1.1 Physical Demands of Football

INTRODUCTION

To understand the physical demands of playing football and the corresponding energy systems, which power the movement of the football player, is fundamentally important for the sports nutrition. Understanding how the player's body responds to meet the challenge of football-specific exercise, provides the basis to inform nutrition recommendations. In this unit we will aim to classify and quantify the physical demands of football. Without this knowledge, it would not be possible to design football-specific nutrition strategies to enhance the development of players and allow them to adequately cope with the physical demands football places on them. The game of football will be introduced before covering how player specific activity has been studied, and the key variables which influence the player's physical workload. Unit 2 will discuss how the player's body responds to meet the physical demands of football activity.

OVERVIEW OF FOOTBALL

A football team is composed of eleven players including one goalkeeper and ten outfield players. Three substitutions are allowed during a 90-minute match. A fourth substitution can be made if the match enters extra time. For the purpose of this course, we will focus on the outfield players. Although general principles of sports nutrition can be applied to goal keepers, the physical demands during a match and training are different and will not be covered in this Unit. Football is a match of two 45-minute halves separated by a 15-minute half-time interval (Figure 1). Two opposing teams compete for possession of a single ball. The objective of the team is to pass or shoot the ball into the opponent goal, whilst preventing the opposing team from completing the same objective. The team's score is a product of the number of goals they have achieved. The match score is a product of the number of goals scored/conceded by both teams. A football match may result in a win, where more goals have been scored than the opponent, a draw where both teams score the same amount of goals or no goals during the match or a loss where the opponent scores more goals. In league competitions, "3" points are awarded to the team for a win, "1" point for a draw and "0" points for a loss. For cup competitions, in the event of a draw, the game may be extended into extra time involving an additional two 15-minute periods. Should there be no result following extra time, the result of the match is decided by both teams competing a penalty shoot-out. In this situation five players from each team are selected to take a penalty. A penalty kick involves, placing the ball on a penalty spot marked 12 yards (11 m) from the goal line and striking the static ball towards to the goal. The goal is defended only by the opposition goal keeper. After five

penalties, the team with the most goals wins the match. In the event of an equal amount of goals being scored, the teams continue to take penalties consecutively until one team outscores the other. The full laws of the match as directed by Fédération Internationale de Football Association (FIFA) can be downloaded here: https://www.fifa.com/mm/Document/FootballDevelopment/Refereeing/02/36/01/11/LawsofthematchwebEN_Neutral.pdf

DID YOU KNOW?

Significant dates in football history:

1849: First written rules of a non-handling form of football produced at Eton school, England.

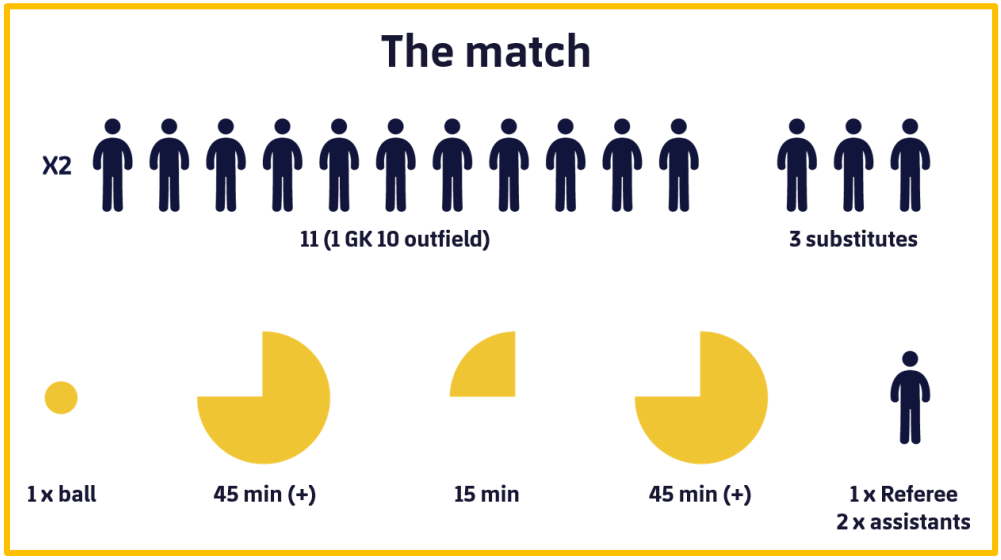
1863: Formation of the Football Association, England

1899: FC Barcelona founded by Joan Gamper

1906: Formation of FIFA

1930: Inauguration of the World Cup

Figure 1: Number of players required and duration of a standard football match



Source: Prepared by the author

DID YOU KNOW?

The ball used in professional leagues and international competitions is a "size 5." The specifications of an official size 5 ball are; circumference: 27 to 28 inches (69 to 71 cm), weight: 14 to 16 oz (400 to 450 grams), pressure: between 8.5 to 15.6 PSI.

MATCH ANALYSIS

There are many challenges a football player must face during a match, including psychological stress, tactical awareness, skill execution, social interaction with team members/opposition as well as the physical demands. This unit will concentrate on the physical demands of football. The assessment of the physical demands can be achieved through the analysis of player movement patterns and quantifying specific football activities.

The energy expended during football is a product of the total distance covered and speed at which that distance was covered (Reilly 1997). The first studies to perform match analysis to determine the physical

demands of football were performed in Sweden in the late 1960s. These early studies used video analysis of short filmed sequences of the football players during a match. The video analysis approach was further developed in England and later in Denmark and, by the early 1990s, scientific data was available on the differences in physical demands among players in different playing positions (Bangsbo 2014). Following these early studies much of our understanding on the physical demands of football is owed to the work of Professor Jens Bangsbo and his research group at the August Krogh Institute, Copenhagen, Denmark and Professor Thomas Reilly and colleagues at Liverpool John Moores University, UK. To date many methods of monitoring player movement during competition are used including tape-recorded commentaries, video recordings, film analysis, synchronized and computer-aided video analysis. It is important to note that whichever method is adopted, it must comply with quality control criteria and provide valid, objective and reliable observations (Reilly 1997). Common methods currently used to capture match activities and classify movements/activity intensity include video-based technologies, Global Positioning Satellite (GPS) and subjective scales. Each of these techniques are described below in more detail.

Video-Based Technologies

The gold standard of capturing physical activities during a match are video-based technologies. Video-based technologies are considered the most accurate systems and use multiple-camera methods developed by companies such as Amisco and Prozone. Such systems use high-speed cameras installed at the stadium to film different sections of the field for post-match analysis. Separate from tactical analysis, these systems also provide detailed information on characteristics of the physical work that occurred during the match. These physical characteristics, captured via time motion analysis, include running intensity, acceleration/deceleration rates, total distances covered and distances covered at different intensities (Bangsbo, 2014). These systems can generate information of every outfield player. More than 2500 codes (see match activity classification below) for a single match are recorded, which can result in more than 3.5 million data points (Bangsbo 2014). However, these systems can only accurately measure approximately 60% of a players' activity the remaining 40% requires manual input to prevent inaccuracies. As a result, data from semi-automatic systems (such as video analysis) is delayed to approximately 24 to 48 hours after the match. In addition to the physical activity profile, video filming can also be used to quantify other important match metrics such as the direction and success rate of passing, tackles and ball interceptions, number of shots and success.

Global Positioning Satellite

Global Positioning Satellite (GPS) systems and GPS-based technologies do not require manual intervention to analyse the activity profiles of the player. Such systems work by players wearing GPS devices, typically in vests worn under training or football shirts during training and/or matches. In general, the outputs (velocities, distances, accelerations, decelerations) generated by GPS systems are determined via mathematical algorithms. A main issue with these systems is that they fail to provide context, such as insight into the opposition or the 'skills' completed by the player (Castellano, Blanco-Villasenor et al. 2011). The use of GPS-based technology has become a common method to assess the physical demands of football, both in training and matches, because. this technology permits real time or deferred analysis of the data. In addition, there is no need for third party assistance, thus the data generated can be rapidly interpreted by the individual club coaches, sports science departments and/or statisticians.

Subjective Scales

Questionnaire and/or "paper/pen" (more recently electronic tablet) based data collection is common in professional clubs. Although this method does not provide any information on the physical activities *per se* (such as distance covered) the overall intensity of the training or match can be determined by asking players to rate their perceived exertion following exercise. Typically, clubs adopt the Borg 1-20 Rating of Perceived Exertion (RPE) scale or a modified 1-10 rating scale (Borg 1982). The Borg scale has been shown to be an accurate and reliable instrument to measure perceived exertion across multiple sports and is a universally adopted method in exercise physiology studies. The RPE of a player can accurately reflect exercise intensity as well as some physiological features of fatigue. The RPE has been reported as a tool sensitive enough to dictate training intensity (Impellizzeri, Rampinini et al. 2004) as well as detect changes in training load in professional players (Gaudino, Iaia et al. 2015).

DID YOU KNOW?

FIFA allowed the use of GPS devices during competitive matches in 2015.

MATCH ACTIVITY CLASSIFICATION

In football, movement activities during matches are generally "coded" according to the intensity, determined by the speed of action (Table 1). When evaluating a players' match performance, the frequency of each type of movement and the time spent or distance covered in each movement can be analysed. The main physical activity categories used to analyse football work rate are standing, walking, jogging, low speed running, moderate speed running (cruising/striding), high speed running and sprinting. These categories have recently been extended to include other activities such as skipping, jockeying and shuffling. Most activities in football are carried out at submaximal intensities and levels of exertion (Figure 2). Analysis of a football match allow those activities (beyond football specific movements: pass, control, shots, headers) to be classified as detailed in Table 1. However, it is important to note that ideally individual player or team specific thresholds can also be set (Carling, Bloomfield et al. 2008, Carling, Bradley et al. 2016). For example, the high-speed running velocities may be significantly different among players.

Table 1: Example of match coded activities and the associated velocities to classify movements

Coded Activity	~ Velocity km/h
standing	0
walking:	0-6
jogging	6-8
low speed run	8-12
moderate speed run	12-15
high speed run	15-18
sprinting	18 – 30 +
backward running	0-10

Source: Prepared by the author

QUANTIFYING PHYSICAL DEMANDS

During a 90-minute match, on average, the distance covered by a top-level outfield player ranges between 10 and 13 km (Bangsbo 1994, Mohr, Krustrup et al. 2003, Bangsbo, Mohr et al. 2006, Di Mascio and Bradley

2013). The majority (>80%) of the distance is covered by walking and low to moderate intensity running (Figure 2). Tabulated data from elite footballers allow either individual or team physical demand standards to be established, these metrics may act as a bench mark from which to inform the recruitment of new players or maintain performance standards (Table 2).

However, it is the high-intensity exercise periods which are associated with critical moments during a football match (Gregson, Drust et al. 2010). This is because the key actions in a match (i.e. goal being scored/conceded) are, in general, preceded by a high intensity effort. Therefore, it is reasonable to suggest that the ability to maintain high intensity efforts for the duration of 90-minutes is a critically important performance consideration. This observation has significant implications for the nutrition of the player which will be discussed in later modules.

The sprints or "all out efforts" in football are rarely longer than 2–4 seconds covering average distances of 10-15 meters. Sprints typically occur every 90 seconds, followed by several seconds of recovery, before players are in action again (Reilly 1997). Longer duration sprints will require greater recovery times. There are two main types of sprint in football: an explosive sprint, defined as attainment of sprint speed preceded by rapid acceleration (from low or moderate speed) reaching the high-speed zone within less than 0.5 seconds and a leading sprint which is characterized by gradual acceleration from low to moderate to high speed (Bangsbo 2014).

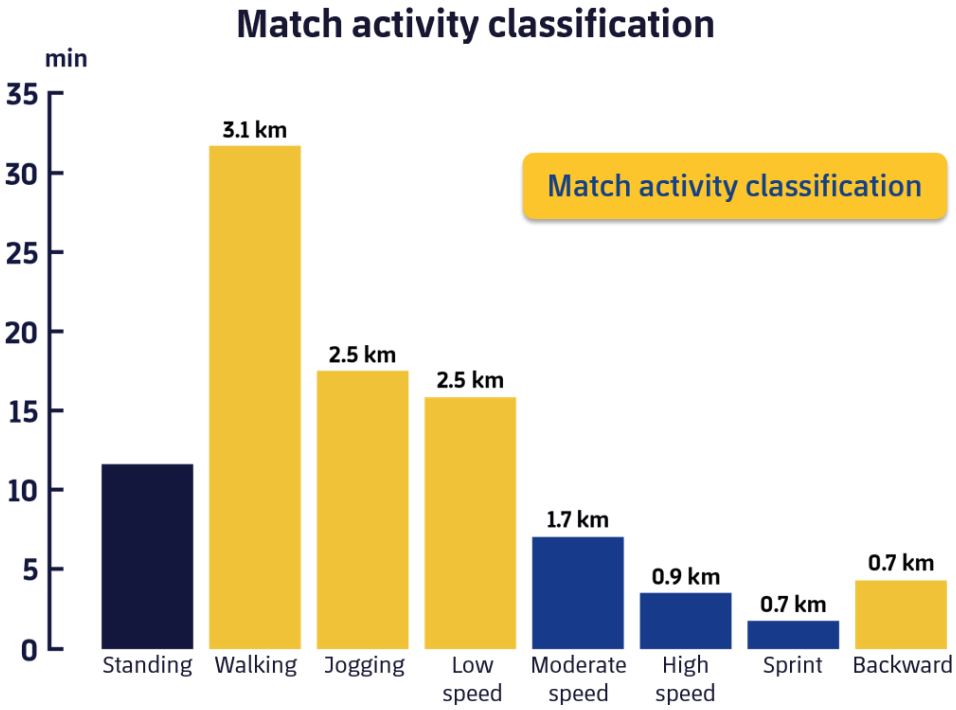
The common pattern of play in football can be described as 'stop and go', i.e. where players perform repeated bouts of brief high-intensity exercise interspersed by periods of lower intensity activity (Williams and Rollo 2015).

This is observed during match play when a player sprints to tackle an opponent (or gain possession of the ball), followed by dribbling the ball, passing it and then jogging into position to support an attack or defence. During a match, a player responds approximately every 3-5 seconds to around 1200 unpredictable changes in activity, instigated by either their own team or their opponents. Analysis of the English Premier League (first division) has shown that physical demands of match play have intensified (Bush, Barnes et al. 2015). Physical performances during matches (analysed using a video tracking system), were collected across seven consecutive seasons (2006-07 to 2012-13). It was found that high-intensity running distance increased (+0.4 km) in the final season in comparison to the first season in all playing positions. In addition, players were also found to be more skilfully proficient, due to an increase in successful pass rate. Thus, the preservation of skill as well as high intensity running are key components for individual player performance.

KEY POINT

The common pattern of play in football can be described as 'stop and go'.

Figure 2: Classification of football activities by the amount of time spent in each activity



Source: Bangsbo et. al., 1994.

Table 2: Example of elite standards of physical performance.

	Elite individual standards	Elite team standards
Overall distance covered	~12 km	~120 km
Distance covered in sprints	~0.6 km	~3.6 km
Distance covered in high speed Runs	~1.6 km	~8.5 km
Number of Sprints	~90	-
Top speed	~9.5 m/s	~9.5 m/s
Average recovery time	~30 s	~35 s
Number of interceptions	~15	-
Number of tackles	~10	-
Change of activity	~1350/match every 4-6 sec	-
Other activities	Heading, passing, Dribbling, Shooting	-
Penalty area entries	-	~40 +
Final third entries	-	~80 +
Crosses	-	~30 +

Source: Prepared by the author. Metrics of football specific activities, shots per match, interceptions, tackles won can also be included and modified to be relevant to the specific position.

OTHER PHYSICALLY DEMANDING ACTIVITIES DURING MATCH PLAY

Football also involves other energy-demanding activities such as alterations in pace, decelerations, changes in direction, execution of specific match skills, heading, tackles, jumps, physical contact for possession of the ball and tracking opponents (Carling et al., 2008). The data presented on high-intensity running for example does not include a number of other energy-intensive activities, such as short accelerations, turns, actions with the ball, tackles and jumps. Most maximal accelerations are not performed at speeds associated with high-intensity running, but are still metabolically taxing (Osgnach, Poser et al. 2010). It has been reported that players in the FA Premier League make about 700 turns in a match, with around 600 of them being 0–90 degrees and are also involved in about 110 actions with the ball, with marked variation between players (Bloomfield, Polman et al. 2007, Bangsbo 2014).

At the top level of the sport the number of tackles and jumps have been shown to vary from 3–27 and 1–36 per match, respectively (Mohr, Krustrup et al. 2003). However, this depends on the individual playing style and position in the team. Regarding headers, central defenders head the ball most frequently, data from the Spanish League and English

leagues suggest that these players head the ball 5-15 times during a match (Bangsbo 2014).

Finally, attacking players and defenders frequently fall to the ground in match-play, with the emphasis usually on defenders to get-up quickly. Thus, repeatedly regaining a standing position from lying on the floor is another physically demanding activity for players during football-specific activity.

DID YOU KNOW

An objective of a "tackle" in football is to dispossess an opposing player of the ball or to prevent the opposing player from completing an activity that they intend to complete.

ON THE BALL ACTIVITIES

A review by Bloomfield et al (2007) investigated ball interactions by players during competitive matches (Figure 3). Although there was variation between playing position, there was no significant difference found in the number of ball interactions. In general, a player will interact with the ball between 90 and 140 times in a match; however, the average time of interaction is extremely short. The typical interaction is a one-touch pass or a control-pass. Players, especially at the elite level, will usually receive the ball within 1 to 5 meters of space between them and an opponent. Consequently, a player usually has less than a second "on the ball" to execute a skill. On the appropriate occasions, a player may control and dribble the ball leading to rare situations of up to 4 seconds of possession. On average, over an entire 90-minute match, a player will typically have up to 60 to 90 seconds of ball time. Thus, players have ~1% of the total playing time to impact the match through "on the ball" interaction.

Figure 3: Frequency of 'on the ball' activity within total match-play performed by players of different positions. Data are means (+-SD)

Variables	Position				*p*
	Striker (n=19)	Midfielder (n=18)	Defender (n=18)	All (n=55)	
Pass long air (right foot)	1.3 (2.5) *	7.0 (6.9)	9.7 (6.9)	5.9 (6.7)	<.001
Pass short air (header)	8.8 (9.2)	5.0 (6.6)	7.0 (6.9)	7.0 (7.7)	.325
Pass short ground (right foot)	13.9 (9.6)	27.3 (28.8) †	9.0 (7.8) †	16.7 (19.3)	.046
Receive (right foot)	14.8 (11.2)	22.7 (20.4)	11.7 (12.1)	16.4 (15.5)	.118
Receive (left foot)	6.3 (7.6)	11.0 (10.3)	5.0 (8.0)	7.4 (8.9)	.061
Dribble	18.0 (13.4)	22.7 (24.3)	12.0 (12.5)	17.6 (17.7)	.152
Total	102.3 (51.1)	139.7 (111.1)	90.3 (47.6)	110.6 (76.9)	.234
Follow up Mann Whitney U tests: * significantly different to both other positions, † pair of positions annotated is significantly different.					

Source: Bloomfield, 2007.

FACTORS WHICH INFLUENCE PHYSICAL DEMANDS OF FOOTBALL

i) STANDARD OF PLAY

As previously mentioned, players typically spend approximately 80% of the match engaged in low-intensity and walking activities (Figure 2). Of interest, is that this pattern does not appear to change between moderate level and top-class level professional players (Figure 4). Instead, the amount of high-speed running may be a distinguishing factor between top-class and moderate-level professional players from those players who complete at a lower standard (Figure 5). For example, a review by Bangsbo (2014) explained how international top-class players performed 28% more high-intensity running (2.43 vs. 1.90 km) and 58% more sprinting (650 vs. 410 m) than professional players at a lower level (Mohr, Krustrup et al. 2003). Furthermore, Ingebrigtsen et al. (2012) found that players in the top teams (top half) in the Danish League covered 30–40% more high-speed running distance compared to the middle and bottom ranked teams (Ingebrigtsen, Bendiksen et al. 2012). Conversely, some studies observed that English Championship players (second league) covered greater overall distance and performed more high-speed running and sprinting than players in the English Premier League (top league) (Di Salvo, Pigozzi et al. 2013). Although these changes were reported to be statistically different, the actual differences (~0.2 km) were negligible in practical terms (Di Salvo, Gregson et al. 2009, Di Salvo, Pigozzi et al. 2013). A similar study comparing the match performance of players in the top three competitive standards of English football found that players in the second (Championship) and third (League 1) leagues performed more high-speed running (>19 km/h) than those in the Premier League (top league) (803, 881 and 681 m, respectively), which was also the case for sprinting (308, 360 and 248 m, respectively)

(Bradley, Carling et al. 2013). This observation was consistent for all outfield players (Bangsbo 2014). In addition, players (n=20) who changed teams, moving down from the Premier League to the Championship League, were found to cover more distance with high-intensity running (1103 vs. 995 m), whereas no difference was observed for players moving up from Championship to Premier League (945 vs. 1021 m). Nevertheless, when comparing higher and lower standard footballers, no difference in the Yo-Yo Intermittent Endurance Test Level 2 was observed (see "Physical capacity"). This would suggest that the difference between the top and second tier players were not due to differences in the players physical fitness (Bradley, Carling et al. 2013).

Interestingly, it has been reported that successful (winning) teams in the Italian Serie A league (first division) appear to cover less (4–12%) high-intensity running distance compared to unsuccessful teams, but more distance while in possession of the ball (Rampinini, Impellizzeri et al. 2009). In addition, players cover more ground with high intensity running when playing against higher in comparison to lower quality opponents (Rampinini, Impellizzeri et al. 2007, Castellano, Blanco-Villasenor et al. 2011, Castellano, Casamichana et al. 2012). Playing against strong opponents has been found to be associated with lower ball possession (Bloomfield, Polman et al. 2005). It is possible that lower-standard players must cover greater distances in an attempt to "close down" players and regain possession. It may also be that higher-standard players are more selective about their high-intensity efforts (Bangsbo 2014). Differences in match demands between higher and lower league players may also be related to playing style. For example, higher level teams may aim for possession tactics, rather than the long ball or direct tactic typically associated with lower standards of play.

Figure 4: Activities performed in percentage of total time are not different between top-class and moderate level players.

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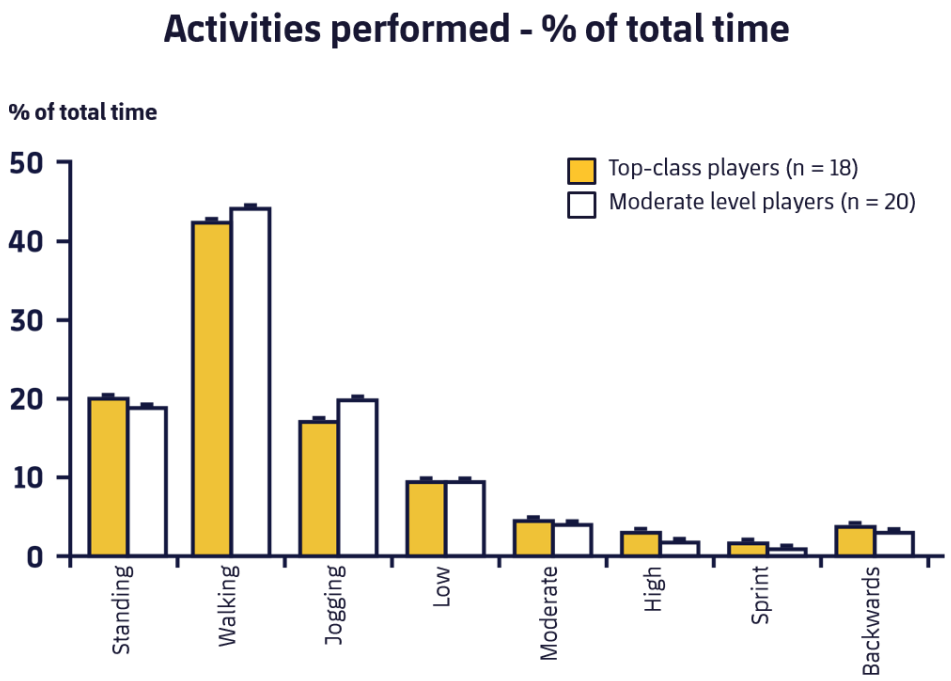
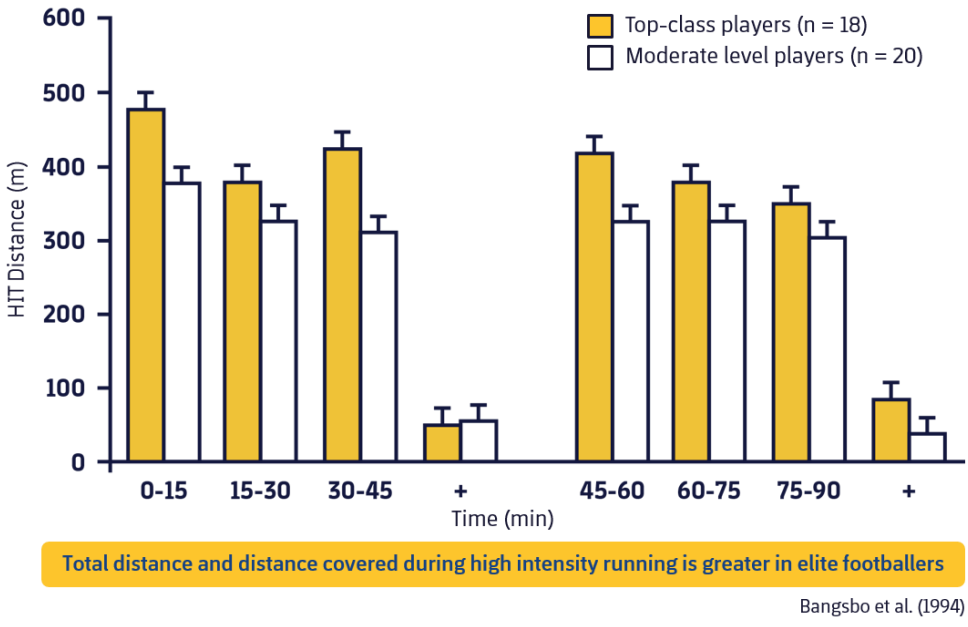


Source: Data tabulated from the English, Danish and Swedish leagues.

Figure 5: Total distance and distance covered during high intensity running is greater in elite footballers



Source: Bangsbo et. al., 2004.

ii) INFLUENCE OF TEAM TACTICS ON PHYSICAL DEMANDS

The distance covered and intensity of activities performed by a player, during a match, will also be heavily influenced by coaches' tactical requests and the team system. In a recent study the effect of playing formation on high-intensity running and technical performance of English Premier League teams was analysed (Bradley, Carling et al. 2011). Bradley et al, found no differences in total distance covered or high-intensity running between the 4-4-2, 4-3-3 and 4-5-1 formations. However, players in a 4-5-1 formation performed less very high-intensity running when their team was in possession and more when their team was not in possession, compared to the 4-4-2 and 4-3-3 formations. These differences may be related to the attacking and defensive characteristics inherent to these playing formations a 4-5-1 formation is considered more defensive than a 4-4-2 or 4-3-3, due to the reinforcement of the midfield areas at the expense of forward players (Bangsbo 2014). Although few differences in physical demands were observed between formations on an individual player basis, formation did impact the physical demands of attacking players. In a 4-3-3 formation forward players performed approximately 30% more high-intensity running than forwards in the 4-4-2 and 4-5-1 formation (Bradley, Carling et al. 2011). It was also observed that attacking players in a 4-5-1 formation had a significant decline in high-intensity running in the second half, which was not observed in the other systems. This could be explained because the 4-5-1 formation requires the single attacking player to pressure the defenders when not in possession of the ball (Bangsbo 2014). Overall ball possession does not seem to differ between the 4-4-2, 4-3-3 and 4-5-1 formations, but the number of passes and the fraction of successful passes are found to be higher in a 4-4-2 compared with 4-3-3 and 4-5-1 formations. Generally, the results suggest that playing formation does not influence the overall activity profiles of players, except for the forward players (Bangsbo 2014). Thus, it could be suggested that "additional" consideration be paid to the nutritional preparations of the attacking players in the 4-5-1 and 4-3-3 formations, especially if they are inexperienced in the system (Bloomfield, Polman et al. 2007, Bangsbo 2014).

DID YOU KNOW

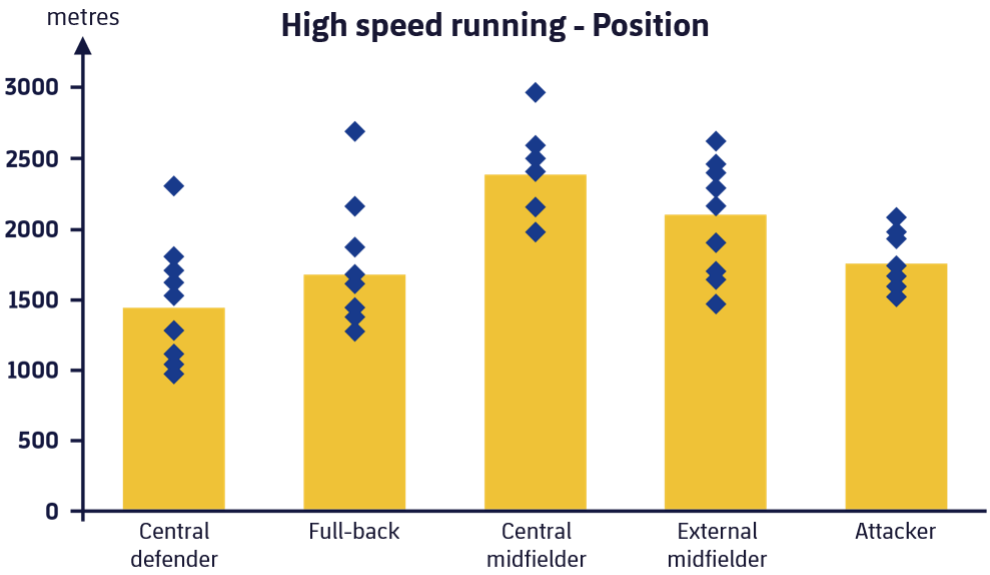
The sequence of numbers in a team's "formation" refers to the number of players moving from defensive to attacking positions. For example, 4-4-2; 4 defenders, 4 midfield players and 2 attacking players. The goal keeper is not included in the "formation" information.

iii) POSITIONAL DIFFERENCES

The activity profile and demands on a player are determined by his/her positional role in the team (Reilly 1997). Mohr et al. (2003) studied top-class players and found that central defenders covered less total distance and engaged in less high-intensity running than players in the other positions, which is probably linked to their tactical roles and lower physical capacity (Bangsbo 1994, Mohr, Krustrup et al. 2003). On the other hand, midfielders typically cover the greatest distances. However, there are marked differences between players within the same position (Figure 6) (Bangsbo 2014). Differences in distance covered has also been reported to differ between players in the same position, this may be related to playing style and could explain contrasting results between studies.

Data from the English Premier league has shown that defenders and central midfielders performed fewer leading sprints compared to other positions (Bloomfield, Polman et al. 2007). In general, data from top English and Spanish leagues suggests that central defenders and central defensive midfield players cover the least high-speed running and sprinting distances, whereas forwards cover the greatest high-speed running distances (Bangsbo 2014). Central defensive midfield players cover a greater distance than central attacking midfielders (Dellal, Chamari et al. 2011) and external/wide midfield players cover the most high-intensity running distance (Carling, Bloomfield et al. 2008). Finally, central attacking and wide midfielders also cover the most distance in high-speed running when their team was in possession of the ball (Bradley, Carling et al. 2013).

Figure 6: Position specific demands of the match in different football leagues



The distance covered with high-speed running during a game for players in different positions. Each player is represented by a symbol.

Source: Bangsbo et. al., 2014.

iv) PHYSICAL CAPACITY

To manage and perform football specific exercise the physical capacity of the player should also be considered. The physical capacity of a player has a great influence on work rate during a match. Differences in physical capacity exist among top-class players even within the same position, which to some extent can explain the differences observed in high-speed running during the match (Bangsbo 2014). Differences in a players physical capacity can be determined using the Yo-Yo Intermittent Recovery Level 1 (Yo-Yo IR1) and Level 2 (Yo-Yo IR2) Tests (Figure 7) (Bangsbo, Iaia et al. 2008).

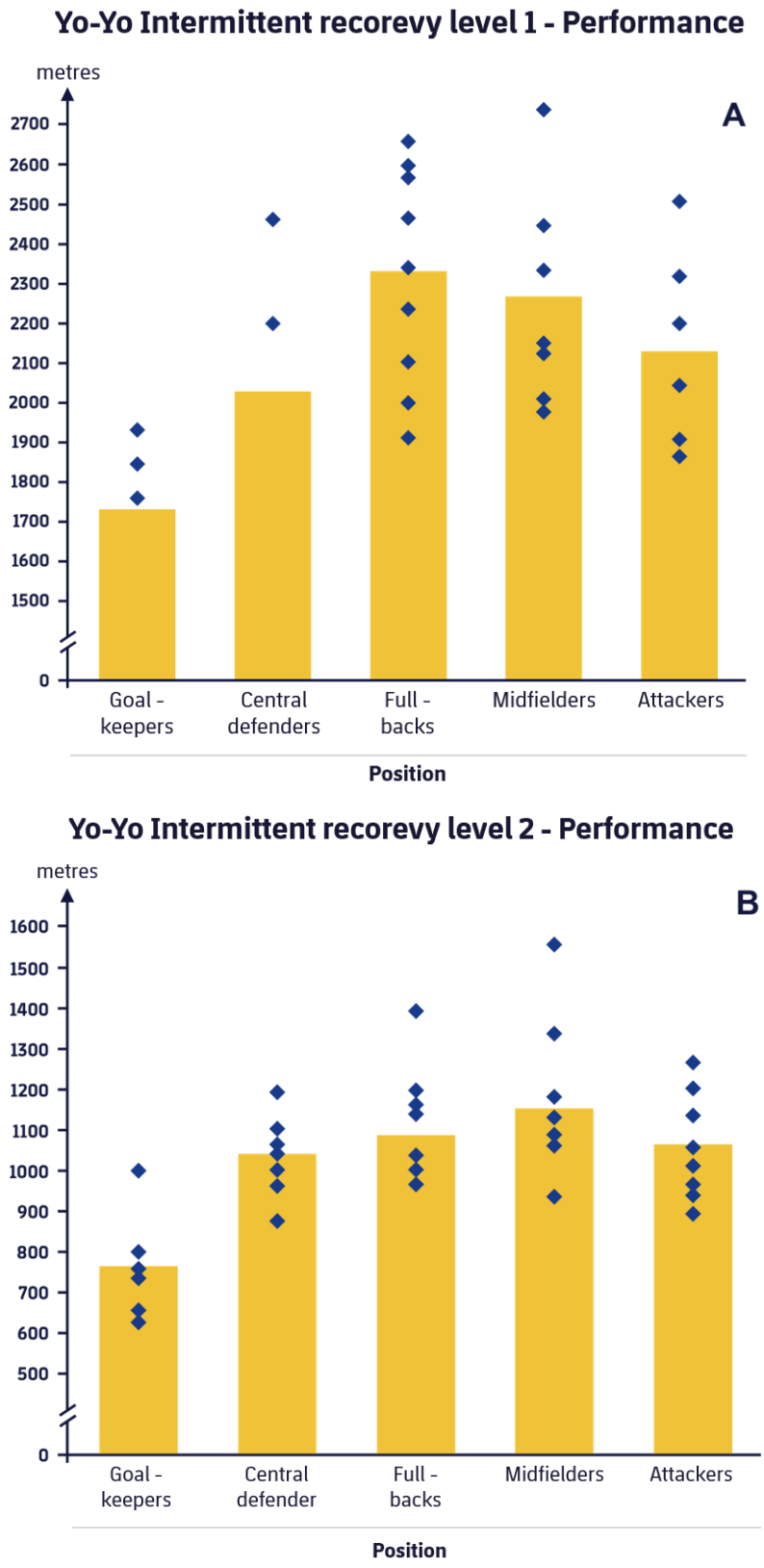
The two Yo-Yo intermittent recovery (IR) tests evaluate an individual's ability to repeatedly perform intense exercise. The Yo-Yo IR1 test focuses on the capacity to carry out intermittent exercise leading to a maximal activation of the aerobic system, whereas Yo-Yo IR2 determines an individual's ability to recover from repeated exercise with a high contribution from the anaerobic system (Bangsbo 2014).

On average, central defenders had lower Yo-Yo IR1 test scores than players in other positions. Whereas no differences were observed in the Yo-Yo IR2 test, showing that on the whole central defenders had lower

intense endurance capacity but the same ability to recover (Krustrup, Mohr et al. 2006).

Physical capacity is highly related to the training load accumulated by the player. For example, trained football players have been reported to have 67% improved Yo-Yo scores in comparison to untrained individuals (Krustrup, Bradley et al. 2015). Interesting, more successful teams have been reported to have superior physical capacities measured by Yo-Yo score (Mohr and Krustrup 2014). The detailed discussion for training a football player is beyond the scope of this unit. In summary, the training load can be subdivided into “external” and “internal” load. External load refers to parameters covered in this Unit such as time, distance, speed, and number of repetitions of each activity performed by the player. Internal load refers to the physiological response to the external load. The internal response relates to specific demands placed on the physiological systems such as the cardiovascular system (Unit 2).

Figure 7: Yo-Yo intermittent recovery level 1 and level 2 in relation to playing position. Each player is represented by a symbol



Source: Bangsbo, 2014.

v) GENDER

The studies described in this unit (Unit 1) have, in general, examined male players, but female players have also been evaluated (Bradley, Dellal et al. 2014). The amount of high-intensity running in elite female football has been shown to be approximately 30% lower than in male elite football (Krustrup, Mohr et al. 2005). This has been confirmed in studies of top-class females competing in the European Champions League, showing that they cover less high-speed running distance than their male counterparts (Bangsbo 2014). One of the major reasons is that female players possess lower physical capacity than male players across a range of aerobic and anaerobic fitness tests (Krustrup, Zebis et al. 2010, Bradley, Bendiksen et al. 2014).

vi) PITCH SIZE

Small-sided games are widely used by coaches to develop technical and tactical skills as well as to improve the endurance of football players (Casamichana & Castellano, 2010). In this sense, several studies have investigated the effects of altering different variables or match rules, including the duration of the match formats and pitch size. During training the size of the pitch can be constantly modified to manipulate the intensity or focus of the session. Some studies have found that small-sided matches played on larger pitches are more intense than those played on smaller ones (Rampinini et al., 2007) whereas other studies have found opposite results. In any case, it is important to recognize that modifying the size of the pitch may change the physical demands placed on a player during training and matches.

vii) HEAT AND HYPOXIA

Players may also be expected to play in temperatures >30°C during early and later stages of the season. Within both competitive and non-competitive football matches, research has reported a reduction in total distances players achieved at high intensity (2.6-57%) in hot conditions (Mohr, Krustrup et al. 2003, Buchheit, Voss et al. 2011, Mohr and Krustrup 2013). The next International Federation of Association Football (FIFA) World Cup (Qatar 2022) will be played in extreme heat of approximately 30°C and may possibly exceed 40°C (Taylor and Rollo 2014). Exertional heat stress elicits substantial decrements upon football-specific performance, due to increasing body temperatures amongst other multi-factorial mechanisms accelerating fatigue (Mohr, Mujika et al. 2010, Nybo, Rasmussen et al. 2014). Thus, high environmental temperatures can influence the completion of football-specific activities (Mohr and Krustrup 2013).

Total distances players achieved at high intensity are known to reduce in hypoxic environments (McSharry 2007) (3-20%). Elite clubs playing in the Union of European Football Associations (UEFA) Champions and Europa leagues could play in altitudes as high as 1,000 meters above sea level. However, "low altitudes" classified as 500 meters – 2,000 meters are sufficient to produce minor impairments in aerobic performance, due to a reduction in partial pressure of oxygen (Gore, Aughey et al. 2013). A reduction in maximum oxygen uptake will inhibit recovery from repeated sprint activities and inhibit total distances covered within a match (Taylor and Rollo 2014). As such, players usually have more time on the ball and may be perceived as more technically proficient.

It is important to recognize the influence that environmental extremes may have on the physical performance of players and subsequent match outcome. Appropriate nutrition strategies to combat these extreme environments will be covered in Course 3.

UNIT 1 Summary

- The physical demands on a football player during a match can be determined from the analysis of match activities using time motion analysis.
- The typical total distance covered by a top-level outfield male player during a match is approximately 10–13 km.
- High intensity running/activities/sprints precede key events in a match.
- Players perform approximately 1200 unpredictable changes in activity, every 3-5 seconds.
- Countless factors influence the physical demands placed on players during a match including but not limited to:
    - Standard of play
    - Playing position
    - Tactical formation
    - Gender
    - Pitch size
    - Environmental factors