High-Intensity Resistance Training on Physical Fitness of University Male Football Players

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Abstract

High-Intensity Resistance Training (HIRT) is posited to augment various attributes essential for football performance, including strength, power, speed, agility, and endurance. HIRT has potential implications for injury prevention, thereby contributing to enhanced on-field performance. The present study aimed to investigate the efficacy of an eight-week HIRT regimen on the physical attributes of male university-level football players. Employing a randomized controlled design, this study involved 24 football players, aged between 19 and 25 years from University of the Punjab, Lahore, Pakistan. To ensure a comprehensive evaluation, participants were assessed both prior to and throughout the intervention, which encompassed three training sessions weekly. Physical fitness parameters assessed included the YoYo Intermittent Recovery Test Level 1 (YYIRT1), the 30-meter sprint time (ST), the Running Anaerobic Sprint Test (RAST), and the Change of Direction time (COD). Subsequent to the eight-week HIRT intervention, a significant difference was noted in all variables for the experimental group between pre-and post-test measurements.

Keywords: *Football, Sports performance, Endurance, Agility, Physical fitness*

Introduction

Football is a sport characterized by intermittent exercise that engages various energetic systems. The activity involves stretches of moderate intensity punctuated by brief spurts of near-maximal exertion (Silva et al., 2022). In a typical match, players often cover distances ranging from 9 to 14 km, with high-intensity runs accounting for 700 to 1,200 meters (Riboli et al., 2022). Furthermore, players exhibit variations in their intensities of acceleration and deceleration, with each occurring approximately 600 times (Vigh-Larsen et al., 2018). Football players must possess advanced physiological and metabolic capacities, coupled with superior physical fitness, to meet the rigorous demands of the sport (Pyne et al., 2014). Achieving optimal performance in football is intricate, presenting a considerable challenge for strength and conditioning professionals (Raya-González et al., 2021). A high level of aerobic fitness is imperative for players to meet their metabolic and energetic demands during gameplay. This often serves as a distinguishing factor between elite and non-elite players.

Higher levels of aerobic fitness are significantly correlated with the ability of players to cover the

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greater distances at varying speed thresholds (Reinhardt et al., 2020). In addition to possessing robust cardiovascular fitness, it is imperative to have well-developed strength and power (Slimani et al., 2017). For example, elevated levels of maximal strength are strongly correlated with enhanced performance in linear sprints and jump (Loturco et al., 2015), whereas the countermovement jump is intricately related to both linear and curvilinear sprinting (Loturco et al., 2020). To enhance performance in the sport of football, the capacity to sprint is of utmost significance, as it represents the most prevalent action leading to goals during periods of open play. Distinctive factors that differentiate individuals who rise to higher levels of football competition include exceptional jumping and sprinting abilities. Nevertheless, football training presents a unique challenge for coaches, as they must prioritize the development of a multifaceted array of physical attributes, as previously mentioned. For instance, substantial attention has been directed towards high-intensity interval training, which grants players both metabolic benefits and a neuromuscular impulse. However, despite these mentioned effects, there is a noticeable void in the existing research regarding the impact of high-intensity resistance training on physical fitness in team sports, including football. Therefore, additional research is warranted to thoroughly investigate the repercussions stemming from participation in such specialized training (Verrall et al., 2005).

Conducting such investigations would be crucial in evaluating the potential advantages and disadvantages of incorporating high-intensity resistance training into football training protocols. This would enable trainers to make well-informed judgments concerning the suitability of this training approach for their athletes. The main goal of this research is to evaluate the influence of a High-Intensity Resistance Training (HIRT) intervention on the physical fitness of male university football players. Furthermore, it was postulated that a HIRT program lasting eight weeks would result in noteworthy improvements in the physical fitness levels of these male university football players.

Materials and Methods

Participants

For this study, a randomized controlled design was utilized and twenty-four football players from the University of the Punjab, Lahore, Pakistan, aged 19-25 years, were selected using a convenience sampling technique. Simple randomization was used to divide the players into two groups, namely the HIRT experimental group (N=12) and the control group (N=12). The participants had an average age of 22±0.22 years and a height of 156±0.77 cm, a weight of 70±0.45 kg and a Body Mass Index (BMI) of 21.80±0.34 kg/m^2.

Inclusion criteria

The study enrolled football athletes who met the following inclusion criteria: (i) possessing a minimum of five years of professional experience in the sport; (ii) having completed a mandatory period of strength and conditioning training specific to football, which lasted no less than two years; (iii) remaining injury-free for at least one month prior to the commencement of the experimental session and throughout the intervention phase; (iv) abstaining from the use of

anabolic steroids or hormonal precursors for a minimum of one year before and during the intervention period and (v) refraining from the use of any medication during both the evaluation and experimental periods.

Exclusion criteria

(i) Incurrence of any form of injury throughout the duration of the study; (ii) absence of medical clearance to engage in resistance training; (iii) inability to attend more than 15% of the designated training sessions during the intervention phase. Comprehensive details pertaining to the study, inclusive of its potential risks and benefits, were meticulously communicated to the participants. Subsequent to a thorough understanding, participants provided informed oral consent and duly signed a written consent form, denoting their voluntary participation. Thereafter, the participants were systematically oriented to the study's procedural protocols.

Testing Procedures

The assessments for this investigation were performed both prior to and subsequent to the intervention. Preceding each assessment, the participants were granted a period of rest lasting 24 hours. The appraisals were conducted in conditions that were controlled, ensuring a constant average ambient temperature of 30 °C for the preliminary examination and 32 °C for the subsequent examination. These evaluations were conducted during the period of 12:00 pm and 1:00 pm to decrease daily fluctuations. Additionally, the training sessions, with a duration ranging from 90 to 100 minutes, were meticulously standardized for all participants to guarantee consistency in the intervention process.

During the experimental phase, a comprehensive assessment was undertaken, encompassing various metrics including anthropometric measurements. Performance tests such as the Running-based Anaerobic Sprint Test (RAST), the Change of Direction (COD) test, and the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1) were systematically administered. Prior to these evaluations, all participants partook in a standardized warm-up protocol, which comprised 5 minutes of aerobic jogging followed by a 10 minutes sequence of dynamic stretching exercises.

Both the experimental and control cohorts adhered to a rigorous training regimen five times a week. The experimental cohort underwent three sessions of High-Intensity Resistance Training (HIRT) interspersed with two sessions specifically centered on the refinement of technique and tactical drills. In juxtaposition, the control cohort was exclusively immersed in sessions accentuating technique and tactical drills for all five days. Each training module was inaugurated with a generalized warm-up spanning 5 to 10 minutes, subsequently succeeded by a specialized warm-up routine lasting approximately 20 minutes. The primary training exercises were then executed. In the concluding phase of each training module, participants engaged in a 10 to 15-minute cool-down segment, characterized by light aerobic activity and stretching routines. As an additional component of this study, two exhibition matches were scheduled, allowing the participants an opportunity to apply their skills in a real-time environment.

Running Based Anaerobic Sprint Test (RAST)

To assess the anaerobic capacity of the participants and their ability to perform repeated sprints, the research team utilized the Running Based Anaerobic Sprint Test (Zagatto et al., 2009). The experimental procedure necessitated that the participants complete six consecutive sprints of maximum effort, covering a distance of 35 meters. Each sprint was followed by a 10-second recovery period. The test was conducted on a standard football field, with participants commencing each sprint from a split stance, utilizing their preferred leading leg. The duration of each sprint was accurately measured using an ACCUSPLIT Pro Survivor - A601X Stopwatch, which featured an extra-large display for enhanced precision. Consequently, the mean duration required for the six sprints was assessed and utilized as the primary outcome measure for data analysis.

30 m Sprint Test

A 30-meter sprint examination (Coelho et al., 2007) was utilized to carry out both the preliminary examination and final evaluation. Every participant executed the sprint examination on two distinct occasions, with a 2 minutes break in between the trials. The exceptional achievement, as demonstrated by the swiftest time from the two trials, was chosen as the definitive outcome.

Change-of-Direction Test

The arrowhead test was conducted in accordance with the protocol delineated in the seminal study by Rago et al. (2020). Participants were meticulously instructed to position one foot on the designated starting line and the other foot immediately behind it, poised for the onset signal. Upon commencement, they were directed to accelerate towards a predetermined point, pivot in the direction of marker B, advance towards marker C, and subsequently revert to the starting point, executing this from both the right and left trajectories. The procedure was replicated twice, with an interspersed 5-minute recuperation interval, and the optimal performance was duly documented.

The Yo-Yo Intermittent Recovery Test-Level 1 (YYIRT)

In the YYIRT assessment (Deprez et al., 2014), participants are required to shuttle between two markers positioned 20 meters apart. Upon the completion of each shuttle, they undertake a 10-second active recovery phase between an additional set of cones set 5 meters apart. The pacing of the participants, both in terms of speed and rest intervals, is dictated by auditory cues in the form of beeping sounds. Should a participant fail to reach the designated marker prior to the sounding of the beep, they are issued a warning. Upon accruing two such warnings, the participant is subsequently disqualified from the assessment. The evaluation persists until the participant is either disqualified or successfully completes the prescribed shuttles within the stipulated time frame.

Training Intervention

An eight-week training program was conducted at the commencement of the sports season. Before the initiation of the experimental study, all players underwent a standardized training regimen under the supervision of qualified coaches. This regimen encompassed on-field training sessions that were bifurcated into strength and conditioning, as well as technical and tactical training components, supplemented by formal matches. The structured environment ensured that there

were five distinct training sessions every week. Specifically, endurance training was the focus of two sessions, while speed, strength, and recovery (or tapering) were each dedicated to a single session. Notably, in the present study, participants in the High-Intensity Resistance Training (HIRT) group underwent three specialized HIRT sessions weekly, augmented by two sessions emphasizing strategies and tactical training. Conversely, the control group was engaged solely in five sessions, with a concentrated focus on technique and tactics. All training sessions were conducted outdoors. Each began with a 10-minute general warm-up comprising jogging and static stretching. Subsequently, a drill-oriented warm-up of approximately 15-20 minutes was carried out. The crux of the session was directed towards sport-specific technical and tactical drills. Finally, each session concluded with a 10-15 minutes cool-down phase, consisting of light running and stretching exercises. It is imperative to note that the organization and structure of these open-field training sessions remained consistent throughout the duration for both the HIRT and control groups. The HIRT group participated in three such sessions each week, while the control group engaged in two sessions that were primarily geared toward technique and tactics. During the HIRT training, participants were enjoined to give their utmost effort and execute all drills at peak intensity. To ensure adherence and motivation, an instructor was present to provide verbal encouragement and oversee the entirety of the sessions.

Statistical Procedures

The data were meticulously analyzed utilizing the IBM-SPSS version 26 software. Descriptive statistical measures, particularly the arithmetic average and measure of variability, were implemented to explicate the results. To ascertain the existence of any statistically substantial disparities between the outcomes preceding and subsequent to the intervention, a paired sample t-test was thoughtfully employed for the examination.

Results

The facts given in Table 1 shows the comparison of means of different factors. Following table 1 propose a significant advancement in all measured factors for the experimental group subsequent to an eight-week intervention of High-Intensity Resistance Training (HIRT). Notably, considerable disparities were observed in the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1), 30-meter Sprint Test (30 m ST), Running-based Anaerobic Sprint Test (RAST), and Change of Direction (COD) evaluations ($p<0.01$). Conversely, the control group exhibited no substantial modifications in these parameters. Based on these discoveries, it can be postulated that an eight-week HIRT regimen has the potential to augment the physical performance capabilities of university football players.

Discussion

The implementation of High-Intensity Resistance Training (HIRT) has yielded notable improvements in physical fitness among male football players. This observation is of great significance, as the HIRT approach appears to be groundbreaking within the regional context.

Table 1

Results of Paired Sample t test of all four interventions

Factors	Group	Test	*N*	M/SD	Percentage difference	*p*
Yo-Yo intermittent recovery test level 1 (YYIRT1)	Experimental	Pre	12	1868.83 ± 74.35	16↑***	<0.00
		Post	12	2183.16 ± 87.66		
	Control	Pre	12	1888.66 ± 47.73	-	0.69
		Post	12	1900.33 ± 56.97		
30 m sprint test (ST)	Experimental	Pre	12	4.63 ± 0.33	14↓***	<0.00
		Post	12	3.98 ± 0.14		
	Control	Pre	12	4.49 ± 0.40	-	0.80
		Post	12	4.54 ± 0.41		
Running-based anaerobic sprint test (RAST)	Experimental	Pre	12	4.58 ± 0.47	12↓***	<0.00
		Post	12	4.01± 0.31		
	Control	Pre	12	4.64 ± 0.44	-	0.67
		Post	12	4.60 ± 0.34		
Change-of-direction time (COD)	Experimental	Pre	12	16.07 ± 0.28	5↓***	<0.00
		Post	12	15.13 ± 0.13		
	Control	Pre	12	15.97 ± 0.40	-	0.72
		Post	12	15.90 ± 0.33		

A thorough examination of the study findings uncovered significant disparities ($p<0.001$) across all the measured variables for the experimental group. These variables encompassed the YoYo Intermittent Recovery Test Level 1 (YYIRT1), the 30-meter Sprint Time (ST), the Running-based Anaerobic Sprint Test (RAST), and the Change of Direction Time (COD). These disparities were observed between the initial assessment (pre-test) and the post-test following an eight weeks intervention period of HIRT. Research has consistently demonstrated that High-Intensity Resistance Training (HIRT) can substantially enhance football players' performance across a variety of metrics.

In a seminal study by Haff et al. (2008), the impact of an eight-week HIRT regimen on the strength and power of collegiate football players was assessed. This rigorous research involved 18 Division I athletes. Subsequent to the intervention, the results illustrated a remarkable increase in the participants' squat and bench press strength, by approximately 10% and 7% respectively. Furthermore, their power output witnessed a noteworthy surge of 5%. Beyond the realms of strength and power, there is emerging evidence to suggest that HIRT can also foster improvements in football players' agility and speed. High-Intensity Resistance Training (HIRT) has increasingly been recognized as a pivotal approach to enhancing athletic performance, particularly for football players.

Kraemer et al. (1995) conducted a seminal study into the effects of HIRT on agility and speed among professional footballers. Spanning a 10-week period, the study incorporated 24 professional football players into a rigorous HIRT regimen. The findings were quite illuminating; there was a 4.5% improvement in the players' 40-yard dash times and an 8.5% elevation in their agility metrics. Moreover, the potential benefits of HIRT extend beyond merely improving agility and speed. Endurance enhancement and injury risk mitigation are two other paramount outcomes associated

with this training paradigm. Blagrove et al. (2018) elucidated these facets in their study involving 22 Division I football players who underwent an eight-week HIRT program. Notably, there was a 7.5% surge in the players' VO_2 max, a metric indicative of cardiovascular endurance. Additionally, these athletes exhibited a 30% reduction in their injury susceptibility. Drawing from the aforementioned research, it becomes evident that HIRT can significantly augment a football player's overall prowess by fostering improvements in strength, power, agility, speed, and endurance.

Additionally, the concomitant reduction in injury risks underscores the potential holistic advantages of HIRT. Given the empirical evidence supporting the efficacy of HIRT in advancing football players' performance metrics, it is imperative for players and coaching staff to contemplate integrating HIRT into their training regimens. Such integration can not only optimize individual player outcomes but also potentially elevate the collective performance of the team on the field.

Conclusion

In the current investigation, the data illustrated that after an intervention lasting eight weeks of High-Intensity Resistance Training (HIRT), all variables that were measured for the experimental group, which encompassed YYIRT1, 30m ST, RAST, and COD, displayed statistically significant differences ($p<0.001$). Conversely, the control group did not exhibit any observable alterations. These findings provide evidence that a regimen of HIRT lasting eight weeks can considerably augment the physical performance of football players at the university level.

Limitations

Following list of limitations are encountered during this research study.

1. The limited sample size in this research may have influenced the outcomes.
2. There was an insufficiency of existing literature on this topic.
3. The current study was unable to measure all the relevant physical variables.
4. An eight-week training program was considered appropriate for the scope of this study.
5. According to the Higher Education Commission of Pakistan, only players aged between 18 and 25 years participated in the sports competition.

Future Research Recommendations

Authors recommended the following themes, on which further research can be undertake.

1. Future researchers can check the effect of High-Intensity Resistance Training (HIRT) on different games and different physical components.
2. In the Future, other Sports Training can also apply to football players.

Conflict of Interest

No conflict of interest was declared by the authors.

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