Running Title: Pacing strategies in female Australian football

# The influence of contextual factors on running performance in female Australian football match-play

Georgia M. Black[1], Tim J. Gabbett[2,3], Geraldine Naughton[4], Michael H. Cole[1], Rich D. Johnston[1] and Brian Dawson[5]

1. *School of Exercise Science, Australian Catholic University, Brisbane, Queensland, Australia.*

2. *Gabbett Performance Solutions, Brisbane, Queensland, Australia*

3. *University of Southern Queensland, Institute for Resilient Regions, Australia*

4. *School of Exercise Science, Australian Catholic University, Melbourne, Victoria, Australia*

5. *The University of Western Australia, Crawley, Western Australian, Australia*

Address correspondence to:

Ms Georgia Black

School of Exercise Science

Australian Catholic University

1100 Nudgee Road

Brisbane, 4014 AUSTRALIA

Email: georgia.black@acu.edu.au

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**Abstract**

Given the recent growth of the professional status among multiple female football codes, the aim of this study is to investigate the effects of contextual factors on activity profiles and pacing strategies in female Australian football players. Thirty-five female Australian football players participated in this study. Global positioning system analysis was completed over one competitive season. Matches were separated into eight 10-minute periods. Greater distances were covered during the first half irrespective of playing position (ES = 0.39-0.50, Likelihood ≥90%). Throughout a number of periods half-backs (defensive players) covered greater distances during losses (ES ≥0.74, Likelihood ≥92%) and against Top 3 opponents (ES ≥1.0, Likelihood ≥ 97%). Midfielders and half-backs covered greater distances (ES ≥ 0.49, Likelihood ≥89%) in the final match period in winning compared with losing matches. A reduction in player work-rate is evident during the second half of matches. The influence of contextual factors varied across positional groups. However, it is clear coaches could use player rotation both early in the match in an attempt to delay the effect of fatigue and more frequently during the second half to increase running intensity.

*Key words:* Pacing strategies, player work-rate, global positioning systems, match outcome, opposition rank

## INTRODUCTION

The recent development of a national female Australian football (AF) tournament has resulted in a rapid growth of the sport and highlighted the lack of available research concerning the activity profiles of female AF match-play. Although it has been established that activity profiles in team sports can be influenced by numerous contextual factors (1,2) the effect of these factors on female AF players is yet to be investigated. In elite male AF matches, total and high-speed distances covered decline from the first to the fourth match quarter (3). In partial agreement with these results, reduced high-speed activity has been reported as matches progressed without changes in total distance covered across the four match quarters (2). Although the importance of high-speed activity has been documented (4), there is a paucity of evidence providing associations between high-speed running and team success.

In elite soccer matches, total and high-speed running distances were greater when teams played higher quality opposition (5,6). Importantly, losing soccer teams covered greater distances than winning teams, with high-speed distances covered without the ball reported to be a distinctive indicator of soccer performance (5,6). Similar trends have emerged in women's rugby sevens match-play with greater total-, moderate- and high-speed distances covered in matches against the top four opponents compared with the bottom four opponents (1). Furthermore, match activity profiles increased in elite male AF players (2) and women's rugby sevens (1) players in losing compared to winning matches. Interestingly, conflicting results have been reported in elite rugby league, where match demands were greater in winning than losing matches and when competing against lower ranked teams (7). It was suggested that the competitive advantage of successful elite rugby league teams was closely linked to their ability to maintain a higher playing intensity than losing teams. Clearly, the relationship between physical match activities and team success varies depending on the sport in question and team style of play. As such, further studies need to be conducted to investigate the link between high-speed running and performance in team sports.

Although the effect of match results on overall match-play running performance is important, pacing strategies of winning and losing teams have also been explored (8,9). Pacing strategies are well-established in self-paced endurance events (10), and also occur in high-intensity intermittent team sports (8,9). Rugby league matches have been previously separated into 8, ten-minute periods with players from winning teams setting a higher pacing strategy than players from losing teams, with a greater total distance and low-speed distance covered across all periods of the match (8). It was proposed that winning teams set a pacing strategy intended to win the match, while the pacing strategies of losing teams were established based on “survival”. However, interchanged players from losing teams demonstrated an “end-spurt” in the final stages of the match indicative of players increasing their work rates in an attempt to win the game (8).

Although variations in activity profiles between quarters have been investigated (2,11), to our knowledge no research has examined the changes in running intensities within match quarters. Furthermore, as all AF research has been conducted on male performers, there is currently no evidence reporting pacing strategies employed by female AF players across different match stages. Collectively, this highlights the need for research that further develops the understanding of the factors that influence running demands during female AF match-play and examines how match outcomes are influenced by the pacing strategy that is implemented. Therefore, the aim of this study was to identify differences in pacing strategies and activity profiles among female AF match-play, based on game outcome and opponent rank.

## METHODS

### *Experimental Approach to the Problem*

This study used a longitudinal and observational study design to analyse the pacing strategies of female AF players from three teams in the six team Queensland AF competition. Each 20-minute quarter was divided into two 10-minute blocks so that each player had eight periods by the end of the match. Data collected during each match were sub-divided into (1) winning and losing matches and (2) matches played against the top 3 opponents and bottom 3 opponents based on final ladder position.

### *Subjects*

Thirty-five players from the three teams competing in the Queensland Women's Australian Football (QWAFL) recreational league (mean ± SD height, 167.7 ± 4.4 cm; body mass, 67.3 ± 11.2 kg; age, 23.7 ± 5.3 years; Yo-Yo Intermittent Recovery 1 distance, 632 ± 255m; senior playing experience, 3.2 ± 2.0 years) volunteered to participate this study. The teams included in this study were the top three performing teams at the end of the season of interest. Before the study, all players received an information sheet outlining the experimental procedures and the risks and benefits associated with participation. This research was approved by the University's Human Research Ethics board and all subjects were informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study.

*Procedures*

Global positioning system (GPS) analysis was completed during 14 matches (totalling 178 appearances) over the 2016 QWAFL season. Players were separated into midfield, half-back (defensive) and half-forward (attacking) positional groups. For the purpose of this study, full back/forwards, back/forward pockets and ruckmen backs were excluded from the analysis as their activity profiles remained constant over four quarters. Data were removed if players were not on the field for at least 75% of the period. The midfield group was represented by 22 players (*n*=51 winning files; *n*=46 losing files; n=60 top 3 opponent; *n*= 35 bottom 3 opponent). Half-backs consisted of 9 players (*n*=24 winning files; *n*=21 losing files; *n*=30 top 3 opponent; *n*= 17 bottom 3 opponent). The half-forward group comprised 7 players (*n*=20 winning files; *n*=16 losing files; *n*=23 top 3 opponent; *n*=13 bottom 3 opponent). The average win/loss record for the teams included in this analysis was 12 wins (range: 9-14) and 4 losses (range: 2-7) across the season. Activity profiles were examined using GPS units (Catapult Sports, Docklands, VIC, Australia) sampling at 10 Hz. Acceptable validity and reliability of the GPS units (S5, Optimeye, Catapult Sports, Docklands, VIC, Australia) used in this study have previously been reported (12). Prior to the warm-up, the GPS unit was switched on and placed in a pouch of a specifically-designed vest provided by the manufacturer so the unit was positioned on the upper-back, between the shoulder blades. Data were downloaded onto a laptop and analysed using software provided by the manufacturer (Sprint, 5.1.7, Catapult Sports, Docklands, VIC, Australia). Player activity profiles were determined using movement speeds corresponding to low-speed (0-2.78 m.sec-

1), moderate-speed (2.79-4.15 m.sec-1), and high-speed (>4.15 m.sec-1) bands (13). Only active field time was included in the analysis; data corresponding with players interchanging off the field were omitted.

*Statistical Analyses*

The initial statistical approach involved linear mixed modelling to account for dependence arising from repeated measurements of performance variables from individual participants. A separate analysis was completed for game period, match result and opposition rank as the fixed effect in each model, respectively. The random effect of player identity was included in each analysis. Based on the practical application of the results, data were further analysed using Cohen's Effect Size (ES) statistic (14), likelihoods and 90% confidence intervals (CI). The likelihood of a difference between groups equal to or greater than the smallest worthwhile change was estimated as 0.2 x between-subjects *SD* (small ES). The magnitude of difference was considered practically meaningful when the likelihood was ≥75%. The magnitude of differences were then assessed with effect sizes of ≤0.2, 0.21–0.6, 0.61–1.2, 1.21–2.0, and >2.0 considered trivial, small, moderate, large, and very large, respectively (15). A custom Excel spreadsheet (Version 16, Microsoft, USA) was used to report ES and confidence intervals (15). All data were reported as means ± SD and the significance level was set at $p<0.05$.

## RESULTS

*Activity profiles across match*

The average total game demands for each positional group are reported in table 1. Across all positional groups, match demands were greater in the first-half than the second-half of match-play (ES=0.39-0.50 [90%CI: 0.24-1.07], Likelihood 90-99%, $p<0.01$) (Figure 1, A-C). For midfielders, greater relative- (ES ≥0.69 [90%CI: 0.43-1.07], Likelihood = almost certainly, 100%, $p<0.001$) and moderate-speed (ES ≥0.53 [90%CI: 0.26-0.93], Likelihood 98-100%, $p<0.001$) distances were covered during the first and third 10-minute periods compared with periods two and four. High-speed distances were greater for midfielders in period one than period two (ES=0.51 [90%CI: 0.24-0.78], Likelihood = very likely, 97%, $p=0.002$). In the second half (i.e. periods five to eight) no differences were observed in distances covered by this group (ES ≤0.24 [90%CI: -0.10-0.52], Likelihood ≤65%, $p\geq0.850$). In contrast, running performances for half-forwards and half-backs were constant throughout the match (periods 1 to 8) (ES ≤0.13 [90%CI: -0.19-0.46], Likelihood ≤59%, $p\geq0.639$). Furthermore, low-speed distances were similar throughout the match for all positional groups (ES ≤0.16 [90%CI: -0.33-0.65], Likelihood ≤45%, $p\geq0.940$).

***Insert Table 1 about here***

***Insert Figure 1 about here***

*Opposition Ranking*

Midfielders spent a greater time on field (9.9 ± 0.02 *vs*. 9.3 ± 1.5 minutes; ES ≥0.59 [90%CI: 0.14-1.30], Likelihood 92-97%, $p\leq0.04$) and covered greater total distances (1101.3 ± 56.2 *vs*. 1009.4 ± 95.5 metres; ES ≥0.44 [90%CI: 0.03-1.10], Likelihood 87-100%, $p\leq0.02$) during periods 1 to 3 when playing top ranked teams compared with bottom ranked opposition.

Midfielders' relative distance remained constant independent of opposition ranking (ES ≤0.10 [90%CI: -0.34-0.40], Likelihood ≤50%, p≥0.196). Half-backs covered similar high-speed distances across eight periods, independent of opposition ranking (ES≤0.15 [90%CI: -0.73-0.82], Likelihood ≤44%, p≥0.131). From period 1 to period 4, half-backs covered greater relative distances than other positions when playing higher quality opposition (ES ≥1.0 [90%CI: 0.29-1.80], Likelihood 97-99%, p<0.01) (Figure 1). The greater first half demands of the half-backs against top-ranked opponents were matched by a greater amount of distance covered at low- (ES ≥1.1 [90%CI: 0.37-2.0], Likelihood 98-100%, p<0.007) and moderate-speed (ES ≥0.67 [90%CI: 0.03-1.51], Likelihood 87-98%, p<0.05). During the final match period, half-backs covered greater relative (ES=0.94 [90%CI: 0.22 -1.67], Likelihood = very likely, 95%, p=0.02) and low-speed (ES=0.77 [90%CI: 0.08-1.15], Likelihood = likely probable, 92%, p=0.05) distances when competing against higher-ranked opponents.

Although not statistically significant (p = 0.07), half-forwards covered meaningfully greater relative distances during period two against top-ranked opponents (ES=0.56 [90%CI: 0.08-1.43], Likelihood = likely probable, 80%). During periods four (ES=0.73 [90%CI: -0.05-1.43], Likelihood = likely probable, 90%, p=0.05) and seven (ES=0.68 [90%CI: 0.08-1.68], Likelihood = likely probable, 91%, p= 0.05) half-forwards covered greater relative distances against higher standard teams than lower ranked opposition teams (Figure 1). These differences were matched by greater distances covered at high-speed against higher-ranked opponents (ES ≥0.54 [90%CI: 0.03-1.48], Likelihood 82-91%, p<0.05).

*Game Result*

Figure 2 shows the influence of match outcome (winning *vs.* losing) on relative and high-speed distances covered by midfielders, half-backs and half-forwards. High-speed activity remained unchanged across a match in midfielders ($p \geq 0.351$). Winning midfielders covered greater relative- (ES = 0.49 [90%CI: 0.11-0.87], Likelihood = likely probable, 89%, p=0.05) and moderate-speed (ES = 0.54 [90%CI: 0.13-0.89], Likelihood = likely probable, 91%, p=0.03) distances than losing midfielders in the final match period. Losing half-backs had a higher running intensity than winning half-backs across a number of match periods. During periods one (ES=0.95 [90%CI: 0.35-1.54], Likelihood = very likely, 98%, p=0.03), two (ES=0.87 [90%CI: 0.31-1.43], Likelihood = very likely, 97%, p=0.210) and eight (ES=0.74 [90%CI: 0.11-1.37], Likelihood = likely probable, 92%, p=0.141) of matches, losing half-backs covered meaningfully greater relative distances than in winning matches. They also covered greater high-speed distances in losing matches during period one (ES=0.90 [90%CI: 0.25-1.54], Likelihood = very likely, 96%, p=0.03), three (ES=1.06 [90%CI: 0.39-1.50], Likelihood = very likely, 98%, p=0.05), four (ES=0.94 [90%CI: 0.07-1.43], Likelihood = very likely, 98%, p=0.05) and eight (ES=0.75 [90%CI: 0.07-1.43], Likelihood = likely probable, 91%, p=0.06) than in winning matches. For half-forwards, physical match demands were similar across the eight periods regardless of match result ($p \geq 0.454$), with the exception of period 8 where these players covered greater high-speed distances in matches won than matches lost (ES = 0.89 [90%CI: 0.25-1.53], Likelihood = very likely, 96%, p=0.02).

***Insert Figure 2 about here***

**DISCUSSION**

This is the first study to investigate the influence of contextual factors (game period, opponent rank and game outcome) on the activity profiles and pacing strategies of female AF players. Despite all positional activity profiles being reduced following the first half of match-play (periods 1-4) the influence of other contextual factors varied across positional groups. Matches against higher standard opposition led to greater game intensity in half-back/forward players irrespective of match outcome. Half-backs were the only positional group for whom game outcome altered running performance over several match periods. However, during the final period of the total match, midfielders and half-forwards produced a higher work-rate in winning rather than losing matches. These findings suggest that activity profiles, and more specifically pacing strategies, differ across positional groups and are dependent on game outcome and the quality of opposition players.

Match running performance was greater during the first half of match-play for all positional groups, which is consistent with other team sport research (5,16) that has demonstrated decreased match intensity across halves. Collectively, these results are suggestive of match-related fatigue (5) and imply that team sport athletes often adopt a high intensity during the first half of play that is not sustainable for the entire match. Notwithstanding, players may have elicited this positive pacing strategy (17) in an effort to dominate their opposition and perhaps gain an early match lead on the scoreboard.  This finding is in agreement with previous performance profiles of an initial high work-rate followed by a reduction in activity within the middle section of an event during prolonged duration activities (17). During the second half, it is hypothesised that pacing strategies are adjusted in attempt to reduce the effect of match-related fatigue.

This is the first study to separate AF matches into eight match periods. Our findings highlighted an “all-out” or “positive” pacing strategy (18) being implemented by female AF midfielders during the first two quarters. It is possible that, at the onset of quarters 1 and 2, midfielders used a higher work-rate with the knowledge they may be interchanged at some point during the quarter (18). As the quarter progressed, match intensity decreased, which may suggest these players implemented a pacing strategy that they were unable to sustain. Alternatively, in considering the positive association between rotations and match running performance (19), the observed decline in work-rate during the latter stages of the game may suggest that midfielders were not rotated regularly enough, leading to increased player fatigue. Further research investigating the influence of rotation number on running performance in female AF players is warranted.

In contrast to the midfield group, both half-backs and half-forwards maintained running intensity within each match quarter. A possible explanation for this finding is that the midfield group covered approximately 20% greater relative distances during a match than other positional groups. Therefore, the less demanding nature of match-play in the half-back and half-forward positional groups may elicit less fatigue, which allows these players to maintain a consistent running performance within quarters.

One interesting finding from this study was that reductions in match intensity were not due to reductions in low-speed activity. Across the eight periods, low-speed distances remained unchanged for all positional groups. While this result is consistent with findings from one elite AF study (20), the majority of research to date has suggested low-speed activity is reduced in attempt to maintain high-speed activity (21-23). This may be due to poorly developed physical qualities in which players exhibit a larger fatigue response and further results in greater reductions in activity profiles (23).

The influence of opposition ranking varied considerably across positional groups. Greater field time and total distances were recorded for midfielders when playing against higher quality opposition. However, relative match distances were similar irrespective of opposition ranking across all match periods. Given that match intensity was comparable in games regardless of opposition quality, coaches could aim to rotate midfielders more frequently throughout quarters when playing against Top 3 competitors in attempt to increase player work-rate during these matches. During 5 of 8 periods half-backs worked at a greater intensity during games against top 3 opponents. These results are similar to those found in women's Rugby Sevens (1) whose activity profiles increased when competing against higher quality opposition. Interestingly, no differences were reported in running performance between different quality opposition in half-forwards. This finding is difficult to reconcile, although it is possible that differences lie in the number of skill involvements in this positional group between high and low standard opposition (6). However, it may also be that this positional group's ability to find space and "lead" for the football is not influenced by opposition quality.

The half-back positional group exhibited a higher work rate in losing than winning matches. A plausible explanation is that when losing, this positional group is under a greater amount of defensive pressure and subsequently match intensity is increased. As has been previously suggested (2), it may be important to consider strategies of rotating this positional group into a back-pocket position or off the field for short periods of time when losing matches to ensure they can withstand defensive pressures throughout the match. While the activity profiles of half-backs were greater when losing than winning, contrasting results were demonstrated in the midfield and half-forward positional groups. For seven of the eight match periods analysed over each match, no differences were reported between winning and losing midfielders and half-forwards. Consistent with some (24), but not all research (4), our results highlight that an ability to cover greater distances is not necessarily indicative of match success. This finding is not surprising given that previous research (2) has suggested that match success is more dependent on skill involvement and efficiency than greater activity profiles in elite male AF players. However, during the period, when matches were won, these positional groups exhibited an "end-spurt" and covered greater distances compared to losing players. While this finding is in disagreement with previous research (8), it is suggested that rather than lowering physical work-rate in the final match stage, perhaps these players finally gained a competitive match edge that allowed them to find space from their opposing players and increase their running intensity.

Although this study is the first to investigate the influence of contextual factors on running performance in AF match-play, a limitation of this research was the relatively small sample size. It should be noted that all participants were recruited from one recreational competition and therefore may not be representative of all female AF players. Furthermore, only the three top teams in the competition took part in this study so the influence of opposition may differ from bottom placed teams.

The findings of this study demonstrate running performance was influenced by match period, quality of opposition and game results in female AF match-play. All positional groups decreased running intensity during the second half of the match. However, midfielders were more affected by match-related fatigue than other positional groups. Half-backs were the only positional group in whom running intensities were affected by game result and opposition ranking. Greater match intensities were exhibited by half-backs when losing and during matches against higher quality opposition, most likely as a result of greater defensive pressures during these games. This research highlights the importance of understanding contextual factors, and the magnitude of these factors on activity profiles in female AF players in all levels of competition

## PRACTICAL APPLICATIONS

Across all positional groups, match-related fatigue resulted in a reduction of player work-rate during the second half of matches. Coaches could use player rotations early in the match in an attempt to delay the effect of fatigue, especially in the midfield positional group. Moreover, coaches could aim to rotate players more frequently in the second half to allow players to work at a higher match intensity for shorter periods of time.

High-speed running was relatively unaltered by match conditions in this population. However, to aid in the advancement of these players and the women's game, training could focus on developing high-speed running performance and exposing players to high-speed activities in attempt to delay the onset of fatigue.

Greater activity profiles during losses and when competing against high-quality opposition should be taken into consideration when programming recovery and subsequent training, particularly in the half-back players.

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**Figure Captions**

**Figure 1.** Work rates of midfielders, half-backs and half-forwards across eight match periods.

(A) Relative and high-speed distances covered by midfielders; (B) relative and high-speed distances covered by half-backs; (C) relative and high-speed distances covered by half-forwards; (D) relative distances covered by midfielders against top 3 and bottom 3 opponents; (E) relative distances covered by half-backs against top 3 and bottom 3 opponents; (F) relative distances covered by half-forwards against top 3 and bottom 3 opponents; (G) high-speed distances covered by midfielders against top 3 and bottom 3 opponents; (H) high-speed distances covered by half-backs against top 3 and bottom 3 opponents; (I) high-speed distances covered by half forwards against top 3 and bottom 3 opponents.

"S" denotes small effect size difference in relative distance covered compared to first half

*denotes significant difference in relative distance compared to previous quarter

^ denotes significant difference in high-speed distance compared to previous quarter

"s" denotes small effect size difference (0.21-0.60) between top and bottom 3 opponents

"m" denotes moderate effect size difference (0.61-1.19) between top and bottom 3 opponents

**Figure 2.** Comparison of work rates of midfielders, half-backs and half-forwards during matches won and matches lost.

(A) Midfielders relative distance covered; (B) midfielders high-speed distance covered; (C) half-back relative distance covered; (D) half-back high-speed distance covered; (E) half-forward relative distance covered; (F) half-forward high-speed distance covered.

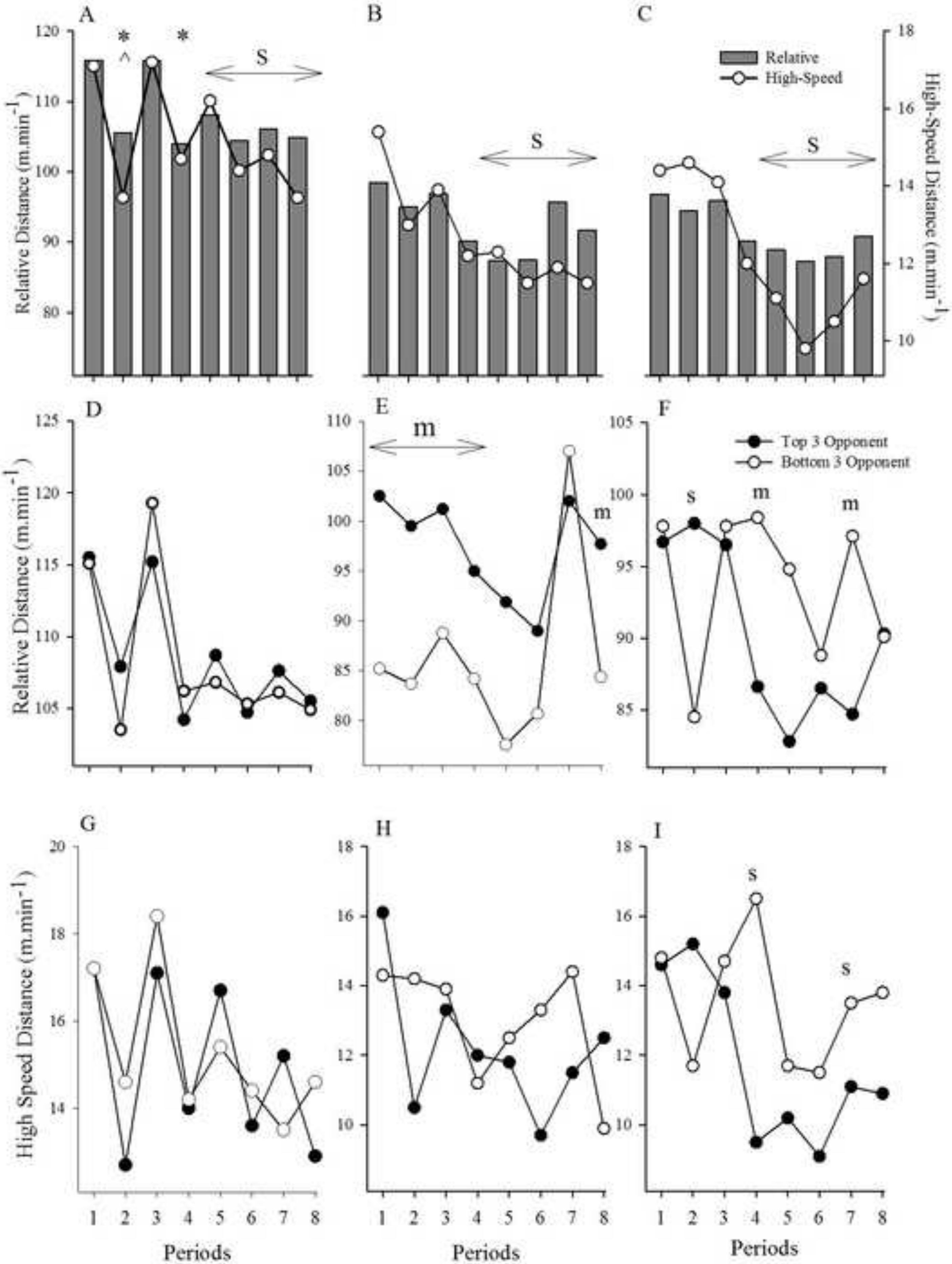
“s” denotes small effect size difference (0.21-0.60) between matches won and lost

“m” denotes moderate effect size difference (0.61-1.19) between matches won and lost

Table 1. Average match demands of female Australian Football match-play.

| | Midfielders | Half-backs | Half-forwards |
|---|---|---|---|
| Field time (min) | 75 ± 7 | 78 ± 5 | 74 ± 8 |
| Total distance (m) | 8087 ± 895 | 7167 ± 1330 | 6706 ± 934 |
| Relative distance ($m.min^{-1}$) | 109 ± 10 | 92 ± 15 | 91 ± 15 |
| Low-Speed distance (m) | 4336 ± 593 | 4278 ± 471 | 4056 ± 643 |
| Relative Low-Speed distance ($m.min^{-1}$) | 58 ± 5 | 55 ± 5 | 55 ± 5 |
| Moderate-Speed distance (m) | 2682 ± 669 | 1915 ± 688 | 1780 ± 404 |
| Relative Moderate-Speed distance ($m.min^{-1}$) | 36 ± 9 | 25 ± 8 | 24 ± 6 |
| High-Speed distance (m) | 1065 ± 341 | 972 ± 413 | 870 ± 228 |
| Relative High-Speed distance ($m.min^{-1}$) | 15 ± 5 | 12 ± 5 | 12 ± 3 |

Data reported as mean ± SD



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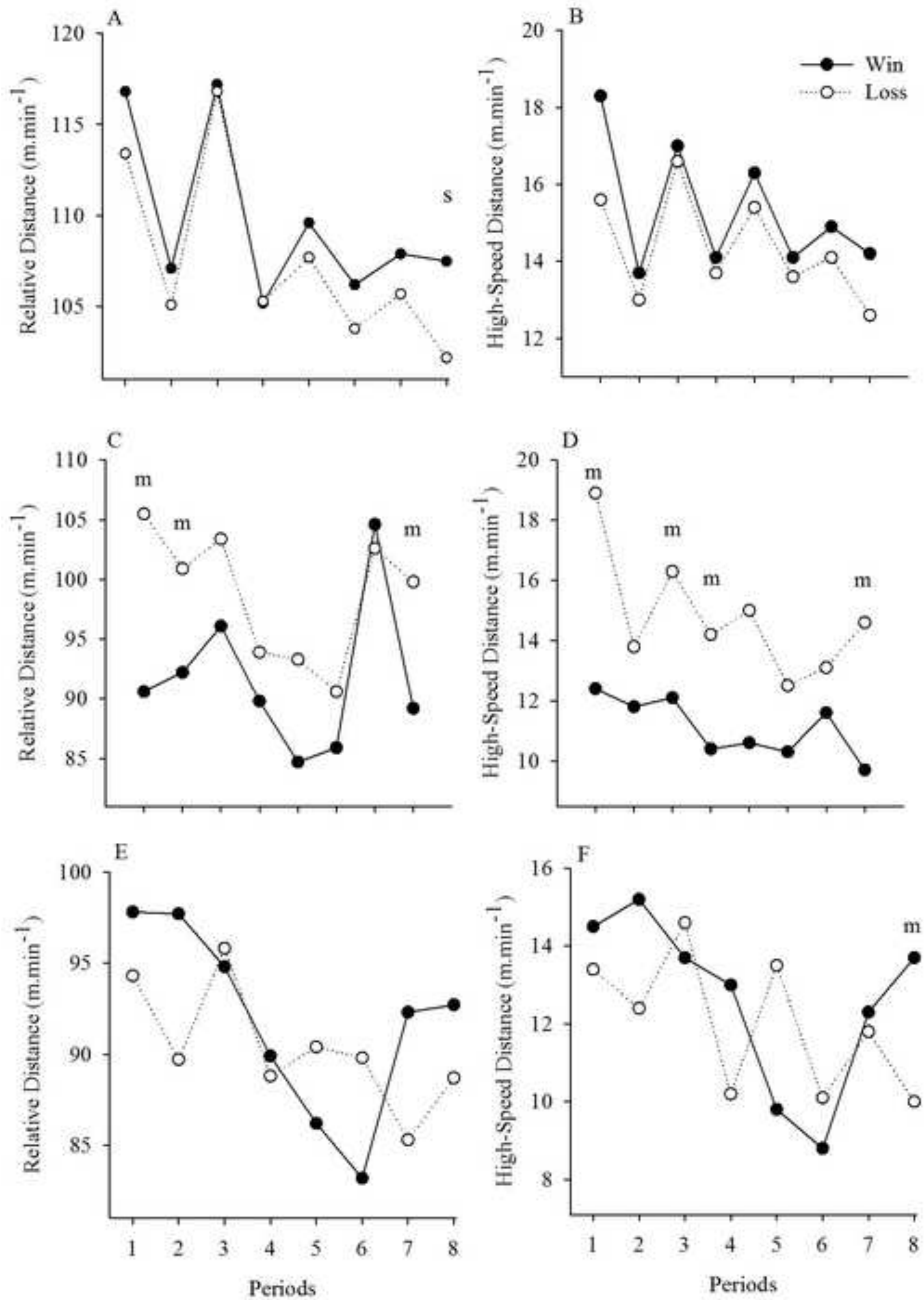

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