The influence of rotations on match running performance in female Australian football midfielders

Abstract

Purpose: With female Australian football (AF) gaining popularity, the understanding of match demands is becoming increasingly important. The aim of this study compare running performances of rotated and whole-quarter state level female Australian Football players during match quarters.

Methods: Twenty-two state-level female AF midfielders wore global positioning system units during 14 games to evaluate activity profiles. The Yo-Yo Intermittent Recovery Test (Level 1[Yo-Yo IR1]) was used as a measure of high-intensity running ability. Each player's data were categorised into either (1) whole-quarter (2) rotation bout 1 (3) rotation bout 2 before being further divided into quartiles. Players were separated into high or low Yo-Yo IR1 groups using a median split based on their Yo-Yo IR1 performance. Short (4-6 minutes), moderate (6-12 minutes) and long (12-18 minutes) on-field bout activity profiles were compared with whole-quarter players.

Results: Rotated players covered greater relative-and high-speed distances than whole-quarter players during a number of quartiles (Effect Size: ES, ≥0.44, Likelihood ≥94%). High Yo-Yo IR1 players covered greater relative and high-speed distances than low Yo-Yo IR1 players in rotation period 1. High Yo-Yo IR1 performance allowed players to cover greater relative distances (ES range=0.57-0.88) and high-speed distances (ES range=0.57-0.86) during rotations. No differences were reported between Yo-Yo IR1 groups when players were required to play whole quarters (ES ≤0.26, Likelihood ≤64%). Players who were on-field for short and moderate durations exhibited greater activity profiles than whole-quarter players.

Conclusions: Rotated players have greater activity profiles than whole-quarter players. Additionally, superior high-speed running ability results in a greater activity profile than players who possess lower high-speed running ability. The findings also highlight the importance of short-to-moderate (4-12 minute) rotation periods and may be used to increase high-intensity running performances within quarters in female AF players.

Key Words: team sports, Yo-Yo IR1, interchange, global positioning systems

Introduction

Australian football (AF) is an intermittent team sport, involving repeated bouts of high intensity activity interspersed with lower-intensity movement.[1] The high-intensity intermittent nature of the sport is particularly evident in the midfield positional group, with elite male AF players covering 135 $m.min^{-1}$ and performing approximately 300 high-intensity efforts over the duration of a match.[1] Due to these match demands and the positional requirements of midfielders to cover a larger proportion of the field than other positional groups, these players are regularly rotated on and off the field.[2] Rotations are implemented during AF matches for a number of reasons including tactical strategies however, based on the high-intensity nature of the game, arguably rotations are most commonly used to delay the onset of fatigue.[2] Not surprisingly, a positive association has been reported between running intensity and number of interchanges across match-play in elite male footballers.[3] Moreover, these researchers demonstrated that in combination with increased rotations, players who performed better on the Yo-Yo intermittent recovery 2 test completed the match at a greater running intensity than players with lower scores.[3] Collectively, this information suggests that by improving the physical fitness of their players [3] and strategically rotating players on and off the field, coaches can manipulate the intensity of the match and potentially gain a competitive edge over the opposition by maintaining player work rate as a result of short recovery periods on the bench.[2] However, while rotations may slow the rate of cumulative fatigue, it is well accepted that irrespective of rotations, player work rate declines across the four match quarters.[4]

Given the inevitable decline in running performance across AF matches, the effectiveness of on-field playing time per rotation has recently been investigated.[2] Specifically, following 5 minutes, relative distances declined and continued in this pattern until the 9-minute mark of a playing period.[2] However, the influence of rotations on running intensity has only been investigated in male players; how rotations affect activity profiles in female AF players is yet to be explored. The relatively recent introduction of females into national and state leagues of AF requires a stronger evidence base for the planning of playing strategies than currently exists. Furthermore, while this research provides insight into the optimal rotation duration, little is understood of the player activity profiles during on-field bouts between rotations. While there is a paucity of information on the changes in running performance during on-field bouts in AF players, differences in running intensities and pacing strategies between whole-game and interchanged rugby league players have been investigated. When analysed as quartiles, players interchanged during the first half of rugby league exhibited a greater work rate during the first match quartile compared with whole-game players and those interchanged during the second half.[5] Following the initial quartile, running intensity declined progressively over the subsequent quartiles in the interchanged players.[5] On the contrary, consistent with previous research,[6] players interchanged during the second half exhibited an "end-spurt" during the final match quartile in comparison to whole-game players.[5] Given the tactical importance and number of rotations completed during AF matches, player pacing strategies within an on-field bout between rotations warrant investigation. Furthermore, the majority of research investigating pacing strategies and changes in running intensity during rotation bouts is restricted to male athletes; the evidence of strategies implemented in female team sports is not yet understood. Therefore, the aim of this longitudinal study in female AF players across competitive matches was three-fold; (1) to compare activity profiles of on-field bouts between rotated and whole-quarter player performances; (2) to identify the changes in

running performance during different on-field bout durations; and (3) to investigate the influence of Yo-Yo intermittent recovery 1 performance on activity profiles.

Methods

Subjects

The influence of rotations on running performance was assessed in 22 state-level female AF midfielders (mean ± SD age: 23.3 ± 3.8 years; body mass: 62.5 ± 6.3 kg). The players were recruited from three of the six teams competing in the state-based Queensland Women's Australian Football League. Prior to the study, players received an information sheet regarding the risks and benefits of the study and provided written consent to participate. The Australian Catholic University's human research ethics board provided approval for the research study (2016-27H).

Design

An observational cohort study was used to investigate the influence of rotations and fitness levels on running demands in female AF midfield players. During the final two weeks of preseason, players were required to complete the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) to assess high intensity running ability. Running performances were measured using Global Positioning System (GPS) units across one competitive season. Matches were comprised of 4 x 20-minute quarters with no time-on added to the game clock. The dichotomisation of data was completed into three phases. First, each player's data were categorised into three different sub-groups; (1) whole-quarter (2) on-field rotation bout 1 (3) on-field rotation bout 2 before each on-field bout being further divided into quartiles. The second component of analysis investigated running performance during competitive match-play by comparing high and low Yo-Yo IR1 groups. Finally, short (4-6 minutes), moderate (6-12 minutes) and long (12-18 minutes) on-field bout activity profiles were compared with whole-quarter players. All of the data included and dichotomised into quartiles in this research is representative of within-quarter analysis. The changes in running performance across different match quarters were not analysed in this study.

Methodology

Following the Yo-Yo IR1 test, the total distance covered during the test was recorded as the Yo-Yo IR1 score. Subsequently, players were divided into two subsets (high fitness or low fitness) from a median split of the Yo-Yo IR1 performances. During testing, participants wore football boots and their normal training clothes; given that some players were unfamiliar with the Yo-Yo IR1 test, the first two levels were incorporated into the warm-up. The typical error of measurement for the Yo-Yo IR1 has been reported as 4.9%.[7]

Match activity profiles were analysed during 14 regular matches during the 2016 competitive season [97 GPS files (mean: 4.5 (range: 3-6) files per player); 388 individual quarters, with 40 (10%) individual quarters later removed as players started the match off-field], using 10 Hz global positioning system (GPS) devices (S5, Optimeye, Catapult Sports, Docklands, VIC, Australia). The units have acceptable reliability and validity for measuring activity

profiles in team sports.[8] Players wore a customised vest with the GPS unit positioned between the shoulder blades; where possible, players wore the same unit during each game. A total of 25 GPS units were used to collect match activity data across multiple teams. Activity profiles were determined by dividing movements into relative total, low-speed (0 to 2.78 $m.sec^{-1}$), moderate-speed (2.79 to 4.15 $m.sec^{-1}$), and high-speed (>4.15 $m.sec^{-1}$) movement bands.[9] All data is reported as distances covered per minute of play.

Analysis of data occurred in three different stages. First, each player's data were categorised into one of three different sub-groups for rotations. Group one comprised players who completed >18 minutes of the quarter and, represented the whole-quarter players (individual quarters = 159; mean ± SD playing duration: 19.9 ± 0.1 minutes). Players in group two were those individuals who started the quarter on the field, but were rotated off the field after a period of time (on-field rotation bout 1 [individual quarters = 189]). The third group consisted of players who were rotated off the field during a quarter (mean ± SD playing duration for bout 1: 7.8 ± 3.0 minutes), but were rotated back onto the field during the same quarter after a period on the bench (on-field rotation bout 2 [individual quarters = 135]). The mean ± SD duration of the on-field bouts were 9.2 ± 3.7 minutes (2.3 minute quartiles) and 7.4 ± 2.4 minutes (1.85 minute quartiles) for playing bout 1 and 2, respectively. Following the division of time-related data, each individual on-field bout was further split into even quartiles. Data were excluded from the analysis if the on-field bout was less than 4 minutes.

For the final component of the analyses, the length of the on-field bouts were divided into (1) short (4 to 6 minutes), (2) moderate (6 to 12 minutes), and (3) long duration (12 to 18 minutes) and subsequently compared with whole-quarter player performances. The average on-field rotation bouts were 5.0 ± 0.9 minutes (individual quarters = 61), 9.8 ± 1.8 minutes (individual quarters = 74) and 15.8 ± 1.5 (individual quarters = 54) minutes for short, moderate and long duration on-field bouts, respectively. Additional exploration of the data occurred when the on-field rotation bouts were further split into even quartiles based on the on-field bout duration.

Statistical Analyses

Log transformation of all data was used to reduce bias and non-uniform error. A linear mixed model with a fixed effect for on-field bout (3 levels; whole-quarter, rotation bout 1 and rotation bout 2) and a random effect for individual player identity was used to assess the influence of rotations on match activity profiles (SPSS 19.0, SPSS Inc, Chicago, IL, USA). A separate linear mixed model with a fixed effect of "quartile" was employed to assess the differences in running performance between quartiles. A further model was used to assess the differences in GPS variables among short-, moderate- and long-duration playing bouts. A final linear mixed model with a fixed effect of "fitness" was used to investigate differences between high and low Yo-Yo IR1 players. The random effect for player identity was included to account for the dependence arising from repeated measurements of running performance variables from individual participants. Cohen's effect size (ES) statistic ± 90% confidence intervals (CI) were also used to determine the magnitude of differences between the two groups. These were classified as substantially greater or lesser when there was a ≥75% likelihood of the effect being equal to or greater than the smallest worthwhile change estimated as 0.2 x between-subjects SD (small ES). Effect sizes of ≤0.2, 0.21–0.6, 0.61–1.2,

1.21–2.0, and >2.0 were considered trivial, small, moderate, large, and very large, respectively.[10] A custom Excel spreadsheet (Version 16, Microsoft, USA) was used to calculate ES and confidence intervals.[10]

Results

Rotated players vs. whole-quarter players

The rotated players covered greater relative total (ES ≥ 0.45 ± 0.29; likelihood = likely probably ≥91%) and moderate-speed (ES ≥ 0.44 ± 0.33; likelihood = likely probably, ≥90%) distances during quartiles one and four than the whole-quarter players (Figure 1). During both on-field bouts, rotated players covered greater relative high-speed distances (ES ≥ 0.89 ± 0.45; likelihood = almost certainly, 100%) than whole-quarter players in quartile four. Greater relative distances were covered by rotated players during quartile one of on-field rotation bout 1 than bout 2 (ES = 0.46 ± 0.27; likelihood = likely probable, 94%). Following quartile one, relative- total (ES = 0.51 ± 0.31; likelihood = almost certainly, 99%) and moderate-speed (ES = 0.50 ± 0.31; likelihood =likely probable, 95%) distances were reduced during on-field rotation bout 1. Relative high-speed distances were increased in quartile four during both rotation bouts in comparison with quartile three (ES ≥0.39 [90%CI: 0.07-0.90]; likelihood =likely probably, ≥85%). During the third quartile, whole-quarter players showed a more reduced relative-total (ES = 0.36 ± 0.19; likelihood = likely probable, 92%) and moderate-speed (ES = 0.30 ± 0.19; likelihood =likely probable, 81%) activity than during quartile two.

Insert Figure 1 here.

Influence of fitness on activity profiles

Figure 2 demonstrates higher fitness players covered greater relative distances (ES ≥ 0.56 [90%CI: 0.12-1.32]; likelihood ≥97%) during the first on-field bout than lower fitness players, with the exception of quartile one (ES = 0.23; likelihood = 65%). These differences were matched by a greater amount of relative high-speed distance covered by higher fitness players than lower fitness players (ES ≥ 0.57 [90%CI: 0.13-1.19]; likelihood ≥92%). Relative distances were comparable across fitness groups during the second on-field bout (ES ≤ 0.31; likelihood ≤ 71%), with the exception of quartile 2 (ES = 0.76 ± 0.50; likelihood =very likely, 97%). During all four quartiles, higher fitness players covered greater relative high-speed distances than the lower fitness players in the second on-field bout (ES ≥ 0.44 [90%CI: 0.07-1.36]; likelihood ≥80%). Relative distances were comparable across fitness groups in the whole-quarter players (ES ≤0.26; likelihood ≤64%).

Insert Figure 2 here.

Playing Duration

During both short and moderate on-field bout durations, players covered greater relative high-speed distances in quartile two (ES ≥0.37 ± 0.55; likelihood ≥80%) and greater relative moderate-speed distances in quartile three (ES ≥0.33 ± 0.55; likelihood = likely probable, ≥80%) than whole-quarter players (Figure 3). Whole-quarter players covered a greater amount of relative low-speed distance in quartile four (ES ≥0.77 ± 0.68; likelihood = almost

certainly, 100%) than both short and moderate on-field bout duration players. Greater relative total (ES ≥0.43 ± 0.46; likelihood = likely probable, ≥87%), moderate- (ES ≥0.38 ± 0.47; likelihood =likely probable, ≥84%) and high-speed distances (ES ≥0.92 ± 0.66; likelihood = almost certainly, 100%) were covered by short and moderate on-field bout duration players than whole-quarter players. Long on-field bout duration players covered greater relative total distances during quartile 1 (ES = 0.84 ± 0.49; likelihood = very likely, 98%) and greater relative high-speed distances during quartile four (ES = 0.65 ± 0.63; likelihood = likely probable, 89%) than whole-quarter players.

Insert Figure 3 here.

When analysing changes in running intensity within groups, following quartile one, long on-field bout duration players had large reductions in relative distances covered (ES = 1.29 ± 0.60; likelihood = almost certainly, 100%) in quartile two. These reductions in relative distances were matched by a decrease in relative moderate- (ES = 0.88 ± 0.72; likelihood = likely probable, 94%) and high-speed (ES = 0.75 ± 0.74; likelihood = likely probable, 89%) activity. Similarly, in quartile three, relative total- (ES = 0.51 ± 0.77; likelihood =likely probable, 75%) and moderate-speed (ES = 0.66 ± 0.71; likelihood = likely probable, 86%) distances were reduced in comparison with quartile two. During both short and long on-field bouts, relative high-speed distances were increased in the final quartile (ES ≥0.51 [90%CI: 0.12-1.78]; likelihood ≥91%).

Discussion

This study is the first to explore the activity profiles of female AF players during periods between rotations when compared with whole-quarter players. Our findings highlight that activity profiles progressively declined during quarters in the whole-quarter players. Following an initial reduction in relative moderate-speed distances covered during the first on-field rotation bout and an increase in relative low-speed distances covered during the second on-field bout, rotated players maintained a higher running intensity than the whole-quarter players over the course of the quarter. Furthermore, rotated players with a greater high-intensity running ability covered greater distances than those with lower high-intensity running ability during on-field bouts. However, when players were required to play a quarter without a rotation, running intensity was comparable across both fitness groups. These findings suggest that irrespective of fitness, to maintain or increase match intensity, players with a greater high-speed running ability still require rest periods within quarters. Additionally, we found players who were on-field for short (4 to 6 minutes) and moderate (7 to 12 minutes) durations exhibited greater activity profiles than whole-quarter players. The results of this study highlight the effectiveness of rotations in female AF and for coaches provide insight into rotation periods that may enable players to maintain a higher running intensity across matches.

During the first on-field rotation bout, an all-out, or positive pacing strategy was adopted,[11] whereby rotated players appeared to initially set a playing intensity that was unsustainable, highlighted by greater distances than whole-quarter players, before reducing their running intensity in the following quartile (Figure 1). Interestingly, while the overall running intensity

and moderate-speed distances declined following the initial quartile, high-intensity distances increased over the duration of the first on-field bout. A plausible explanation for these findings may be that players attempted to conserve energy for high-speed activity to allow an increased work rate during the end of their on-field bout. Furthermore, it is likely players had prior knowledge of when they would be rotated off the field, which in turn may have resulted in an increase in high-speed activity as their on-field bout progressed. Although meaningful relationships were found between Yo-Yo IR1 performance and relative high-speed running distance, factors in addition to Yo-Yo IR1 performance (such as match contextual factors[12] and self-pacing strategies[11]) may also influence the activity profiles observed across quartiles. On the contrary, players during the second on-field bout seemed to adopt a negative pacing strategy,[11] with an increase in both relative total and high-speed activity following the first quartile. In agreement with previous research,[13] it is possible the players were aware that starting the second bout with a high running intensity may not be sustainable for the remainder of the quarter, therefore implemented a pacing strategy to delay the onset of fatigue.[13] Whole-quarter players used a similar strategy to the first on-field bout players, reducing running intensity as the quarter progressed. As previous research has linked rotations to an increase in running intensity[3] it is not surprising that during the final two quartiles, the relative-, moderate-, and high-speed distances of rotated players surpassed whole-quarter players.

A notable finding from this study was the running performance of players during the second on-field bout. The bout on the bench resulted in greater relative- and high-speed distances during their second on-field bout compared with whole-quarter players. As pacing is regulated through a comparison of past experiences and current exercise demands,[14] it is possible that during the second on-field rotation bout, players were aware of the time remaining in the quarter and therefore had an understanding of the bout endpoint. Although in disagreement with previous research in AF,[15] this notion is further supported by the "end-spurt" (increase in intensity towards the end of a competition)[6] exhibited by the rotated players in quartile four, where greater high-speed distances were covered in comparison with the previous quartile. As poor levels of fitness have been associated with the preservation of energy in the early stages of competition in an attempt to complete matches,[13] the disparity in evidence between our results and previous AF research may be partially explained by differences in fitness levels in the participants investigated.

While running intensity did not differ in the first quartile, players with a greater high-intensity running ability were able to cover greater relative total and high-speed distances during quartiles two through four than players with poorer Yo-Yo IR1 test scores during the first on-field bout. This finding highlights that superior Yo-Yo IR1 performance is associated with a greater running intensity and an even-paced pacing strategy[13] across the first on-field bout. Additionally, it appears that lower Yo-Yo IR1 performers adopted a similar running intensity to the higher Yo-Yo IR1 group during the initial quartile. However, following the first quartile, low Yo-Yo IR1 performers either consciously or subconsciously identified they were unable to maintain that intensity and subsequently reduced running performance in an attempt to conserve energy and minimise the risk of physiological failure.[13,14,16] During the second on-field bout, although relative-distances were comparable across both fitness groups, the superior Yo-Yo IR1 performers covered greater high-speed distances across all quartiles than lower Yo-Yo IR1 players. Players with a greater high-intensity running ability were potentially able to increase their work rates when required within the context of the game

(e.g. making leads for the football or creating space), whereas, the ability of low fitness players to increase work rate may have been limited by their lower Yo-Yo IR1 scores. Collectively, these results suggest high-intensity intermittent running ability is important for running performance in female AF players. However, when players were required to play full quarters with no rotations, no differences were reported between higher and lower fitness groups. While coaches may prefer players with greater high-intensity running ability to spend more time on-field, to gain the benefits of superior fitness levels and to maintain higher match intensities, these players still require rest periods within each quarter.

Our findings also demonstrate that the length of rotation influences running intensity across a quarter. Specifically, during short on-field bouts, greater relative- and moderate-speed distances were covered in quartiles one, three and four compared with whole-quarter players. Similarly, moderate on-field bout duration players covered greater moderate- and high-speed distances than whole-quarter players in a number of quartiles. Following the first quartile, long on-field duration players competed at a running intensity below that of whole-quarter players in the subsequent two quartiles. This finding disagrees with previous research that found running intensity only declined after between 5 and 9 minutes on-field.[2] Our findings suggested players should be rotated off the field after between 4 and 12 minutes to maintain a running intensity greater than whole-quarter players. Interestingly, irrespective of rotation length, all rotated players covered greater relative- and high-speed distances in the final quartile compared with whole-quarter players. It seems whole-quarter players further reduced intensity in the final stages of a quarter to complete game tasks in a reasonable physiological state; in contrast, players who were rotated may increase their intensity as a result of knowledge of the exercise endpoint.[17] A plausible explanation for this finding is that players can be delivered messages on-field regarding when a rotation is required; this information could allow players to complete exercise bouts optimally [11] through an increase in running intensity.

Although this is the first study to investigate the influence of rotations on running performance in female AF, the small sample size and the restriction of player recruitment from only one Australian State competition are both limitations that require consideration when interpreting the results. Furthermore, due to the small sample size from only one positional group, this study did not investigate how rotations influenced running performance across different match quarters. Given that research has shown declines in running intensity as matches progress,[4] it is possible that pacing strategies would differ across quarters. Additionally, the Yo-Yo IR1 was only assessed once at the end of preseason. As such it is possible that physical fitness may have improved or declined as the season progressed. Notwithstanding, these results provide coaching staff with evidence that running performance declines as the on-field bout duration increases and demonstrates the importance of high-intensity intermittent running ability in female AF match-play.

Practical Applications

Coaches should expect rotated players to perform at a higher intensity than whole-quarter players during their on-field bouts if they are rotated within 6 minutes of play. Players who are on-field for up to 12 minutes before being rotated will also maintain a higher match intensity than whole-quarter players.

The assessment of high-intensity running ability is important for female Australian football players, as superior Yo-Yo IR1 performance was linked with greater average match running intensity during the first on-field bout. Furthermore, during the second on-field bout for rotated players, higher Yo-Yo IR1performers covered greater high-speed distances over all four quartiles than players with lower scores. Players with poorly developed physical fitness should be identified early in the preseason to address individual deficiencies and allow sufficient time for improvements.

Higher Yo-Yo IR1performers may only perform greater pacing strategies and match intensities if they are rotated within quarters. Coaches should aim to rotate players each quarter, irrespective of fitness levels, in order to maintain higher match intensities.

Conclusions

Players who were rotated within quarters covered greater relative and high-speed distances over a number of quartiles than whole-quarter players. Furthermore, while high-speed running progressively declined over quartiles in whole-quarter players, high-speed distances increased across quartiles in rotated players. When high and low Yo-Yo IR1performers were compared during on-field rotation bout 1, higher Yo-Yo IR1performers were able to maintain a higher match running intensity across quartiles. During both on-field rotation periods, greater high-speed distances were covered by higher Yo-Yo IR1performance players compared to lower Yo-Yo IR1performance players. Conversely, activity profiles were comparable across fitness groups in whole-quarter players, suggesting that players with a greater high-intensity running ability required rotations within quarters to maximise the advantage of their superior physical fitness. Finally, our results suggested that players who were rotated after 4 to 12 minutes of play covered greater relative-, moderate- and high-speed distances than whole-quarter players. However, rotated players who remained on-field for longer than 12 minutes of play performed at a lower intensity than whole-quarter players during the second and third quartiles.

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Figure captions

Figure 1.

The running demands across quartiles during the first on-field bout, second on-field bout and whole-quarter players.

"1" denotes difference (ES range = 0.44-1.01) between on-field bout 1 players and whole-quarter players

"2" denotes difference (ES range = 0.40-0.89) between on-field bout 2 players and whole-quarter players

"s-b1" denotes small difference (ES range = 0.21-0.60) from previous quartile in 1st on-field bout

"s-b2" denotes small difference (ES range = 0.21-0.60) from previous quartile in 2nd on-field bout

"s-NR" denotes a small difference (ES range = 0.21-0.60) from previous quartile in whole-quarter players.

Figure 2.

Changes in running performance across quartiles in high fitness and low fitness players; (1A) relative distance covered during on-field bout 1; (1B) high-speed distances covered during on-field bout 1; (2A) relative distances covered during on-field bout 2; (2B) high-speed distances covered during on-field bout 2; (3A) relative distances covered by whole-quarter players; (3B) high-speed distances covered by whole-quarter players.

"m" denotes a moderate difference (ES range = 0.61-1.2) between high and low fitness players

"s" denotes a small difference (ES range = 0.21-0.6) between high and low fitness players

Figure 3.

Distances covered per minute relative to whole-quarter players (0-line) in short, moderate and long on-field bouts.

"m" denotes a moderate difference (ES range = 0.61-1.2) from whole-quarter players.

"s" denotes a small difference (ES range = 0.21-0.60) from whole-quarter players.

"*" denotes a meaningful difference (ES range = 0.51-1.29) from previous quarter.

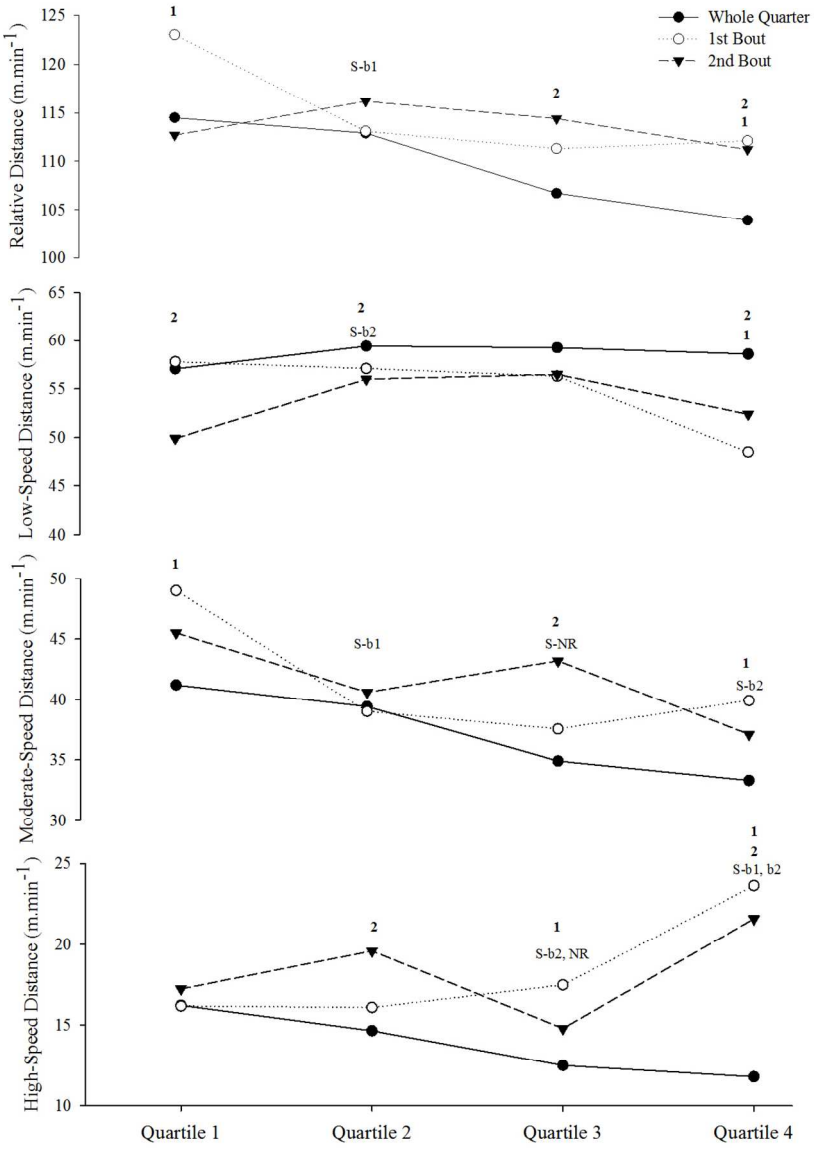
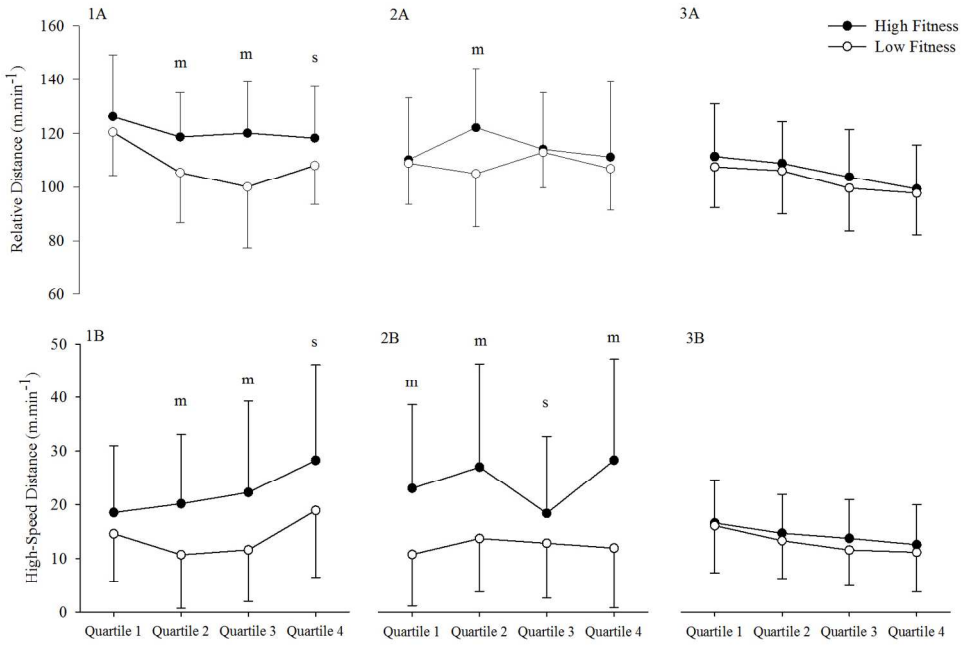

Whole Quarter
1st Bout
2nd Bout
Relative Distance (m.min-1)
Low-Speed Distance (m.min-1)
Moderate-Speed Distance (m.min-1)
High-Speed Distance (m.min-1)
S-b1
S-b2
S-NR
S-b2, NR
S-b1, b2
Quartile 1
Quartile 2
Quartile 3
Quartile 4

Figure 1.


1A
2A
3A
High Fitness
Low Fitness
Relative Distance (m.min-1)
160
140
120
100
80
60
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s
m
1B
2B
3B
High-Speed Distance (m.min-1)
50
40
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Quartile 4

Figure 2.

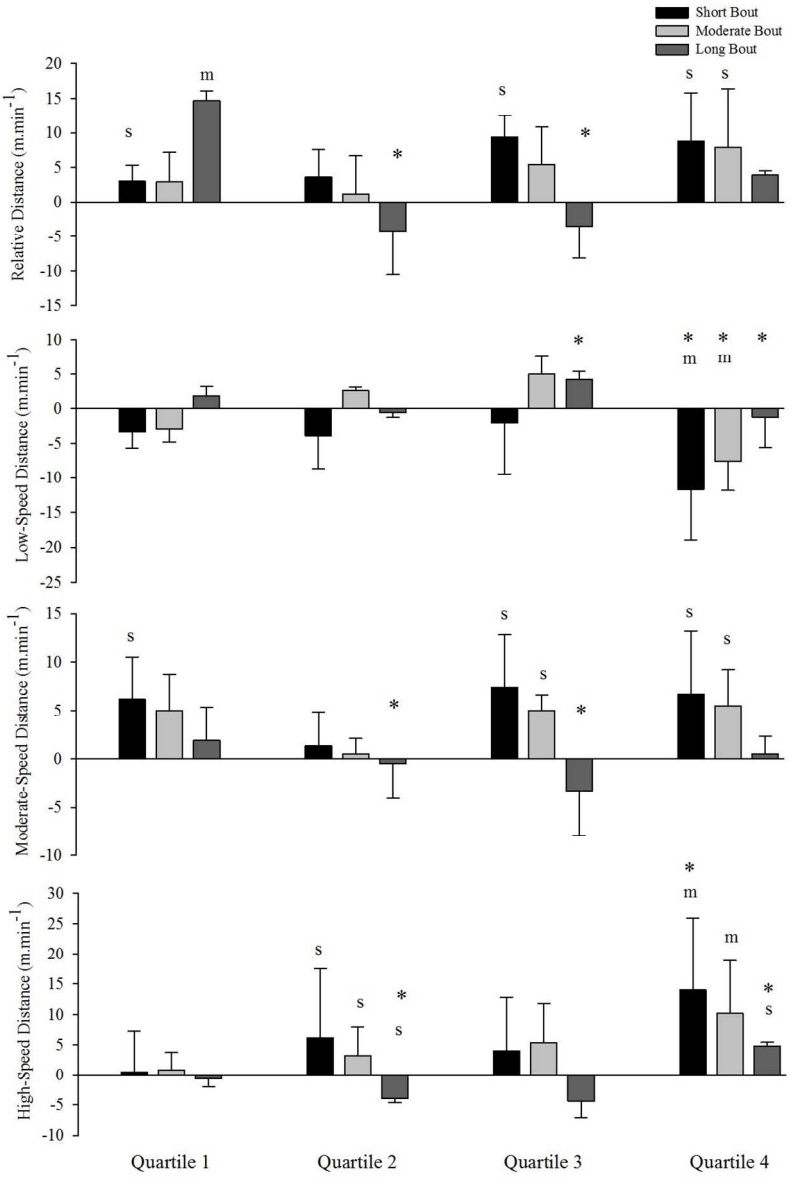
Short Bout
Moderate Bout
Long Bout
Relative Distance (m.min-1)
Low-Speed Distance (m.min-1)
Moderate-Speed Distance (m.min-1)
High-Speed Distance (m.min-1)
Quartile 1
Quartile 2
Quartile 3
Quartile 4

Figure 3.