Ade, J, Fitzpatrick, J and Bradley, PS

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Article

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High-Intensity Efforts in Elite Soccer Matches and Associated Movement Patterns, Technical Skills and Tactical Actions. Information for Position-Specific Training Drills.

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Abstract

This study aimed to translate movement patterns, technical skills and tactical actions associated with high-intensity efforts into metrics that could potentially be used to construct position-specific conditioning drills. Twenty individual English Premier League players high-intensity running profiles were observed multiple times (n=100) using a computerised tracking system. Data were analysed using a novel High Intensity Movement Programme across five positions (centre back, full-back, central midfielder, wide midfielder and centre forward). High-intensity efforts in contact with the ball and the average speed of efforts were greater in wide midfielders than centre backs, central midfielders and centre forwards (ES: 0.9-2.1, $P<0.05$). Wide midfielders produced more repeated efforts than centre backs and central midfielders (ES: 0.6-1.3, $P<0.05$). In possession, wide midfielders executed more tricks post effort than centre backs and central midfielders (ES: 1.2-1.3, $P<0.01$). Full-backs and wide midfielders performed more crosses post effort than other positions (ES: 1.1-2.0, $P<0.01$). Out of possession, centre forwards completed more efforts closing down the opposition (ES: 1.4-5.0, $P<0.01$) but less tracking opposition runners than other positions (ES: 1.5-1.8, $P<0.01$). Centre forwards performed more arc runs before efforts compared to centre backs, full-backs and wide midfielders (ES: 0.9-1.4, $P<0.05$), however centre backs completed more 0-90° turns compared to full-backs, central midfielders and wide midfielders (ES: 0.9-1.1, $P<0.01$). The data demonstrate unique high-intensity trends in and out of possession that could assist practitioners when devising position-specific drills.

Introduction

Soccer is a highly intermittent sport with a myriad of physical, technical and tactical parameters contributing to team performance (Stølen, Chamari, Castagna, & Wisløff, 2005). The physical demands of elite match-play have substantially increased in the last decade (Bradley et al., 2015) and thus the need to optimise a player's physical capacity using running and soccer based drills has received increasing attention (Ade, Harley & Bradley, 2014; Gunnarsson et al., 2012; Ingebrigtsen et al., 2013). Despite a plethora of research, only one study has used performance data in the form of the most intense match-play period to configure a soccer-specific high-intensity training drill (Kelly et al., 2013). The drill not only produced a greater mean heart rate response than small-sided games but also showed less inter-player variability. Although the physical stimulus was soccer-specific, no technical and tactical match data were used in the drill construction despite these been discriminatory factors between competitive standards (Bradley et al., 2013, 2015) and thus should be considered when developing highly specific game based drills.

Positional variation in match performance parameters is a robust finding within the research literature. Typically, wide midfielders cover the most high-intensity running during a match (Bradley et al., 2009; Dellal et al., 2010; Di Salvo et al., 2009). When data are expressed relative to the total distance covered in a match, full-backs cover the greatest proportion of high-intensity running with central midfielders performing the most frequent efforts with limited recovery (Carling, Le Gall & Dupont, 2012). From a technical perspective, forwards and central midfielders have more touches per ball possession with central midfielders performing and completing more passes (Redwood-Brown, Bussell & Bharaj, 2012; Taylor, Mellalieu & James, 2004). Although these findings have implications for developing specific training drills that mimic positional characteristics (Bush et al., 2015), limited research has actually translated the unique technical and physical positional demands into drill construction metrics. Bloomfield et al., (2007) is the only study that has quantified the movement and technical demands of various positions during elite match play using a valid classification system that could be applied to training. For instance, midfielders performed fewer 0-90° turns and spent less time standing and shuffling than other positions. While defenders spent less time sprinting than midfielders and forwards but greater time travelling backwards. Although the technical analysis was basic it highlighted forwards performed less long passes with midfielders performing more short passes. This information is translational if separate drills for each position are constructed either as a rehabilitation session or isolated drill (Van Winkel et al., 2013). However, additional information on high-intensity and technical actions in conjunction with pitch location, possession status, combination play and tactics would be advantageous for drill construction. This would allow practitioners to condition a number of positions simultaneously using combination drills incorporating game- and position-specific ball work (Van Winkel et al., 2013). This approach seems to be more effective in the applied environment due to player enjoyment and coach acceptance (Hill-Hass et al., 2011). Therefore, the aim of this study was to translate movement patterns, technical skills and tactical actions associated with high-intensity efforts into metrics that could be used to construct position-specific conditioning drills.

Methods

Match Analysis and Player Data

Match performance data were collected from a single English Premier League club across consecutive seasons (2010-11 to 2013-14) using a computerised tracking system (AMISCO Pro®, Sport-Universal Process, Nice, France). Players' activities were captured during matches by cameras positioned at roof level and analysed using proprietary software. The validity of this tracking system has been previously verified (Rodriguez de la Cruz, Croisier, & Bury, 2010; Zubillaga, 2006) and has been shown to detect performance decrements during a soccer match (Randers et al., 2010) while a similar optical tracking system has reported excellent correlations (r = 0.999) with average speed measured using timing gates (Di Salvo et al., 2006). Ethical approval was obtained from the appropriate institutional ethics committee and permission to publish was granted by the professional club and match provider.

Twenty individual players were observed multiple times and analysed across five positions: centre back (CB: n=4, observations=20), full-back (FB: n=4, observations=20), central midfielder (CM: n=4, observations=20), wide midfielder (WM: n=4, observations=20) and centre forward (CF: n=4, observations=20). These observations were obtained from 46 home games (22 wins, 9 draws, 15 defeats with an average ball possession of 52±6%), using only home matches ensured that a camera was always accessible to provide a wide-angle full pitch recording of all players throughout matches. Match data were only included for analysis if: (1) players complete the entire match and remained in the same position, (2) both teams finished matches with 11 players, (3) the score differential was <3 and (4) the team used typical formations (4-4-2 or 4-5-1).

High-Intensity Efforts

High-intensity efforts were defined as activities reaching speeds >21 $km \cdot h^{-1}$ for a minimum of 1 s (Bradley et al., 2014; Castellano, Blanco-Villaseñor & Alvarez, 2011; Dellal et al., 2010). The frequency, distance covered, duration and average speed of high-intensity efforts were analysed in addition to the recovery time between efforts. Furthermore, repeated high-intensity efforts (RHIE) defined as a minimum of two efforts separated by a maximum of 20 s were reported (Gabbett, Wiig & Spencer, 2013).

High-Intensity Movement Programme (HIMP)

Movements associated with each high-intensity effort were analysed using video recordings provided by AMISCO® and a wide-angle recording of all players throughout matches. Each effort was linked to a recording that could be viewed at 0.5 × normal speed. To aid position-specific drill design, a High-Intensity Movement Programme (HIMP) was devised. Similar to previous work, the HIMP reported turning angles and ball-based high-intensity activities (Bloomfield et al., 2004). However, unlike other research, activities were quantified in (IP) and out of ball possession (OP) and were broken down into pre, during and post efforts. The HIMP consisted of five major categories: (1) Movement Patterns, (2) Pitch Location, (3) Technical Skill, (4) Tactical Actions and (5) Combination Play. The categories are summarised in Table 1. with the exception of pitch location.

The pitch location of a player before and after each effort was calculated using a grid generated from the AMISCO® software. Pitch length was divided into thirds to establish defensive, middle and attacking zones while central areas of the pitch were equal to the width of the penalty box with the remaining areas considered wide.

A similar technology used by Prozone called MatchViewer has been found to be reliable and valid when reporting pitch location of technical events with a mean absolute error 3.6 m (Bradley et al., 2007). Player location was established using the time period and exact duration of the effort provided by the AMISCO® software. In contrast, movement patterns, technical skills, combination play and tactical actions were coded using the video recordings allowing an additional 3 s before and after each effort.

Inter-reliability was assessed by two observers coding one player for each position (n=5) from randomly selected games (n=5). Two familiarisation sessions were conducted to understand the coding process and discuss the HIMP descriptions. The observers had access to the HIMP descriptions throughout the process (Table 1). Intra-reliability assessment was conducted by one observer coding a randomly selected match and player five times. A minimum of seven days separated each observation. All data analyses were conducted independently in a quiet office for a maximum period of 2 h with breaks every 30 min to ensure optimal concentration levels (Atencio, 1996; Bloomfield et al., 2007). All five major categories of the HIMP were analysed as a complete data set and reported excellent inter- and intra-observer agreement (k>0.8 and >0.9, respectively).

Statistical Analysis

Data analyses were conducted using software (SPSS, Chicago, IL, USA) and z-scores were calculated to verify normality. One-way ANOVA's explored positional differences and Bonferroni post hoc tests identified localised effects. Statistical significance was set at $P<0.05$. Effect sizes (ES) were calculated to determine meaningful differences with magnitudes classed as trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0), and very large (>2.0-4.0; Batterham & Hopkins, 2006). Intra-positional match-to-match variability was examined using the coefficient of variation (CV) for each variable. Values are presented as mean and standard deviations unless otherwise stated.

**** Table 1 near here ****

Results

High-Intensity Efforts

CB performed less high-intensity efforts and had longer recoveries between efforts than other positions (ES: 1.1-1.6, $P<0.05$; Table 2). FB and WM covered greater distance during efforts compared to CB (ES: 0.7-1.1, $P<0.01$). The number of efforts in contact with the ball and the average speed of efforts were greater in WM than in CB, CM and CF (ES: 0.9-2.1, $P<0.05$). WM produced more repeated efforts than CB and CM (ES: 0.6-1.3, $P<0.05$). Moderate mean intra-positional variation (CV=10.0%) was reported for the number of efforts in contact with the ball. Very large intra-positional variation was evident for the number of HI efforts, the recovery time between efforts, and number of RHIE (CV > 30.0%, 24.7%, 55.8%, respectively).

**** Table 2 near here ****

Movement Patterns

In possession, FB completed a lower percentage of arc runs before high-intensity efforts compared to CM (ES: 1.1, $P<0.01$, Table 3). Out of possession, CF performed more arc runs before efforts compared to CB, FB and WM (ES: 0.9-1.4, $P<0.05$), however CB completed more 0-90° turns before efforts compared to FB, CM and WM (ES: 0.9-1.1, $P<0.01$). FB executed a greater percentage of 90-180° turns before efforts compared to CB, CM, WM and CF (ES: 0.8-2.2, $P<0.05$). Out of possession, CF completed a greater proportion of arc runs than CB and FB (ES: 0.8, $P<0.05$) with CF also executing more arc runs post effort than CB, CM and WM (ES: 0.9-1.4, $P<0.01$). CB completed a greater proportion of 0-90° turns after efforts than FB (ES: 1.4, $P<0.05$). Large to very large intra-positional variation was reported for all movement patterns performed IP and OP (CV >11.1%).

**** Table 3 near here ****

Pitch Location

Inter-positional differences are presented in Table 4. In possession, all positions started the majority of efforts in the middle third of the pitch in central locations, though FB finished almost equal efforts in wide areas. CB and CM finished most efforts in the middle third of the pitch while FB, WM and CF finished most efforts in the attacking third. CB, CM and CF finished most efforts in central locations. FB finished most efforts in wide locations while WM finished an almost equal number of efforts in central and wide areas. Out of possession, all positions started most efforts in the middle third of the pitch and in central locations. CB and FB finished most efforts in the defensive third of the pitch, WM and CF finished most efforts in the middle third of the pitch while CM finished an equal number in the defensive and middle thirds. Moderate to very large intra-positional variation was reported for the start and end location of HI efforts (CV >8.9%).

**** Table 4 near here ****

Technical Skills

In possession, CB performed a greater proportion of long passes post high-intensity effort than WM and CF (ES: 0.7, P<0.05, Table 5). WM executed more tricks post effort than CB and CM (ES: 1.2-1.3, P<0.01). FB and WM performed more crosses post effort than other positions (ES: 1.1-2.0, P<0.01). Out of possession, CF performed less tackles post effort than FB, CM and WM (ES: 1.1-1.8, P<0.05). Very large intra-positional variation was reported for technical skills performed before and after HI efforts (CV >59.9%).

**** Table 5 near here ****

Tactical Actions

In possession, CF performed a greater percentage of high-intensity efforts breaking into the box than other positions (ES: 0.7-1.1, P<0.05) but ran with the ball less compared to FB and WM (ES: 1.3, P<0.05, Table 6). FB produced more overlapping runs than all positions (ES: 0.8-1.9, P<0.01). Out of possession, CF completed more efforts closing down the opposition (ES: 1.4-5.0, P<0.01) but less tracking opposition runners than other positions (ES: 1.5-1.8, P<0.01). WM and CF had fewer efforts covering the opposition than other positions (ES: 1.4-1.8, P<0.01) WM performed more recovery runs than other positions (ES: 0.9-2.4, P<0.01). Very large intra-positional variation was reported for tactical actions IP and OP (CV >31.8%).

**** Table 6 near here ****

Combination Play

WM received a greater percentage of passes from CM pre high-intensity effort than CB (ES: 0.8, $P<0.05$, Table 7) and more passes from CF than CB and FB (ES: 0.9-1.0, $P<0.01$). WM performed a greater percentage of passes to FB pre effort than other positions (ES: 0.8-1.1, $P<0.01$). CB received more passes from CM (ES: 0.7, $P<0.05$) and performed more passes to the goalkeeper than CM, WM and CF post effort (ES: 0.7, $P<0.05$). Very large intra-positional variation was reported for combination play pre and post HI effort (CV >77.5%).

**** Table 7 near here ****

Discussion

The present study revealed position-specific trends for high-intensity efforts with special reference to movement patterns, pitch location, technical skills, tactical actions and combination play. Similar to previous research indicating match-to-match variability of physical and technical metrics are high to very high (Bush et al., 2015; Carling, Bradley, McCall & Dupont, 2016; Gregson et al., 2011) the HIMP displayed moderate to very high intra-positional match-to-match variability. Nonetheless, the objective data provides additional information for practitioners wishing to design position specific drills. Various permutations of this data could allow this information to be translational. For instance, applied scientists could potentially create high-intensity combination drills in which all positions are worked in unison with game- and position-specific ball work present (Van Winkel et al., 2013). A starting point for drill development is to quantify position-specific trends in high-intensity metrics and the present data demonstrated that CB had the longest recoveries between consecutive high-intensity efforts, which concurs with previous research (Carling et al., 2012). The disparity in recovery times between studies (271 vs 195 s) is probably related to the differing high-intensity speed thresholds used (>21 vs 19.7 $km \cdot h^{-1}$). Moreover, WM produced more repeated high-intensity efforts compared to CB, CM and CF and these efforts were longer in distance and duration. Although some literature exists for comparative purposes, evaluating trends is problematic due to variations in the methods adopted across studies (Barbero-Alvarez et al., 2014; Carling et al., 2012; Gabbett et al., 2013). Despite this, the duration and distance of efforts across positions are valuable prescription metrics when constructing combination drills, particularly when considered relative to one another. However, practitioners should be aware that the data reported in the present study are means and if overload is desired then players need to be conditioned to 'worst case scenarios' such as those reported during intense match-play periods (Di Mascio & Bradley, 2013) or using predefined work-rest ratio from the literature (Iaia & Bangsbo, 2010; Iaia, Rampinini & Bangsbo, 2009).

Positional differences in pitch location during high-intensity efforts are expected due to distinct tactical roles (Wilson, 2008). The data demonstrates that in possession WM drive inside the pitch at high-intensity more than CB, FB and CM, performing an equal percentage of efforts in central and wide locations, which agrees with the most recent tactics outlined by the Football Association (FA) (Bate & Peacock, 2010). Supported by previous findings (Hughes et al., 2012; Van Lingen, 1997), FB and WM performed more crosses after runs than other positions due to efforts finishing in wide attacking pitch areas. Typically, WM perform efforts with the ball, which aligns with recommendations by the FA for WM to attack with the ball in 1 vs 1 situations (Bate & Peacock, 2010). CF finished more efforts in the attacking third of the pitch while driving through the middle, running in behind or breaking into the opposition box. Such tactics are required to exploit space in order to score and create space for teammates (Bangsbo & Peitersen, 2004).

Out of possession, all positions begin most efforts in the central and middle third of the pitch. All positions finished the majority of efforts in central locations with the exception of WM that finished in wide areas possibly due to tracking back with the opposition FB. The location of efforts across positions when out of possession is consistent with the coaching literature that suggest players should remain narrow and compact to limit space for the opposition (Bangsbo & Peitersen, 2002; Hughes, 1994). For effective drill design on a full-sized pitch, the start and end location of efforts could be replicated to enhance the ecological validity of drills. Thus, duplicating position-specific in and out of possession scenarios but with overload. For example, the FB starts an effort in the defensive third before overlapping the WM, to receive a pass in the wide attacking third to perform a cross. Simultaneously the CF breaks into the box to score while being tracked by the CB both having started in the middle third of the pitch. The CM drives through the middle of the pitch performing an arc run to support the attack ending with a possible shot on goal.

Movement patterns associated with efforts during possession highlight CM and WM perform more arc runs before efforts compared to FB. This may be due to the fact FB start more efforts in wide areas of the pitch compared to midfielders that are in more congested central locations (Bush et al., 2015 Tipping, 2007). However, FB did perform more arc runs during efforts in possession than WM, possibly due to overlapping runs. CF performed more arc runs after efforts compared to CB and FB possibly to remain onside when trying to run in behind the opposition or recovering position during a misplaced pass. Although no positional differences were evident for 0-90° turns preceding efforts in possession, this is an important drill design metric due to its prevalence (>32%). When supporting play, discrete changes of direction are required to evade an opposition player or to find space to receive a pass (Bate & Jeffereys, 2014). Another movement to consider in drills after efforts in possession would be 0-90° turns for WM (37%) and CF (35%). This is possibly related to reacting to a second phase of the attack or to evade an opposition player to receive a pass or create space to shoot (Bate & Peacock, 2010). CB performed more 90-180° turns when recovering back into position. Furthermore, a swerve occurs in >33% of efforts across all positions and should therefore be considered when designing in and out of possession position-specific conditioning drills. Swerves are often referred to as slaloms when performed as part of a conditioning drill and are necessary to evade players or simply to advance up the pitch in congested areas (Bate & Jeffereys, 2004).

Out of possession, CF performed more arc runs than CB and FB before, during and after efforts. This could be due to channeling an opponent with the ball one way while closing them down in order to delay their attack and enable teammates to support the press (Michels, 2001). However, only post effort occurrence was >30% and it should also be acknowledged that CF only perform 32% of efforts out of possession. CB performed more 0-90° turns pre and post efforts compared to FB and CM and due to its occurrence (>39%) should be considered when designing positional drills out of possession. Most efforts performed by CB out of possession are anticipated with players already on a half turn as sudden directional changes are necessary to react to opposition movement (Bangsbo & Peitersen, 2002). FB performed more 90-180° turns pre efforts compared to others with an occurrence of 32% often transitioning from attack into defence in order to perform a recovery run. Previous research examining positional demands of Premier League soccer matches reported no differences performing arc runs across playing positions but did report midfield players performed less 0-90° turns and swerves than defenders and forwards (Bloomfield et al., 2007). However, direct comparisons to the present study are not possible as the data was from 15-min of general play rather than isolated efforts over a full match and it did not account for whether players were in or out of possession.

In possession, CB performed more long passes after efforts than WM and CF, supporting previous research (Van Lingen, 1997). Although the percentage of efforts performed before a long pass is low (8%) the intra-position mean standardised difference was large compared to other technical skills (>1.2 SD). Direct comparisons are not possible, but research supports these findings as defenders and midfielders performed more long passes than forwards during matches (Bloomfield et al., 2007). In the present study, WM performed more tricks than FB and CF pre effort and CB, CM and CF post effort. Although overall percentage of efforts was again low pre and post effort (4 and 6%, respectively), intra-position differences pre effort were large (>1.2 SD). Tricks are required to beat an opponent in 1 vs 1 play and should be demonstrated by WM to create goal-scoring opportunities (Hughes et al., 2010; Wiemeyer, 2003). When employing intra-position mean standardized differences (>0.6 SD) as criteria to identify key components during drill design, CF and CM should perform a shot on goal, CF and CB should execute a header, while FB and WM should deliver a cross post high intensity effort. All of the above mentioned technical skills are identified as key attributes for the relevant positions within the coaching literature (Bangsbo & Peitersen, 2004; Bate & Peacock, 2010;

Hughes, 1994; Hughes et al., 2012; Van Lingen, 1997; Wiemeyer, 2003). Out of possession, FB performed more tackles and headers post effort, which are key defensive indicators (Hughes et al., 2012) despite being infrequent (3 and 9%, respectively). In contrast, Mohr et al. (2003) reported in a sample of Italian and Danish players that FB performed less tackles and headers than other positions. The discrepancies between findings may be due to quantifying general match play rather than isolated efforts, different playing styles between the leagues and failure to quantify skills in or out of possession.

Although the overall percentage of combination play between positions pre and post efforts was generally low (<13 and <20%, respectively) intra-position mean standardised differences could be used to prescribe the most likely scenario when designing drills to incorporate passing sequences. Though not interlinked, the data details that pre effort, CB received more passes from the goalkeeper and completed the greatest percent of passes to WM, while post effort, CB received more passes from CM and completed the greatest percent of passes to WM. The combination play reported for CB is supported by large intra-position differences relative to all other positions. This process can be implemented for each position in which all combination plays are supported by intra-position mean standardised differences considered at least moderate (>0.6 SD). This data allows practitioners to easily prescribe isolated positional drills, however, position-specific combination drills require both objective data and the art of coaching.

The reader should be aware of the present study's limitations. Due to the high match-to-match variability practitioners should apply the HIMP on their own data due to unique individual physical profiles and team's style of play, which can impact match performances (Bradley et al., 2011). Moreover, using distances covered during high-intensity efforts is one-dimensional when attempting to determine the demands of match-play as it does not quantify metabolically taxing activities such as acceleration and decelerations (Varley & Aughey, 2013).

The information provided in the present study is not intended to dictate the methods of the soccer coach but to help practitioners condition players in the absence of a coach led training session. The authors acknowledge the implications of a hypothetico-deductive method where the complexities and unpredictability of soccer is oversimplified (Mackenzie & Cushion, 2013), however such information can transfer to drill construction during the rehabilitation process when it is necessary to increase physiological load using controlled drills incorporating soccer specific movement patterns and skills (Van Winkel et al., 2013). As the player progresses through the rehabilitation process the drills should become more reactive in nature to better simulate the complex nature of the sport in preparation to train with the squad (Adams et al., 2012; Gleason, Kramer & Stone, 2015). That said, soccer players perform training drills during pitch based recovery sessions working on patterns of play which are predictable, however as with the proposed conditioning drills, the execution of technical skills require players to be reactive and engage in some form of decision making (Delgado-Bordonau & Mendez-Villanueva, 2012).

If the philosophy of the practitioner is to overload one component of fitness as in supra-maximal training using high-intensity running, the data in the present study could be advantageous. Should high-intensity running drills be designed on the information in this paper, the work to rest ratio and method of recovery between efforts can be manipulated to target different physiological energy systems (Buchheit & Laursen, 2013, Iaia & Bangsbo, 2010). The data from the present paper is not meant to act as a prescriptive recipe but to help inform fitness staff of the most common soccer actions associated to high speed running. Therefore, the present data can be implemented into isolated position-specific drills during rehabilitation or additional conditioning. However, the skill of the practitioner is to design combination drills to train a number of positions simultaneously while ensuring variation for motivation and decision making to represent the game. Future research should aim to quantify mechanical loading during intense match play to provide guidelines for appropriate training methods.

Conclusion

The data demonstrate unique position-specific trends that should help practitioners devise positional drills and thus help to bridge the gap between scientific research and practical application, however the high math-to-match variability of the HIMP categories needs to be acknowledged.

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Table Legends

Table 1. High Intensity Movement Programme (HIMP).

Table 2. Physical data for high-intensity efforts and repeated high-intensity bouts across positions.

Table 3. Movement patterns performed pre, mid and post high-intensity effort in and out of possession across positions.

Table 4. Pitch location of high-intensity efforts in and out of possession across positions.

Table 5. Technical skills performed pre and post high-intensity effort in possession and out of possession across positions.

Table 6. Tactical actions associated with high-intensity efforts in and out of possession across playing positions.

Table 7. In possession combination play pre and post high-intensity effort across positions.