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Duration-specific running intensities of Australian Football match-play

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ABSTRACT

Objectives: To establish the position and duration-specific running demands of Australian Football (AF) competition for the prescription and monitoring of specific training drills.
Design: An observational time-motion analysis was performed on 40 professional AF players during 30 games throughout the 2014–15 competitive seasons.
Methods: Player movements were collected and peak values were calculated for moving averages of between 1–10 min in duration for relative distance ($m\,min^{-1}$), high-speed relative distance (HS $m\,min^{-1}$), average acceleration/deceleration ($m\,s^2$) and metabolic power (P_{met}). A mixed-model analysis was used to detect positional differences, and differences were described using a magnitude-based network.
Results: Relative distance was *likely* greater for midfielders (MID), and mobile forwards (MF) compared to tall backs (TB) across all moving average durations assessed, with MF peaking at $223 \pm 35\,m\,min^{-1}$ for a 1-min window. High-speed relative distance was at least *likely* to be greater for MF compared to all other positions, across all moving average durations (ES = 0.27–0.94). Acceleration/deceleration demands were similar across positions.
Conclusions: The present study demonstrated that the peak running intensities of AF are well above previously reported peak intensities when considering the distance-based running requirements of match-play. Whilst the acceleration-based metric was unable to detect large differences between positions, it is important to note their contribution to the overall competition demands. This study presents a useful framework for the prescription and monitoring of drills specific to AF competition requirements.

1. Introduction

Australian Football (AF) is an intermittent team sport where both high velocity running and high intensity accelerations/decelerations are important.[1] Global Positioning System (GPS) units are permitted to be worn during competition and are used by all teams competing within the Australian Football League (AFL),[2] resulting in extensive research quantifying the physical demands[2–4] and energetic costs of match play.[1] Of particular interest is the assessment of the peak periods of activity during competition, as previously demonstrated in rugby league.[5] Amongst AF players, it has been shown that less experienced players elicit a greater reduction in physical and technical performance following the most intense periods of the game compared to their more experienced counterparts.[3] Knowledge of the peak physical demands of elite match-play allows coaches to prepare players for the most demanding requirements of competition. This is highly relevant in the prescription of game based training methodologies, for example small sided games or conditioning games, that are aimed at mimicking the physical and tactical demands of competition.[6] The intensity of such training can then be referenced against these peak periods of activity to ensure the players are adequately prepared for the rigours of competition.

Previous research has attempted to identify the peak periods of match play using time and/or distances within specific velocity bands,[1,2,4] or volume of work performed within a discrete

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time frame (e.g., 3-min block).[3] There is an inconsistency between studies regarding the classification of speed zones, and therefore comparisons between studies are often difficult. Further, the use of pre-defined time periods has been shown to substantially underestimate the peak running demands of soccer competition by >20–25% compared to when using a moving 5-min average technique.[7] This error occurs as a result of the peak period not falling completely within the discrete time frame used, and such discrepancies in results could lead to coaches underpreparing athletes for the most intense periods of team sport competition.[7] Therefore, it would seem that a moving average method may be a more appropriate for outlining the most demanding periods of match play.

Throughout a match, AF players typically cover distances of ~13 km at average intensities of up to 128 m min^{-1}, depending on position.[1] Furthermore, these players cover substantially more distance at high speed (>5.5 m s^{-1}) per minute of match play compared to both rugby league and soccer players.[8] However, given the fluctuating nature of team sport running demands,[9] whole-match averages do not reflect the intensities reached at pivotal moments throughout the match.[10] Recent research has established the most intense periods of rugby league competition using a moving average technique across a range of durations (1–10 min).[5,11] These studies demonstrated a substantial increase in running intensity as the length of the moving average decreased, indicative of a fluctuating running profile of professional rugby league players. Given the considerable running demands imposed on professional AF players,[2–4] it would seem beneficial to replicate these methods amongst such a cohort, to ascertain the peak running intensities these athletes are exposed to throughout match play.

Within team sports, particularly the collision–dominant sports, players are often not afforded the opportunity to reach maximal velocity due to spatial constraints imposed by field dimensions or opposing players.[12] Therefore, the ability to generate speed over a short distance or duration is vital for successful field sport performance.[13] Despite the uncertainty surrounding the reliability of GPS for assessing acceleration/deceleration demands,[14] the evaluation of these efforts is common in a team sports such as AF.[1,15] Furthermore, the metabolic power (P_{met}, W kg^{-1}) metric has recently emerged as a useful tool in quantifying the movement demands of team sports, accounting for both high-speed running, and acceleration and deceleration that often occurs at low speeds.[16,17] Whilst the validity of this measure for quantifying the true physiological cost of team-sports activity has been recently challenged,[18–20] this measure exhibits considerable stability,[21] and therefore may provide further insight into the external running demands of team sports, regardless of the metabolic cost of the activity. Indeed, when considering whole-match values, this measure has been utilized to differentiate positions during AF match play.[1] It may be the case that such differences are magnified when considering the peak demands of competition, and therefore a moving average method analysis to detect peak intensities beyond whole-match averages is warranted. The purpose of this investigation was to establish the duration-specific peak running intensities of elite AF competition to be used in the prescription and monitoring of an appropriately periodized program.

2. Methods

An observational design was used to establish position-specific distance and acceleration-based movement indicators for professional AF players. Data were collected from 40 professional AF players (age 24 ± 3 year, mass 87.9 ± 5.4 kg, height 1.91 ± 0.04 m) playing for the same club during 30 matches across the 2014 and 2015 AFL competitions (16 wins, 14 losses). Between matches, a typical training week generally consisted of 3 field sessions, 3 resistance sessions and 3 recovery-based sessions. The total number of match observations was 623, and the mean (±SD) number of observations per player was 16 ± 10 (range 1–29). Players were classified into positions as midfielders (MID), mobile backs (MB), mobile forwards (MF), rucks (RKS), tall backs (TB) and tall forwards (TF), and the total observations per positional group were 235, 128, 94, 37, 71 and 58, respectively. Informed consent and institutional ethics approval were obtained prior to the commencement of the study (HREC no: H-2013-0283).

The movement demands of competition were assessed using a portable GPS unit, sampling at 10 Hz (Catapult S5, Catapult Innovations, Melbourne, Australia). The unit was worn in a custom-made pouch fitted into the player's jersey, positioned on the upper back, slightly superior to the scapulae. To minimize inter-unit error,[14] each player was assigned the same unit for the entire season. The validity and reliability of these units has been previously reported.[21,22] Upon completion of each match, data were downloaded using the necessary proprietary software (Openfield v.1.12.0, Catapult Innovations, Melbourne, Australia). This software provided instantaneous velocity data (m s^{-1}), which was then re-imported into customised software (R; v R-3.1.3) for further analysis. Firstly, this software calculated the distance covered by each athlete, per unit of time (relative distance; m min^{-1}), and distance covered at high-speed (relative distance >5.5 m s^{-1}; HS m min^{-1}). The instantaneous acceleration/deceleration of the participant was calculated using the rate of change in velocity, and all values were made to be positive, providing an indication of the absolute acceleration/deceleration requirements (AveAcc). This whole-period average was chosen in preference to a traditional count method, where efforts that do not reach the desired threshold remain unquantified despite incurring some degree of physical cost. Whilst a limitation of this method may be that the ability to differentiate between acceleration and deceleration using this metric, this method allows for the incorporation of all data points, regardless of the magnitude. Next, P_{met} was derived using a series of calculations, the details of which have been reported previously.[16,17] Finally, the software applied a moving average over each output variable (relative distance, HS relative distance, average acceleration/deceleration and P_{met}), using ten different durations (1–10 min), and the maximum value for each duration was recorded (10 durations for each of the four variables).[11] Data was then collated and averaged for each playing position, for between-position comparisons.

Assumptions of normality were confirmed prior to statistical analyses using the Shapiro–Wilk test. Linear mixed-effects models were constructed to establish differences in individual running performance between position (n = 6) and moving average duration (n = 10). To account for error associated with repeated measures from the same athlete, individuals were included as a random effect in the model, allowing different within-individual standard deviations. The effect of positional group on running intensities of each duration was determined by including a fixed effect in the model. Additionally, the interaction of the teams ranking and opposition ranking were accounted for in the model also by fixed effects, which were retained if statistical significance (p < 0.05) was reached and improved the model criteria. If these were not achieved, the interaction was removed from the model. For pairwise comparisons between positions and moving average durations, the post-hoc Least Squares mean test was used. A magnitude-based inference network (REF) was used to identify differences that were greater than the smallest worthwhile difference (SWD), calculated as 0.20 × the between-subject standard deviation. Standardized differences were classified according to Hopkins et al.[24] as small (>0.2), moderate (>0.6), large (>1.2) and very large (>2). Differences were considered real if the likelihood of the observed effect