

Profiling the effects of pre-season on cardiovascular and sprinting performance among elite youth football players

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Published online: November 30, 2022

(Accepted for publication November 15, 2022)

DOI:10.7752/jpes.2022.11340

Abstract:

Football is one of the most popular team sports and is played globally by all levels and age groups. Amateur, professional, and elite groups can be differentiated by the preparation of the team. The preparation for a challenging and competitive football league needs to be planned thoroughly to ensure the players can perform at their maximum. The manipulation of a training program to suit the match demands is crucial to developing and achieving maximum performance. Thus, this study aimed to determine elite youth football players' cardiovascular fitness and sprinting performance after undergoing a six-week intensive pre-season training program that had been tailored to the demands of a match. Perak II elite youth football players ($n=24$, age= 23.29 ± 3.02) participated in this study. The Yoyo Intermittent Recovery Test Level 2 (YYIR2) protocol determined their cardiovascular fitness performance and a 20m sprint test was used to determine their sprinting performance. Data analysed using a Paired Sample T-Test showed a significant improvement in cardiovascular fitness performance (pre-test 58.20 ± 3.10 ml•kg⁻¹•min⁻¹, post-test 67.73 ± 4.41 ml•kg⁻¹•min⁻¹) and sprinting ability performance (pre-test 3.16 ± 0.15 sec, post-test 3.09 ± 0.12 sec). In conclusion, the results indicated that the six-week pre-season training program, which included aerobic, anaerobic, and resistance training, as well as technical-tactical training drills, significantly improved cardiovascular fitness and sprinting ability. The findings imply that proper pre-season training programs based on intermittent anaerobic and aerobic training can enhance professional football players' performance and an appropriate performance-monitoring program can determine the effectiveness of a pre-season program.

Key Words: Pre-Season, Cardiovascular Fitness, Sprint, Elite Youth, Football, Perak II

Introduction

Football is one of the most famous team sports globally, and the number of players involved or participating in this sport is increasing (Dobrowolski, Karczemna, & Włodarek, 2020). A high degree of individual skills and performance ability will lead to better collective team performance. Both individual and team ability must be enhanced to ensure the team can perform on top form. A training sequence that results in a better understanding between players, improves technical ability, develops tactical discipline adaptation, and expands football intelligence needs to be developed (Sin & Aprinanda, 2020).

One of the leading characteristics of high-level football performance is performing high-intensity sprints within football-specific actions. A previous study has also confirmed that proper resistance or sprinting training improves linear sprinting performance (Jimenez-Reyes, García Ramos, & Cuadrado, 2020). Comparing sprinting ability according to positional role shows that forward players produce greater force output than defenders or goalkeepers. This supports the fact that most of the action before a goal is scored involves linear short sprinting (Haugen, Breitschädel, & Seiler, 2020; Jimenez-Reyes et al., 2020).

High-quality physical activity is not limited to male professional football players. The increased demand for speed and changes of direction was also found to be substantial in female professional football players who participated in the professional English Women's Super League (Emmonds, Nicholson, Begg, Jones, & Bissas, 2019). In conjunction with age maturation and sprinting ability, a study conducted among youth and senior football players to determine physical abilities showed that the youth players were able to accelerate in a shorter distance up to five metres better than senior players, and this supports the fact that sprinting power also plays a vital role in youth football players' development (Loturco et al., 2019). The importance of sprinting and high-speed running in football matches is unquestionable, and a previous study also shows that professional football players with higher aerobic capacity levels will be able to cover more sprinting distance (Radziński, Szwarc, Padrón-Cabo, & Jastrzębski, 2020).

Other than high-speed running qualities, aerobic capacity excellence also influences football matches. Most professional players cover around nine to 14 kilometres per game, of which 18% is covered through acceleration and deceleration (Akenhead, Harley, & Twedde, 2016; Manzi, Impellizzeri, & Castagna, 2014). Aerobic fitness validity in football has been widely studied, and strength and conditioning coaches should

consider aerobic capacity training programs to ensure the players are well prepared for the official matches throughout the league season (Manzi et al., 2014). As football is characterised as an intense and intermittent sport played over 90 minutes, a recent study shows that sprint interval training brought greater improvements in aerobic and anaerobic performance capacity, as well as being football-specific and less time-consuming (Ferley, Scholten, & Vukovich, 2020).

Based on the sport's specific needs and match demands, which require excellent aerobic-anaerobic capacity and power, strength and explosive ability, a holistic training plan package needs to be prepared for the players. Full planning must not start to be implemented during the season but prior to the start of the league, when the pre-season phase needs to have been completed. Apart from improving performance, pre-season preparation also can reduce the risk of injury. A pre-season training program also needs to prepare the players for the demands of competitive matches and football while developing their maximum physical capacities (Ekstrand, Spreco, Windt, & Khan, 2020). When preparing a pre-season training program, the National Strength and Conditioning Association (NSCA) suggested that a comprehensive training program should emphasise a combination training approach, including strength training, plyometric training, and variations of sprint interval training (Ferley et al., 2020).

Hence, in line with the importance of developing outstanding cardiovascular performance and sprinting ability in pre-season preparation, including a specific performance-monitoring program, this study was conducted to determine the effects of a six-week pre-season training program.

Material & methods

Experimental Approach to the Problem

This study was an experimental and descriptive case study. All the training programs implemented and the data recorded were from actual pre-season programs and performance-monitoring sessions. The subjects underwent six weeks of the pre-season training program, which consisted of aerobic and anaerobic training. The program focused on the relevance of football-specific training, including high-intensity aerobic intermittent sessions, speed-endurance sessions, resistance strength training, repetitive sprint and acceleration sessions, intensive small-sided games sessions, and plyometric training. Besides the training plan, fitness-testing sessions were included in the pre-season program.

Participants

This study involved twenty-four elite youth football players from Perak II who had participated in the Malaysian Premier League. All the participants were free from any significant injuries that would require them to rest for more than one week and be fit to participate in a team training program.

Instrument and Procedures

The bodyweight of the players was measured using the Omron digital body weight scale (Kyoto, Japan), and their height was measured using a Seca Stable Stadiometer (Hamburg, Germany). To measure a distance of 20m for the sprints and YYIR2, a 50m CK Tools tape measurement (Nordrhein-Westfalen, Germany) was used. A Casio handheld stopwatch (Tokyo, Japan) was used to measure the sprint times. The cardiovascular fitness performance test was conducted using the Yoyo Intermittent Recovery Level 2 test protocol (Bangsbo, Iaia, & Krstrup, 2008).

At first, all the players were briefed on the study that would be conducted during the pre-test fitness sessions and informed consent was provided. The players underwent a standardised 10-minute warm-up protocol before the fitness testing during the pre-test and post-test.

Five minutes after the players had completed the standardised warm-up protocol, the 20m sprint test was conducted. The players were given three trials for the 20m sprint test and a two-minute rest interval between attempts. The players were made ready in a standing start at the starting line. Once prepared, they took off from the starting line and ran at maximum speed past the 20m finishing line. A marker was put in place at the 30m line as a target for the players to ensure they crossed the 20m finishing line at the highest speed and only slowed down after reaching the 30m line marker. The timekeeper stood parallel with the 20m finishing line and recorded the time from the players' take-off until their torso had crossed the finishing line.

The Yoyo Intermittent Recovery Level 2 (YYIR2) test was conducted thirty minutes after the 20m sprint test had been completed. The YYIR2 protocol involves an incremental speed of 2 x 20m shuttle runs with a ten-second recovery run of 5m. The rate between each beep sound increased progressively throughout the test, and at least one foot was to be placed on the starting line before running and once reaching the line. The participants had to reach the starting line before the beep sound and could only leave the starting line after the next beep sound.

The participants were given a one-time warning if they failed to reach the starting line or went before the beep sound. If they failed for a second time, the participant would be eliminated. The participants performed as many shuttle runs as possible according to the sound recording. Once eliminated or withdrawn from the test, each participant's shuttle score was recorded.

PRE-SEASON				
WEEKS	WEEK 1 & 2	WEEK 3 & 4	WEEK 5	WEEK 6
AEROBIC	ENDURANCE MODERATE INTENSITY	ENDURANCE HIGH INTENSITY	ENDURANCE HIGH INTENSITY	COMBINATION
ANAEROBIC	SPEED ENDURANCE MAINTENANCE	SPEED ENDURANCE PRODUCTION	SPEED	COMBINATION & SAQ
RESISTANCE TRAINING	BASIC STRENGTH	TRANSFERENCE POWER	FOOTBALL POWER	FOOTBALL POWER
TECHNICAL/ TACTICAL	1V1-1-8V8	7V7-4V4	3V3-1V1	11V11-1V1-SET PLAY

Fig. 1: Six-week pre-season training plan.

Results

The means and standard deviation (SD) of the demographic data were acquired from descriptive statistics. A Paired Samples T-Test was used to measure how significant the improvements in cardiovascular fitness and sprint performance were. The Statistical Package for Social Science (SPSS) version 22 (IBM, USA) was used to perform all statistical analyses.

Table 1: Descriptive Statistics of Demographic Data.

	Age (years) (mean $\pm$ SD)	Weight (kg) (mean $\pm$ SD)	Height (cm) (mean $\pm$ SD)
Mean	23.29 $\pm$ 3.02	61.04 $\pm$ 8.61	176.95 $\pm$ 7.37
Minimum	19	58	165
Maximum	28	88	193

Table 2: Sprint Times and Cardiovascular Fitness Performance based on Paired Samples T-Test.

Variables	Mean $\pm$ SD	Sig. (2-tailed)
Pre-test 20m Sprint (sec)	3.16 $\pm$ 0.15	.006
Post-test 20m Sprint (sec)	3.09 $\pm$ 0.12	
Pre-test YYIR2 (ml•kg ⁻¹ •min ⁻¹)	58.20 $\pm$ 3.10	.000
Post-test YYIR2 (ml•kg ⁻¹ •min ⁻¹)	67.73 $\pm$ 4.41	

Significance level is set at 0.05.

Table 2 shows the pre-test and post-test results after six weeks of pre-season training in terms of cardiovascular fitness and sprinting performance. The cardiovascular fitness performance results show significant improvements after six weeks of pre-season training (pre-test 58.20 $\pm$ 3.10 ml•kg⁻¹•min⁻¹, post-test 67.73 $\pm$ 4.41 ml•kg⁻¹•min⁻¹). The increased $\dot{V}O_2$ max values demonstrated the players' ability to cover more distance and reach a higher level in the YYIR2 test. After six weeks of pre-season training, a significant improvement was also evident in sprinting performance (pre-test 3.16 $\pm$ 0.15 sec, post-test 3.09 $\pm$ 0.12 sec). Sprinting times had reduced, reflecting the improvement in the players' sprinting ability.

Discussion

This study aimed to determine elite youth football players' cardiovascular fitness and sprinting performance after a six-week pre-season training program. The results of the 20m sprint tests and YYIR2 tests were obtained, and significant improvements were shown in both these variables. The baseline was acquired before the pre-season started, and the post-test was conducted after six weeks of pre-season training. The strength and conditioning pre-season training program included physical and technical exercises such as speed drills, speed endurance drills, high aerobic intensity drills, agility or change of direction drills, strength training, explosive or power training, plyometric training, reaction time drills, proprioception drills, and football-specific small-sided games.

The players' increments in speed ability may reflect the improvements in their strength, which is supported by a previous study explaining that explosive training performed to momentary failure could generate significant improvements in strength, speed, and jump performance (Griffiths et al., 2019). Strength appears to be a primary factor affecting and producing effective movement. For professional football players, jump height and sprint performance have been highly correlated with maximum strength. Besides sprinting, muscular

strength is also associated with the rate of force development, jumping, power, change of direction, and post-activation potentiation (Ryan Curtis, Courteney Benjamin, Robert Huggins, 2020).

Meanwhile, the significant improvements in cardiovascular fitness performance reflected the ability of the players to perform any activity with higher intensity and over a prolonged duration. The various football-specific training drills embedded in physical and technical ability can develop players' aerobic and anaerobic fitness performance. Specific-to-football physiological demands and a scientific-based approach led to the maximum match-performance outcome. Training such as high-intensity interval training (HIIT), individualisation of HIIT, long interval HIIT, short interval HIIT, sprint-based HIIT, change of direction HIIT, game-based training, small-sided games, medium-sided games, and large-sided games have been shown to produce positive results in terms of improving cardiovascular fitness performance (Ryan Curtis, Courteney Benjamin, Robert Huggins, 2020).

In this study, the participants underwent an actual training program according to the plan of the team's head coach and strength and conditioning coach. Field fitness testing was used, reflecting the actual players' specific football ability. The pre-season training program that was implemented included aerobic and anaerobic training that significantly improved the players' speed and cardiovascular fitness performance.

Conclusions

This study provides direct information from a performance-monitoring process, while the outcome is also practical and relevant to assessing the effectiveness of pre-season training programs. When developing a training plan, the sports-specific needs and demands must be outlined and used as a key reference. While preparing a training session program, it is crucial to conduct an assessment and specify the performance-monitoring program. The field test conducted as a performance-monitoring tool was specific and related to the actual environment of the sport. The chosen fitness testing variables indirectly reflected other fitness components that play an essential role in producing excellent performance. A 20m sprint test not only delivers the sprinting ability of the players but also demonstrates the strength and power that influence the kinetic and kinematic actions in sprinting.

The YYIR2 test measures the aerobic capacity of players and is particular to the ecology of football as an intermittent sport. Besides producing the maximum oxygen consumption values, the YYIR2 also reflects a player's recovery rate ability and prolongs their sporadic activity ability. In conclusion, a proper and comprehensive pre-season training program is crucial when delivering an effective pre-season plan, and the football-specific element should also be taken into consideration by the head coach and strength and conditioning coach. This study also implies that a six-week pre-season training program with relevant aerobic and anaerobic training sessions can enhance cardiovascular and sprint performance.

Conflicts of interest

The author was a strength and conditioning coach for the Perak II team and would like to acknowledge the significant cooperation of the players in this study.

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