Journal: Journal of Sports Sciences

Title: The influence of successive matches on match-running performance during an under-23 international soccer tournament: The necessity of individual analysis

Submission Type: Original Article

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Preferred running head: Match running performance over successive matches

Abstract word-count: 195

Text only word-count: 3550

Number of figures: 2

Number of tables: 2

Abstract

Purpose: This study investigated the effects of successive matches on match-running in elite under-23 soccer players during an international tournament. **Methods:** Match-running data was collected using a semi-automated multi-camera tracking system during an international under-23 tournament from all participating outfield players. Players who played 100% of all group stage matches were included (3 matches separated by 72 hours, n=44). Differences in match-running performance between matches were identified using a generalized linear mixed model. **Results:** There were no clear effects for total, walking, jogging, running, high-speed running and sprinting distance between matches 1 and 3 (Effect Size (ES); -0.32 to 0.05). Positional analysis found that sprint distance was largely maintained from match 1 to 3 across all positions. Attackers had a moderate decrease in total, jogging and running distance between match 1 and 3 (ES; -0.72 to -0.66). Classifying players as increasers or decreasers in match-running revealed that match-running changes are susceptible to individual differences. **Conclusions:** Sprint performance appears to be maintained over successive matches regardless of playing position. However, reductions in other match-running categories vary between positions. Changes in match-running over successive matches effect individuals differently thus Players should be monitored on an individual basis.

Key Words: football, match analysis, congested fixtures, physical performance, Prozone

Introduction

Physical performance in soccer may be quantified by the distance players cover at certain speeds during match-play. It has been suggested that soccer players may experience neuromuscular fatigue for up to 72 hours following a match with declines in counter-movement jump, isometric strength of the hamstring and peak sprint speed observed during this period (Nedelec et al., 2014). Additionally, reductions have been observed in match-running by players required to play successive matches with less than 72 hours in between during domestic competition, for example 3 matches in 5 days (Odetoyinbo, Wooster, & Lane, 2007). In contrast, match-running was unaffected in French Ligue 1 players who played three consecutive games within 7 days (Carling & Dupont, 2011). While domestic competitions are typically scheduled to play 1 or 2 games per week, allowing >72 hours between games, most youth (i.e., <U23) tournaments are typically played over shorter periods. For example, the under-20 World Cup in New Zealand in 2015 saw the finalists play 7 matches over 20 days with 3 days between the three group stage matches and 4 days between the knockout matches (FIFA, 2015). In these situations players may be required to compete in successive matches separated by less than 72 hours and therefore may experience residual fatigue throughout the tournament.

Many contextual factors have been found to influence match-running including playing position (Di Salvo et al., 2007; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009), the quality of the opponent and the score-line (Castellano, Blanco-Villasenor, & Alvarez, 2011) resulting in substantial match-to-match variation (Gregson, Drust, Atkinson, & Di Salvo, 2010). Thus, it is difficult to determine whether changes in match-running performance are due to acute or residual fatigue or simply a consequence of these contextual factors. The majority of research investigating fixture congestion has been conducted using matches from domestic competition combined with those from club cup competitions (Carling, Le Gall, & Dupont, 2012; Dellal, Lago-Penas, Rey, Chamari, & Orhant, 2015; Dupont et al., 2010). Match-running has been assessed by comparing distances covered during congested periods such as 2 matches per week, to non-congested periods such as 1 match per week (Dellal et al., 2015; Dupont et al., 2010). While these studies found no differences in match-running between congested and non-congested periods the study designs did not permit the assessment of changes in match-running that players may experience over successive (e.g. >2) matches during congested periods.

To determine the influence of successive matches on match-running performance it is important that the players included in the analysis not only complete the majority of each match but also participate in and complete all successive matches. In youth players, accelerations per minute but not match-running distances were found to decline across a tournament (5 matches in 3 days), however, match lengths were modified to 2 x 25 min halves (Arruda et al., 2015). In senior players, research into successive matches have either assessed the average team distances and not restricted their analysis to players who play 100% of all matches (Carling et al., 2012) or have used low sample sizes (Carling & Dupont, 2011; Odetoyinbo et al., 2007). This is primarily due to the fact that clubs will often rotate players between matches during domestic competitions and only a low number of players are exposed to successive matches (Carling, McCall, Le Gall, & Dupont, 2015). However, during tournaments teams may restrict player rotations in order to play their best players given the importance of each match. Therefore, while the majority of the squad may be rotated there will be players who may be required to play successive matches.

The under-23 Asian Football Confederation Championship was an international tournament contested by the under-23 youth teams from 16 countries that took place in Doha, Qatar. All matches were played in stadiums installed with the Prozone system allowing player match-running to be recorded. Further, matches during the group stages were always separated by 3 days (i.e., ~72 hours) presenting an opportunity for match-running to be examined over successive matches in multiple teams. Previous research using single teams in their analysis have been unable to observe the effects of successive matches on match-running as they have not been able to use a repeated measures design limited to only those players who are involved in all matches (Arruda et al., 2015; Carling et al., 2012). Additionally, changes in match-running data from a single team may be unduly biased by contextual factors. In this study, the inclusion of players from multiple teams was proposed to provide greater variation among these contextual factors. The aim of this study was to identify the effects of successive matches on match-running in elite under-23 soccer players during an international tournament. A secondary aim was to identify both individual and positional trends.

Method

Participants and match data

Match-running data were collected from all outfield players who participated in the 2016 under-23 Asian Football Confederation Championship (281 players from 16 teams). Goalkeepers were excluded from the analysis. The tournament consisted of an initial group stage where four groups of 4 teams played each other once with the top 2 teams progressing to the knockout stages which consisted of quarter-finals, semi-finals, a third place final and the final. All group stage matches were separated by 3 days (~72 hours) resulting in 3 matches in 7 days. To investigate the effects of successive matches on match-running only group stage matches were analyzed for several reasons. First, given half the teams were eliminated only a small proportion were involved in 100% of all matches beyond the group stage. Second, a large number of knock-out matches went to extra-time making it difficult to compare to the group stage matches. Third, at 72 hours post-game there is evidence suggesting neuromuscular factors are not fully recovered (Nedelec et al., 2014).

Players were only included in the analysis if they participated in 100% of group stage matches 1, 2 and 3 (All matches; 44 players, 132 match files) and started in the same position in all matches. Starting positions were confirmed by the team sheets submitted to Prozone. These players represented 13 different teams with the number of players from each team ranging from 1 to 5. Of the 132 matches 36 were wins for the player's team while 48 matches were draws and 48 were losses. Players were further assigned to the following positions: wide defender (WD), central defender (CD), central midfielder (CM) and attacker (ATT). Although wide midfielders and forwards are typically grouped as separate positions they were combined to represent attacking players due to the low number of players in these roles (n=4 and n=5, respectively).

Data were collected as a condition of employment in which player performance is routinely measured during match-play (Winter & Maughan, 2009). The study was approved by the local research ethics committee and conformed to the recommendations of the Declaration of Helsinki. To ensure team and player confidentiality, all physical performance data were anonymized before analysis. Permission to publish this data was granted by Prozone (Prozone Sports Ltd., Leeds, UK).

Physical performance measures

Player movement data were reported as total distance, walking; 0.19 – 1.99 $m.s^{-1}$, jogging 2.00 – 3.99 $m.s^{-1}$, high-speed running; 4.00 -5.49 $m.s^{-1}$, very high-speed running distance; 5.50 – 6.99 $m.s^{-1}$ and sprint distance; $\geq$ 7.00 $m.s^{-1}$ (Bradley et al., 2009; Di Salvo et al., 2009). All movements were expressed in absolute terms (m). As match lengths differed due to differences in injury time, distances were standardized by including an offset in the statistical model for match time (minutes played divided by 90). The reliability and validity of Prozone to measure physical performance has previously been reported (Di Salvo, Collins, McNeill, & Cardinale, 2006; Di Salvo et al., 2009).

Statistical Analyses

Separate analyses were performed for all physical performance measures using a generalized linear mixed model (Proc Glimmix) using the statistical analysis system (SAS; Version 9.4, SAS Institute, Cary, NC). To identify differences in physical performance measures, analyses were performed using the match number as a fixed main effect (match 1, match 2, match

3). A random effect for each player and each match was included in the model to account for repeated measurement within and between matches. An offset for match time was also included. For a more detailed analysis of players who participated in three successive matches, player position was included as a fixed main effect (CD, WD, CM, and ATT) and analyzed as an interaction; match with player position. For all analyses the log link function and the Poisson distribution were invoked with an over-dispersed residual to account for any clustering of counts (Murray & Varley, 2015). An inference about the true value of a given effect (difference in means) was based on its uncertainty in relation to the smallest important difference, which was determined by standardization as 0.20 of the standard deviation between teams in an average match (Hopkins, Marshall, Batterham, & Hanin, 2009). This standard deviation was derived from the mixed model by adding the variance for the true difference between players (provided by the random effect for the player identity) with the match-to-match variance within players (provided by the over-dispersion factor multiplied by the mean, which is the Poisson variance). The resulting observed between player variances were different for each level of a predictor variable, so the variances were averaged across all levels before taking the square root. This method accounts for the within player match-to-match variation that occurs between matches.

Inferences were non-clinical: an effect was deemed unclear if the 90% confidence interval included the smallest important positive and negative differences; the effect was otherwise deemed clear. Quantitative chances of a greater or lesser substantial true difference between levels of a predictor were calculated using programming steps in SAS based on the same sampling theory that underlies the calculation of traditional p values (Batterham & Hopkins, 2006). These chances were then assessed qualitatively for clear outcomes as follows: >25 – 75%, possibly; >75-95%, likely; >95 – 99%, very likely; >99%, almost certainly. The magnitude of a given clear effect was determined from its observed standardized value (the difference in means divided by the between subject standard deviation) using the following scale; <0.20, trivial; 0.20-0.59, small; 0.60-1.19, moderate; ≥1.20, large (Hopkins et al., 2009). For clarity only effects with a likelihood >75% are presented.

Analysis of individual responders

Players were categorized into three responder types (Increasers, Stable, Decreasers) based on their change in match-running from match 1 to 3. The within-subject coefficient of variation for match 1 and 2 were calculated for each player in addition to the percentage change in match-running between the average of match 1 and 2 to match 3. Individual differences of more than 1.5times the CV were classified as Increasers (positive change) or Decreasers (negative change) while those remaining were classified as Stable (Scharhag-Rosenberger, Walitzek, Kindermann, & Meyer, 2012). These were expressed as frequencies according to each match-running category.

Results

Player exposure to successive matches

Players who completed 100% of the group stage matches (3 matches) represented 16% of all outfield players involved in the tournament and 28% of all starting outfield players in match 3. Altogether 15 players completed 100% of all matches including the quarter-finals (19% of all starting outfield players in match 4). Only, 4 players completed 100% of all matches including the semi-finals (10% of all starting outfield players in match 5). The same 4 players completed 100% of all matches in the tournament (20% of all starting outfield players in the final).

Match-running performance

The distances covered in each movement category for players who played all group stage matches are presented in Table 1. Players who played all group stage matches had a small increase in sprint distance from match 1 to match 2 and a small decrease in total distance from match 2 to match 3, however, for all other movement categories the effects between matches were unclear (Figure 1).

---Table 1 here---

---Figure 1 here---

Central midfielders had no clear differences in any movement category between match 1, match 2 and match 3 (Figure 2). Wide defenders had a small increase in walking distance and a decrease in running distance in match 3 compared to match 1 (Figure 2). Central defenders had a small decrease in total distance, high-speed running and sprinting between match 2 and match 3 (Figure 2). In addition there was a small decrease in high-speed running between match 1 and 3. Attackers covered the lowest total, jogging, running and high-speed running distance in match 3

(Figure 2). Walking distance increased by a small magnitude in match 2 and 3 compared to match 1. Both central defenders and attackers had a small and large increase respectively in sprint distance in match 2 compared to match 1.

---Figure 2 here---

There was a wide spread in the way individuals responded to successive matches across all movement categories (Table 2).

---Table 2 here---

Discussion

This is the first study to investigate the effects of successive matches on match-running performance of players from all teams in a competitive tournament. The main findings were: a) players who played successive matches were able to largely maintain their match-running; b) when assessing players according to their position some differences were observed, however, sprint distance was maintained regardless of position; c) changes in match running over successive matches are subject to individual responses.

This study demonstrates that although successive matches may not occur for the majority of players during a tournament due to squad rotation, there are still players who will be required to play successive matches. It is likely that coaches consider these players to be the most important for team success. Teams who had qualified for the knockout stage prior to match 3, rotated their players with no players from already qualified teams completing 100% of the group stage matches. This indicates that coaches, if assured of tournament progression, believe that resting key players is important. On average 3 players per team were exposed to 100% of the group stage matches ranging from 1 to 5 players per team. Squad rotation and subsequent exposure to successive matches within club-level soccer demonstrates that less than 40% of a squad will be required to play full matches across consecutive matches (Carling, McCall, et al., 2015). While results suggest that exposure to successive matches is low in both tournament and domestic competition, arguably, a phenomena effecting 30% of the team in a tournament remains pertinent to coaches. Therefore, understanding the effects of successive matches on the relatively low number of players remains important.

The results of this study show that match-running was maintained in those who played all group stage matches when position was not accounted for. This supports previous findings that generally players are able to maintain their match-running performance when time between matches is relatively short (Carling & Dupont, 2011). However, there was a trend, albeit statistically unclear, for total, jogging, running and high-speed running distance to be lowest in match 3, whereas sprint distance in match 3 was consistent with match 1 (Table 1 and Figure 1). In a French Ligue 1 Team, the team average total and low-speed distance were found to increase and decrease across a prolonged period of successive matches (8 matches over 26 days), while high-intensity running (>19.1 km.hr^{-1}) was unchanged (Carling et al., 2012). In this study player inclusion was not restricted to those who played a full match or participated in all matches but rather a team analysis, however, it supports the current study's finding that when looking at players independent of playing position (i.e. the team), they are generally able to maintain match-running at higher speeds (in the case of the current study, sprinting) over successive matches. Youth soccer players (~15 yrs) were able to maintain maximal running speed, and were not found to have significant differences in total or high-intensity running distance per minute when playing five 50 to 60 minute matches in three days (Arruda et al., 2015). However, the number of accelerations per minute were found to decline across the tournament. Therefore while players may be able to maintain sprint performance during matches, they may be unable to maintain accelerations which are potentially more energetically demanding (Osgnach, Poser, Bernardini, Rinaldo, & di Prampero, 2010). Future research should explore the relationship between sprint distance and accelerations over successive matches as research suggests that only a small percentage of maximal accelerations lead to a sprint (Varley & Aughey, 2013).

When players were analyzed by position several trends were apparent. Although the majority of effects were unclear there was a trend for total, jogging, running and high-speed running distance to be the lowest in match 3 for all positions with the exception of central midfielders (Table 1, Figure 2). While the combination of wide midfielders and forwards into a single position likely increased the variability of the data, attackers were found to have the largest reductions of all positions. A possible explanation for this is that players in attacking positions are substituted more frequently than all other positions (Bradley, Lago-Penas, Rey, & Sampaio, 2014). Therefore the attackers in this study may not have been prepared to play 3 complete successive matches. Interestingly, sprint distance was maintained across all positions reinforcing the suggestion that players are capable of maintaining sprint performance during successive matches.

The classification of players into increasers, decreasers or stable indicates that there is a wide range of response types for each movement category (Table 2). Analyses were conducted to ascertain whether position accounted for response type, however there were no positional trends. This means that even though common patterns were evident amongst positions (Figure 2) playing position is still susceptible to individual responses. For example, although high-speed running was largely maintained there was still a spread of individuals categorized as increasers or decreasers (Table 2). This suggests that practitioners should monitor player match-running on an individual basis. Further, the movement categories used in this study to assess match running were based on absolute speed thresholds. Expressing match running using relative thresholds based on player physical capacities (e.g. % of maximal sprint speed), would account for individual differences in physical fitness. While it was not possible to assess match-running using relative thresholds in the current study, future research should assess successive matches in this manner to identify if different patterns are observed.

The inclusion of players from multiple teams provided a unique analysis into the effects of successive matches on match-running. However, information regarding the use of any recovery strategies between matches were not recorded. It has been suggested that post-match recovery interventions such as hydrotherapy may assist with the maintenance of match-running during successive matches (Carling et al., 2012). Additionally, physical fitness may influence player match-running during intensified periods of play by a greater ability to recover from matches with increased fitness resulting in greater external workloads in elite youth rugby players during a tournament (Johnston, Gabbett, & Jenkins, 2015). However, the relationship between physical fitness, match-running and recovery is less clear in football and warrants further examination. Although speculative, differences in team recovery procedures or player fitness may explain some of the variation in match-running performance across the three matches. Another limitation was the inability to include information regarding acceleration, deceleration or body impacts which have been shown to decline over successive matches in youth players during a tournament (Arruda et al., 2015). Although Prozone provides information on acceleration and deceleration the validity and reliability of these measures are unknown. Given the potential importance of these movements, further investigation of these energetically demanding movements using validated technology (Varley, Fairweather, & Aughey, 2012) is required in successive matches. Finally, as changes in match-running may be due to a range of contextual factors it is difficult to attribute the findings solely to fatigue. It has been suggested that simulated match-play with pre- and post-performance testing may be required to truly quantify fatigue (Carling, Gregson, et al., 2015). However, the current study design allowed control over several contextual factors. First, all matches were played in stadiums unfamiliar to all teams, therefore match location was considered as away for all teams. Second, players who played all group stage matches were from teams that all required a win in their 3rd match to avoid elimination from the tournament.

Practical Applications

- Match-running should not be used in isolation to determine whether players are selected or rested during tournaments.
- Although players largely maintain match-running over successive matches, players should be monitored on an individual basis as game exposure will vary between players.
- Players in attacking roles (forwards and wide midfielders) may be more susceptible to decreases in match-running over successive matches compared to other positions. Coaches may consider rotations or closer monitoring of physical performance and recovery of players in these positions
- Players are capable of maintaining sprint performance over successive matches regardless of playing position

Conclusions

This study investigated match-running performance over successive matches using players from all 16 teams involved in an international tournament. It supports previous research that suggests match-running is largely maintained over successive matches. However, the individualized approach in the analysis suggests that players will respond differently and individualized monitoring is required. Future research should explore the influence of successive matches in both youth and senior tournaments and consider additional physical variables such as acceleration, deceleration and player loads, and subjective, technical and physiological measures.

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Table 1. Match-running distances (m) covered in group stage matches (mean ± standard deviation)

Position	Movement	Match 1	Match 2	Match 3
All Players n=44 From 13 teams	**Total**	10177 ± 730	10266 ± 736	9979 ± 717
	Walking	3359 ± 210	3428 ± 214	3420 ± 214
	Jogging	4055 ± 429	4072 ± 430	3937 ± 417
	Running	1704 ± 362	1686 ± 359	1602 ± 343
	High-Speed Running	719 ± 189	717 ± 188	675 ± 179
	Sprinting	261 ± 98	292 ± 108	265 ± 100
Central Defenders n=15 From 11 teams	**Total**	9625 ± 555	9725 ± 560	9441 ± 545
	Walking	3410 ± 206	3465 ± 209	3449 ± 208
	Jogging	3932 ± 378	3973 ± 382	3847 ± 371
	Running	1454 ± 262	1463 ± 263	1391 ± 252
	High-Speed Running	563 ± 113	565 ± 113	511 ± 105
	Sprinting	191 ± 58	217 ± 63	193 ± 58
Wide Defenders n=14 From 9 teams	**Total**	10324 ± 590	10365 ± 592	10130 ± 580
	Walking	3308 ± 201	3386 ± 205	3391 ± 205
	Jogging	4051 ± 388	4125 ± 395	3965 ± 381
	Running	1790 ± 313	1746 ± 306	1665 ± 294
	High-Speed Running	800 ± 146	766 ± 141	744 ± 138
	Sprinting	332 ± 84	329 ± 84	310 ± 80
Central Midfielders n=7 From 5 teams	**Total**	10875 ± 617	10931 ± 620	10874 ± 617
	Walking	3252 ± 198	3306 ± 201	3262 ± 199
	Jogging	4482 ± 425	4508 ± 428	4443 ± 422
	Running	2085 ± 357	2065 ± 354	2049 ± 351
	High-Speed Running	822 ± 149	807 ± 147	818 ± 148
	Sprinting	237 ± 66	247 ± 68	261 ± 71
Attackers n=8 From 8 teams	**Total**	10371 ± 592	10513 ± 599	9997 ± 573
	Walking	3445 ± 208	3536 ± 213	3550 ± 214
	Jogging	3935 ± 379	3838 ± 370	3665 ± 355
	Running	1761 ± 308	1731 ± 304	1568 ± 279
	High-Speed Running	830 ± 150	870 ± 155	785 ± 144
	Sprinting	336 ± 85	448 ± 105	372 ± 91

Table 2. Frequency of individual changes in match-running in match 3 compared to match 1 and 2 for players who played all group stage matches (n=44). Data is absolute number and percentage of total

	Total	Walking	Jogging	Running	High-Speed Running	Sprinting
Increaser	7 (16%)	9 (20%)	7 (16%)	7 (16%)	8 (18%)	6 (14%)
Stable	23 (52%)	30 (68%)	24 (55%)	19 (43%)	21 (48%)	13 (57%)
Decreaser	14 (32%)	5 (11%)	13 (30%)	18 (41%)	15 (34%)	13 (30%)