TITLE PAGE

Physiological Profile and Activity Pattern of Minor Gaelic Football Players

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ABSTRACT and key words

The purpose of this study was to evaluate the physiological profile and activity pattern in club and county level under 18 (U-18) Gaelic football players relative to playing position. Participants (n = 85) were analysed over 17 official 15-a-side matches using global positioning system (GPS) technology (SPI Pro X II, GPSports Systems Pty) and heart rate (HR) telemetry. During the second part of this study, 63 participants underwent an incremental treadmill test to assess their maximal oxygen uptake ($\dot{V}O_2max$) and peak HR (HRmax). Players covered a mean distance of 5,774 $\pm$ 737m over a full 60 min match. The mean %HRmax and %$\dot{V}O_2$max observed during match play was 81.6 $\pm$ 4.3% and 70.1 $\pm$ 7.75%, respectively. Playing level had no effect on distance covered, player movement patterns or %HRmax observed during match play. Midfield players covered significantly greater distance than defenders (p=0.033). Playing position had no effect on %HRmax or the frequency of sprinting or high intensity running during match play. The frequency of jogging, cruise running, striding (p=0.000) and walking (p=0.003) was greater in the midfield position than the forward position. Time had a significant effect (F(1,39)=33.512, p-value =0.000 and ηp^2 = 0.462) on distance covered and %HRmax, both of which showed a reduction between playing periods. Gaelic football is predominantly characterised by low to moderate intensity activity interspersed with periods of high intensity running. The information provided may be used as a framework for coaches in the design and prescription of training strategies. Positional specific training may be warranted given the comparatively greater demands observed in the midfield playing position. Replicating the demands of match play in training may reduce the decline in distance covered and %HRmax observed during the second half of match play.

KEY WORDS: GPS technology, team sports, activity pattern, heart rate

INTRODUCTION

Gaelic football is the most popular team sport in Ireland, and one of five games organized and promoted by the Gaelic Athletic Association (GAA). Community based clubs are the cornerstone of the GAA, and competitions are organised from underage up to and including senior level. The best club level players are selected to represent their county and are considered elite Gaelic football players. At the highest level senior county teams compete in the All-Ireland football championship, the final of which attracts up to 82,000 spectators. The inter-county minor (U-18) championship runs in tandem with the senior competition. The minor final acts as a curtain raiser to the senior final, which is broadcast on national television to over 1 million viewers (24).

Gaelic football is a field based contact game played between two teams of 15 players on a rectangular grass surface approximately 145 m long and 90 m wide. The ball which is similar in size but slightly heavier than that used in soccer can be played over any distance by foot or hand, and can be carried using the accepted solo running technique (41). The primary objective of the team in possession is to create and exploit space in order to score between goalposts located on both end lines. The intermittent nature of Gaelic football demands that players perform repeated short duration, high intensity bouts of anaerobic exercise interspersed with sustained light to moderate aerobic activity. Superimposed on the physiological demands of match play are key technical activities such as winning possession of the ball, evading opponents and breaking tackles which involve high running velocities, agility, strength and power.

Observing athletes during competition can provide useful information regarding the physiological demands and activity pattern during match play. However, the complex and irregular nature of field based sports are incompatible with traditional methods of studying exercise in laboratory conditions (21). The quantitative measurement of player movement patterns has been greatly improved by advances in time motion analysis (45). Originally developed as a military tool, global positioning software (GPS) has become increasingly popular among sport scientists as a method of tracking movement patterns in many field based team sports (1, 9, 17, 27, 51). Modern GPS devices are portable, robust and lightweight making them particularly suited to field based sports (3). Early GPS models with low sample rates were susceptible to considerable error during high intensity activity (> 20 $km^{.}h^{-1}$), particularly on non-linear paths (15, 25, 49, 52, 53). However, recent studies have demonstrated that the level of measurement error during high intensity activity may be reduced through the use of GPS devices with a sample rate of ≥ 5 Hz (14, 31, 39, 50).

Obtaining physiological data in a competitive environment is limited by the rules and regulations of competition (28). Modern GPS devices are compatible with heart rate (HR) monitoring technology facilitating the collection of locomotive and HR data simultaneously. In addition, the linear relationship between heart rate (HR) and oxygen consumption (%$\dot{V}O_2$) measured during an incremental treadmill test in a laboratory setting allows the use of HR data to estimate the oxygen uptake during match play (20, 22).

Despite the widespread adoption of GPS technology in team sports, surprisingly few studies have been published on the physiological demands and activity profiles during Gaelic football matches (23, 32, 34, 38, 42), and only one study has involved players ≤ 18 years (43). Reilly *et al.*, (2015) evaluated the physiological demands and activity patterns

3

during match play in youth (U-15) Gaelic football players. The study found that players performed at an intensity equating to 85% of heart rate max (HRmax) and covered an average distance of 5732 ± 1047 m during 60 min competitive matches. There was a significant reduction in distance covered between the first and second min 30 min period of match play. A reduction in high intensity activity between the first and third quarter, and the first and final quarter of match play was also reported.

The purpose of this study was to describe the movement patterns, heart rate response and estimated oxygen uptake during match play in club and county level U-18 male Gaelic football players. A secondary aim was to compare the physiological demands and activity patterns relative to playing position and playing period. It was hypothesised that the total distance covered and overall physiological demands would be greatest in the midfield position, and that defenders and forward players would perform a greater amount of high intensity running than midfield players. In addition, there would be a reduction in the total distance covered, frequency of high-intensity running bouts and physiological responses between the first and second half.

METHODS

Experimental Approach to the Problem

An observational design was used to evaluate the physiological response and activity pattern of U-18 Gaelic football players during match play. Participants were members of club and county level Gaelic football teams. The club level players represented the best U-18 Gaelic football players in their respective communities. The county players are a

4

selection of the finest club players in their respective county. Included in the county teams that participated in this study are the 2012 provincial and All-Ireland football champions. This study involved 1) evaluating HR response and player movement patterns during match play, and 2) a laboratory based maximal aerobic capacity assessment ($\dot{V}O_2$max). In order to compare the movement patterns and physiological demand during match play relative to playing position, players were categorised as defenders (n=36), midfield (n=13) and forward (n=36) players (Figure 1). Data was collected during the competition phase of the season.

Insert Figure 1

Participants

A total of 85 U-18 Gaelic football players representing 6 different teams (3 club, 3 county level) were monitored during 17 competitive games (8 club, 9 county level) in this study. Participants trained on average twice per week and played a competitive game most weekends. Each participant had a minimum of 2 years playing experience. Participants were provided with a plain language statement outlining the nature and demands of the study as well as the inherent risks. Written informed consent was obtained from each participant and their parents prior to participation. The experimental procedures were approved by a University Research Ethics Committee. Participants were advised that they could withdraw from the study at any time.

Procedures

All matches were played on a standard adult pitch (130-145 m x 80-90 m) and consisted of two 30 min periods with a 10 min half-time interval. Thirty min prior to the

start of each game 10 outfield players were fitted with a portable 10-Hz GPS device (SPI Pro X II, GPSports Systems Pty. Ltd, Canberra, Australia; weight 76 g; size 48 x 20 x 87 mm) in the upper thoracic region. A HR telemetry system (Polar Team Pro, Polar Precision Performance SW 3.0, Kempele, Finland) was placed around the chest. The GPS device was supported in a purpose built harness worn by the player underneath his playing kit. Player selection was rotated in an attempt to limit bias from individual responses. No instruction was provided to players outside their normal tactical cues.

The playing number of each participant and unit number of each device were manually recorded for identification purposes. To ensure that data collection was strictly limited to match activities, the GPS system was synced with an electronic mobile device (iPhone 4GS, Apple Inc. San Francisco, USA) that was used to manually record the exact start and end time of the first and second period of play. The exact times of all tactical or injury enforced substitutions were also manually recorded. Data were later downloaded from each GPS unit to a personal laptop computer (Intel i7, Intel, Santa Clara, CA). Analysis was undertaken using a specifically designed computer software analysis programme (Java 1.6, Sun Microsystems, Santa Clara, CA).

Of the 85 participants, 63 made a single visit to the Human Performance Laboratory. The remaining 22 participants were unable to attend due to injury or personal circumstances. Anthropometric measurements were taken and maximal oxygen uptake was directly assessed for each participant using open circuit spirometry during an incremental treadmill test. HR data was stored on a receiver that was attached to an elastic strap and placed around the participant's chest. Testing took place mid-week over a 2 h period between the hours of 16:00 and 20:00. Participants were requested to abstain for

6

strenuous physical activity for at least 24 h, and fast for 3 h prior to testing. Participants wore loose sports clothing, appropriate footwear, and were permitted to drink water ad-libitum prior to testing.

Anthropometry

Height was measured to the nearest cm using a portable stadiometer (Seca 707 Balance Scales, GmbH, Hamburg, Germany). Body mass was obtained to the nearest 0.1 kg using a calibrated scale (Seca 707 Balance Scales, GmbH, Hamburg, Germany). Footwear was removed prior to both measurements. BMI was calculated as body mass (kg) divided by squared body height in metres. Harpenden skin fold callipers (Baty International Ltd, West Sussex, UK) were used to measure double thickness subcutaneous adipose tissue on the right side of the body. The following anatomical sites were measured: triceps, pectoralis, subscapular, abdomen, midaxillary, suprailiac and thigh. Measurements were taken following the guidelines outlined by the International Society for the Advancement of Kinathropometry (29). Body density was calculated using the Jackson and Pollock equation (30) and body fat was determined using the Siri equation (44).

Cardiorespiratory Assessment

Maximal oxygen uptake ($\dot{V}O_2$max) was assessed on an automated treadmill (Woodway ELG55) using an incremental protocol. The protocol consisted of initial 4 x 4 min stages. The initial treadmill velocity was set at 6.0 km·h^{-1} and was increased by 2.0 km·h^{-1} at the end of each stage. Treadmill velocity remained constant after the fourth stage and the treadmill gradient was increased by 2% in the initial min after the fourth stage and at 2 min intervals thereafter, until volitional exhaustion. Expiratory gases were measured using a

7

Sensormedics Vmax 229 metabolic system (Sensormedics Vmax 229, Sensormedics Corp., CA), and HR was continually measured using a wireless telemetry system (Polar Team Pro, Polar Precision Performance SW 3.0, Kempele, Finland). $\dot{V}O_2$max was determined by averaging the 3 highest consecutive 20 sec values. HRmax was considered the peak HR value measured during testing.

Match Analysis

Heart Rate during Match Play

Heart rate was continuously measured with a sampling frequency of 5 sec using a wireless team system (Polar Team Pro, Polar Precision Performance SW 3.0, Kempele, Finland). The data was transferred to a personal laptop computer for analysis. Oxygen uptake during each game was estimated for each subject using the individual linear regression equation between HR and $\dot{V}O_2$ obtained during the incremental treadmill test.

Activity Categories

Player movements were categorised as walking (0-6 $km^.h^{-1}$), jogging (6-12 $km^.h^{-1}$), cruise running (12-14 $km^.h^{-1}$), striding (14-18 $km^.h^{-1}$), high-intensity running (18-20 $km^.h^{-1}$) and sprinting ($\geq$20 $km^.h^{-1}$). The speed thresholds for each category are similar to that reported by Cunniffe *et* al., (2009) (17). Entry into a speed zone was recognised and recorded when a player maintained the relevant running velocity for $\geq$2 sec. The frequency, duration and distance covered in each speed zone were evaluated.

Statistical Analysis

Data were analysed using SPSS (IBM SPSS Statistics v21). Descriptive statistics (mean ± SD) were calculated for all data. A MANOVA analysis was conducted using the multivariate general linearised model (GLM) to examine the effect of level and position on distance and heart rate during match play. Estimated oxygen uptake was highly correlated with heart rate (Pearson's correlation coefficient = 0.49, *p*=0.001) and therefore excluded from analysis. Data were tested for normality and homegenity using the Shapiro-Wilks statistic, and Box's test of equality of covariance matrices, respectively. All assumptions were met for the analysis of distance and heart rate as the dependent variables. A GLM was therefore conducted with level and position as the between subject effects and time (first and second half) as the within subject effect. The measurements between the first and second half of match play were treated as repeated measures. Significance was set at α = 0.05 using a Bonferroni correction factor in SPSS (0.05/6 = 0.0083). A further analysis was conducted on the contribution to distance covered by the various movement types with regard to the level and position variables. Each of these movement types was treated as dependent variables with position, level and the interaction between level and position as the main factor levels. Initial analysis using a a Shapiro-Wilk's test revealed considerable non-normality of the dependent variables, a number of which were also significantly correlated. For example, the distance covered per bout of jogging and stride running (Pearson's correlation = 0.437, *p*=0.002), and jogging and cruise running (Pearson's correlation = 0.377, *p*=0.009) were both significantly correlated. The reserachers therefore felt it prudent not to use a MANOVA / GLM analysis due the considerable violations of the theoretical assumptions that underpin each model. As the count of each movement types

9

was available a repeated measures GLM analysis with a Poisson link function was deemed appropriate. Each movement type was analysed against level, position and the interaction between position and level. Parameter estimates for level (club vs county) and position (defender vs forward; defender vs midfield; midfield vs forward) were estimated. This gave a pairwise comparison of the independent variables for each movement type. The significance level was set at $\alpha = 0.05$ using a Bonferroni correction factor in SPSS (0.05/6 = 0.0083) on the number of occasions that each movement type occurred.

RESULTS

On average, players covered $5{,}774 \pm 737$m and performed at $81.6 \pm 4.3\%$ HRmax / $70.1 \pm 7.75\%$ $\dot{V}O_2$max during 60 min competitive match play. The multivariate results using Philai's Trace, Wilks λ, Hoteling's Trace and Roy's largest Root demonstrated that time had a significant effect $F_{(1,39)}=33.512$, p-value = 0.000 and ηp^2 (Partial Eta Squared) = 0.462 on distance and heart rate (Figures 2-3). There were no significant interaction effects between time and the level, $F_{(1,39)} = 0.592$, p-value = 0.446, $\eta p^2 = 0.015$ or position, $F_{(2,39)} = 0.017$, p-value = 0.983, $\eta p^2 = 0.001$, variables. The 3 way interaction between time, level and position was also insignificant, $F_{(2,39)} = 0.324$, p-value = 0.725, $\eta p^2 = 0.016$.

Insert Figures 2-3

On examination of the between subjects effects of level, position and interaction between level and position, there was a significant main effect for position $F_{(2,39)} = 3.5321$, p-value = 0.039; $\eta p^2 = 0.153$. The level variable ($F_{(1,39}=2.574$, $p=0.117$, $\eta p^2 =0.062$)

10

and the interaction between the level and position variables (F(2,39=0.197, p=0.822, ηp^2 =0.010) were insignificant. Univariate post hoc analysis revealed that midfield players covered significantly (p=0.033 adjusted for a Bonferroni correction factor (3 pairwise comparisons), LSD p-value=0.011) greater distance than defenders during match play (Figure 4).

Insert Figure 4

Table 1 outlines the mean frequency, duration and distance covered of each movement category during each half of play over a full 60 min match. Players performed on average, 491 discrete events from walking to sprinting during match play. Low intensity activity represented 92% of total playing time, consisting of standing (10%), walking (67%) and jogging (15%). Moderate intensity activity represented 6% of playing time, consisting of cruise running (2%) and striding activity (4%). Only 2% of total playing time involved high intensity running (0.5%) and sprinting (1.5%) (Figure 5). The repeated measures GLM analysis with a Poisson link function on the frequency of each movement category revealed that midfield players perform a significantly greater amount of jogging, cruise running, striding (p=0.000) and walking (p=0.003) than forward players (Table 2).

Insert Tables 1-2

Insert Figure 5

Anthropometric measurements and $\dot{V}O_2$max values relative to playing position are outlined in Table 3.

Insert Table 3

11

DISCUSSION

This is the first study to evaluate the physiological demand and movement patterns during match play in club or county level U-18 Gaelic football players. Interestingly, playing level had no effect on total distance, player movement patterns or heart rate response observed during match play, indicating that technical ability rather than physical fitness is likely to distinguish between U-18 club and county level players. Having said this, an understanding of the physiological demands and movement patterns during match play will aid coaches in the development of sport specific training strategies for young players.

Distance Covered

The mean distance covered by U-18 players in this study is similar to that reported in younger (U-15) Gaelic football players (43). Elite adult Gaelic football players cover 8.5 km during 70 min matches (32). However, the duration of adult matches is 10 min greater than underage matches. When expressed relative to the total min of match play the difference in total distance covered between elite adult and U-18 Gaelic football players is less pronounced (7.3 vs 5.8 km). The total distance covered during 90 min of match play by elite soccer players of a similar age to the participants in this study ranges from 7.6-8.8 km (11, 26). Relative to the total min of match play, elite young soccer players cover marginally less distance than Gaelic football players (5.5 vs 5.8 km) of a similar age and standard.

Previous research found that elite midfield soccer players (7, 12, 18, 19, 40) cover the most distance during match play. It was hypothesised that Gaelic football players in the midfield position would cover the greatest distance during match play, which was partly

accepted. Our findings are largely in agreement with Reilly *et al*, (2015) who found that among 15 yr. old Gaelic football players, midfield players cover a greater distance than defenders and forward players (43). Given that midfield players are expected to link defence and attack it is not surprising that midfield players largely cover a greater distance than the other positional groups. The similarity in $\dot{V}O_2$max levels between playing positions in the present study suggests that distance covered during match play is largely determined by the tactical requirements of each playing position rather than superior fitness levels.

Several studies in other field-based sports (7-9, 13, 40, 43) have found that the majority of distance covered during match play occurs during the first half of play. The reduction in distance covered between the first and second half observed in this study may be due to a number of reasons. The development of fatigue is the most obvious explanation and the physiological mechanisms of which are multifaceted. A reduction in muscle temperature during the half time period has been found to impair repeated sprint performance at the onset of the second half in elite soccer players (37). The accumulation of blood lactate and/or membrane acidosis following periods of high intensity activity may also contribute to temporary fatigue during match play (33). Furthermore, during prolonged intermittent activity typical of invasion field-based sports, depletion of muscle glycogen stores is likely a contributing factor. In elite soccer players, almost half of type I and type IIa muscle fibres are completely glycogen depleted post game (33). External factors such as the score in the game or phase of the season could influence the motivation level of the players and in turn the degree of effort during the latter stages of match play.

Movement Categories

To date, research in Gaelic football has failed to provide common and clearly defined movement categories between studies (32, 34, 38, 43). The allocation of movement categories in this study are were based on the work of Cunniffe *et al.*, (2009) involving rugby union players (17). The classification of sprinting (≥20 $km^.h^{-1}$) in the present study corresponded with the average peak running speed of 22 $km^.h^{-1}$ obtained from maximal 20 m linear speed data in U-18 Gaelic football players (16). The speed zones selected in this study were therefore believed to be typical of varying locomotor categories experienced during Gaelic football match play.

On average, 92% of playing time in this study consisted of low intensity aerobic activities including standing, walking and jogging. 6% of playing times was categorised as moderate intensity (cruise running/ striding) and only 2% of playing time was spent performing high intensity running and sprinting. Reilly *et al.*, (2015) used comparable speed zones in their description of U-15 Gaelic football players and reported similar findings with 88% of total playing time constituting low intensity activity (43). Similarly, moderate and high intensity activity represented 8% and 4.2% of playing time, respectively. Together these findings highlight that Gaelic football is predominantly characterised by light aerobic walking or jogging interspersed with short duration high intensity running. Several researchers have undertaken similar studies in other field-based sports (7-9, 11-13, 18, 36, 40, 47). However, the use of different definitions and notation techniques make it difficult to compare findings.

Playing position has been found to have a significant influence on the volume of high intensity activity undertaken in elite soccer players (7, 18, 19), U-18 and elite adult female Gaelic football players (34, 43). Studies in elite adult Gaelic football players have provided conflicting results (32, 38). The hypothesis that the frequency and duration of high intensity running and sprinting would be position specific was rejected. Playing position had no effect on the frequency of high intensity activity (high intensity running / sprinting). In contrast, Reilly *et al.*, (2015) found that midfield players perform a significantly greater amount of sprints than players positioned in the full-back and full-forward lines (43). The conflicting findings may be explained by the marginally higher threshold for sprinting activity (≥ 22 km$^.$h^{-1} vs. ≥ 20 km$^.$h^{-1}) and broader categorisation of playing positions by Reilly *et al.*

A greater amount of low to moderate activity was performed by midfield players compared to forwards in this study. The primary role of a midfield player in Gaelic football is to secure and advance possession from the middle area of the field. Although midfield players are typically positioned in the middle sector of the playing field, they are often required to advance forward or retreat towards their own goal to assist team mates create and/or prevent scoring opportunities. It is likely that a large proportion of the low-moderate intensity running performed by midfield players occurs after these phases of play when returning to their position in the central area the field.

Heart Rate Response

Heart rate is generally considered a valid indicator of exercise intensity and has been widely employed in the study of field-based team sports (17, 35, 47). The mean HRmax of

82% in the present study is comparable with elite youth, club and county adult Gaelic football players (23, 42, 43). It was hypothesised that the physiological demands during match play would be greatest in the midfield position. However, no significant difference was found between playing positions. Having said this, midfield players performed at a marginally higher mean %HRmax than the other positional groups particularly during the first half of match play. This may be attributed to the comparatively greater distance covered in the midfield position.

The reduction in heart rate response between the first and second half of match play was expected. Similar findings have been reported among youth players in other field based sports (2, 6). In contrast, studies in elite adult Gaelic football players found no difference in the relative or absolute HR response during the first and second half of play (23, 42). The difference may be attributed to the greater training age or more economical movement of elite senior players. Although not statistically significant, the considerable increase in the frequency of walking between the first and second half of play may also explain the reduced relative HR observed between playing periods.

Oxygen Consumption

The mean %$\dot{V}O_2$max attained during match play was 71% which is in agreement with studies in adult Gaelic football players, youth and adult soccer players (5, 23, 47). This suggests that the physiological workload during Gaelic football is comparable in young and adult players. However, caution should be taken when interpreting these findings as external factors such as stress, dehydration and hyperthermia which can affect the

cardiovascular response during match play and subsequently the linearity of the HR-$\dot{V}O_2$ relation (5).

Summary

Gaelic football is predominantly characterised by low to moderate intensity activity interspersed with high intensity running. The movement patterns and physiological demands of match play in U-18 Gaelic football games closely resemble that in young soccer players of a similar age and playing level. Players in the midfield position covered the greatest distance during match play, the majority of which at a low-moderate intensity. Playing position had no significant effect on the frequency of high intensity activity or the physiological response observed during match play. The decrease in %HRmax found during the second half of match play coincided with a reduction in total distance and increased frequency of walking.

There are a number of limitations to this study. Firstly, data was collected during matches in a preparatory competition with unlimited substitutions which may have affected the overall demand of match play. Oxygen uptake was estimated and not directly measured during the individual games. There was a considerable score difference between teams during a small number of games during which motivation levels may have been diminished. The playing surface and weather conditions were inconsistent between matches. The effect of game related activities on the physiological response during match play was not considered. The similarity between playing positions in this study across a number of parameters may be due to the broad description of playing positions.

PRACTICAL APPLICATION

This is the first study to evaluate the activity pattern and physiological demand during match play in U-18 Gaelic football players. The information provided may be used as a framework for coaches in the design and prescription of training strategies, which will have important implications in terms of improving the specificity of current training methods. An understanding of the physiological demands of match play is necessary in order to devise sport specific training strategies. Coaches may use this information to replicate the intensity of match play during practice sessions. This may better prepare players for competition and reduce the decline in distance covered and intensity observed during the second half of match play. Midfield players are required to cover the greatest distance, which should be reflected in their preparation. The influence of important factors such as game related activities, the quality of the opposition, the score line and the stage of the season on the movement patterns and physiological response during match play warrant further investigation. Future research should also endeavour to include a broader categorisation of playing positions than the present study.

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FIGURE LEGENDS

Figure 1   Categorisation of playing positions

Figure 2   Effect of time on (A) total distance and (B) HR relative to playing level

Figure 3   Effect of time on (A) total distance and (B) HR relative to playing position

Figure.4   Total distance covered during match play relative to playing position

Figure 5   Percentage playing time in each movement category

TABLES

Table 1. Player movement patterns during each half and a full match (n=85)

Variable	Playing Period		
	First Half	Second Half	Full Match
Sprinting			
Frequency (n)	9.83 ± 3.2	8.17 ± 3.89	18 ± 5.87
Duration (s)	3.35 ± 0.37	3.32 ± 0.47	3.35 ± 0.34
Distance (m)	20.93 ± 2.58	20.66 ± 3.27	20.89 ± 2.24
High Intensity Running			
Frequency (n)	4.92 ± 1.98	4.46 ± 2.2	9.38 ± 3.42
Duration (s)	2.31 ± 0.18	2.36 ± 0.23	2.35 ± 0.14
Distance (m)	12.06 ± 0.97	12.31 ± 1.3	12.26 ± 0.78
Striding			
Frequency (n)	23.33 ± 7.09	22.08 ± 9.56	45.42 ± 14.68
Duration (s)	2.84 ± 0.22	2.87 ± 0.24	2.87 ± 0.24
Distance (m)	12.46 ± 1	12.57 ± 1.07	12.58 ± 1.07
Cruise Running			
Frequency (n)	15.02 ± 5.29	15.23 ± 8.05	30.25 ± 11.97
Duration (s)	2.55 ± 0.19	2.55 ± 0.19	2.55 ± 0.14
Distance (m)	9.29 ± 0.68	9.33 ± 0.78	9.32 ± 0.51
Jogging			
Frequency (n)	73.21 ± 17.73	74.48 ± 26.21	147.69 ± 0.39
Duration (s)	3.69 ± 0.24	3.84 ± 0.29	3.76 ± 0.22
Distance (m)	9.46 ± 0.68	9.72 ± 0.78	9.6 ± 0.6
Walking			
Frequency (n)	100.83 ± 14.8	141.85 ± 31.82	242.69 ± 40.1
Duration (s)	10.1 ± 1.13	9.83 ± 1.16	9.94 ± 0.96
Distance (m)	11.28 ± 1.37	10.36 ± 1.54	10.75 ± 1.15

Values are mean ± SD

Table 2. Player movement patterns relative to playing position during a full match

Variable	Playing Position		
	Defender (n=36)	Midfield (n=13)	Forward (n=36)
Sprinting			
Frequency (n)	15.53 ± 5.93	21.07 ± 5.87	17.75 ± 4.68
Duration (s)	3.35 ± 0.34	3.34 ± 0.39	3.36 ± 0.38
Distance (m)	20.89 ± 2.24	20.69 ± 2.64	20.72 ± 2.1
High Intensity Running			
Frequency (n)	8.41 ± 2.74	11.27 ± 4.64	8.62 ± 1.86
Duration (s)	2.36 ± 0.15	2.31 ± 0.17	2.38 ± 0.11
Distance (m)	12.31 ± 0.83	12.06 ± 0.85	12.39 ± 0.64
Striding			
Frequency (n)	38.88 ± 10.18	$58.07 \pm 16.19^{*}$	40.5 ± 9.27
Duration (s)	2.83 ± 0.13	2.95 ± 0.23	2.83 ± 0.12
Distance (m)	12.39 ± 0.58	12.89 ± 1.06	12.42 ± 0.48
Cruise Running			
Frequency (n)	23.82 ± 7.24	$42.27 \pm 12.74^{*}$	25.81 ± 5.41
Duration (s)	2.55 ± 0.13	2.61 ± 0.15	2.51 ± 0.13
Distance (m)	9.31 ± 0.5	9.51 ± 0.53	9.16 ± 0.47
Jogging			
Frequency (n)	129 ± 31.38	$186.27 \pm 25.5^{*}$	131.38 ± 30.25
Duration (s)	3.68 ± 0.14	3.85 ± 0.3	3.76 ± 0.17
Distance (m)	9.33 ± 0.37	9.86 ± 0.86	9.63 ± 0.39
Walking			
Frequency (n)	240.71 ± 50.07	$260.4 \pm 33.83^{\dagger}$	228.19 ± 27.46
Duration (s)	9.91 ± 0.9	9.51 ± 0.91	10.38 ± 0.91
Distance (m)	10.37 ± 1.11	10.77 ± 1.21	11.15 ± 1.08

Values are mean ± SD. $^{*}p$=0.000 vs. forward; $^{\dagger}p$=0.003 vs. forward

Table 3. Anthropometric and physiological characteristics relative to playing position

Variable	Combined (n = 63)	Defender (n = 27)	Midfield (n = 11)	Forward (n = 25)
		Playing Position		
Age	17.57 ± 0.53	17.48 ± 0.58	17.91 ± 0.3	17.52 ± 0.51
Height (m)	1.82 ± 0.06	1.79 ± 0.05	1.89 ± 0.03	1.81 ± 0.06
Weight (kg)	74.76 ± 8.2	71.45 ± 6.72	81.21 ± 5.53	75.5 ± 8.94
BMI (kg·m^2)	22.65 ± 1.97	22.32 ± 1.59	22.85 ± 2.05	22.94 ± 2.3
Sum of 7 skin folds (mm)	66.83 ± 16.91	65.39 ± 15.47	66.52 ± 17.34	68.52 ± 18.68
Body Fat (%)	8.77 ± 2.34	8.57 ± 2.14	8.78 ± 2.43	9 ± 2.57
$\dot{V}O_2max$ (ml·kg^{-1}·min^{-1})	57.83 ± 5.6	59 ± 4.78	58.32 ± 3.62	56.35 ± 6.85

Values are mean ± SD
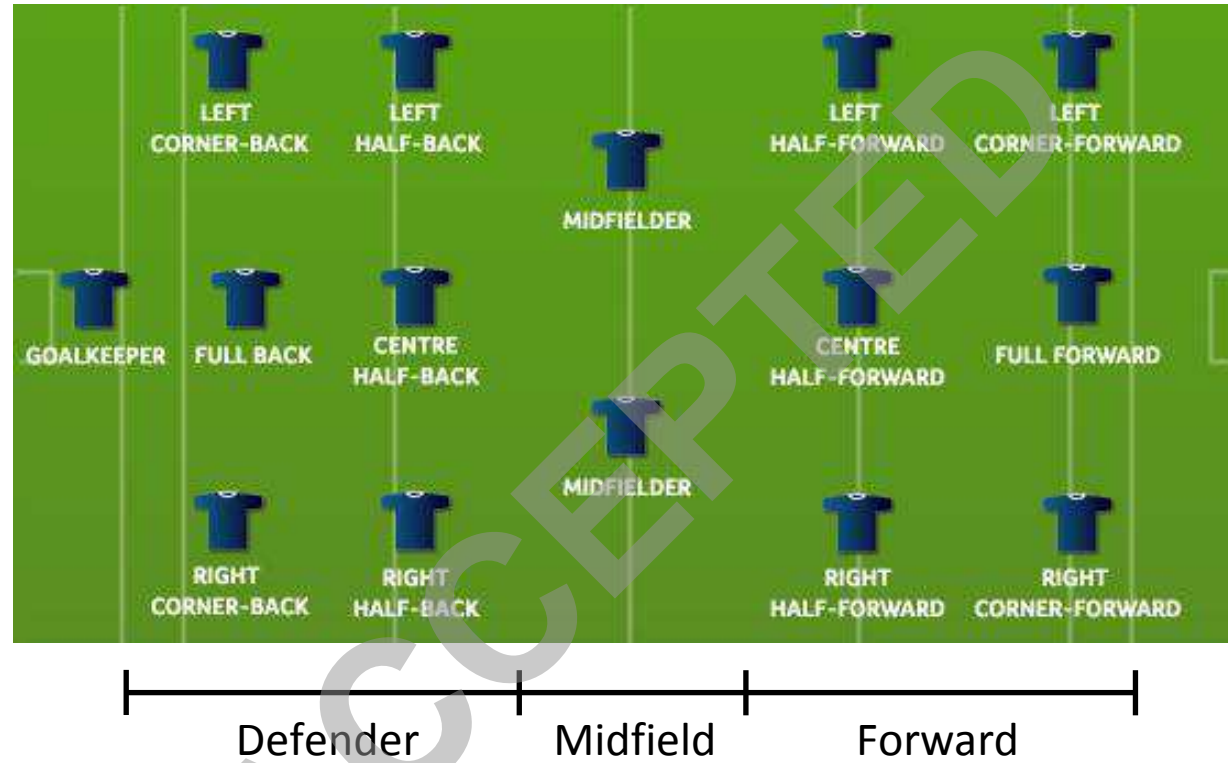
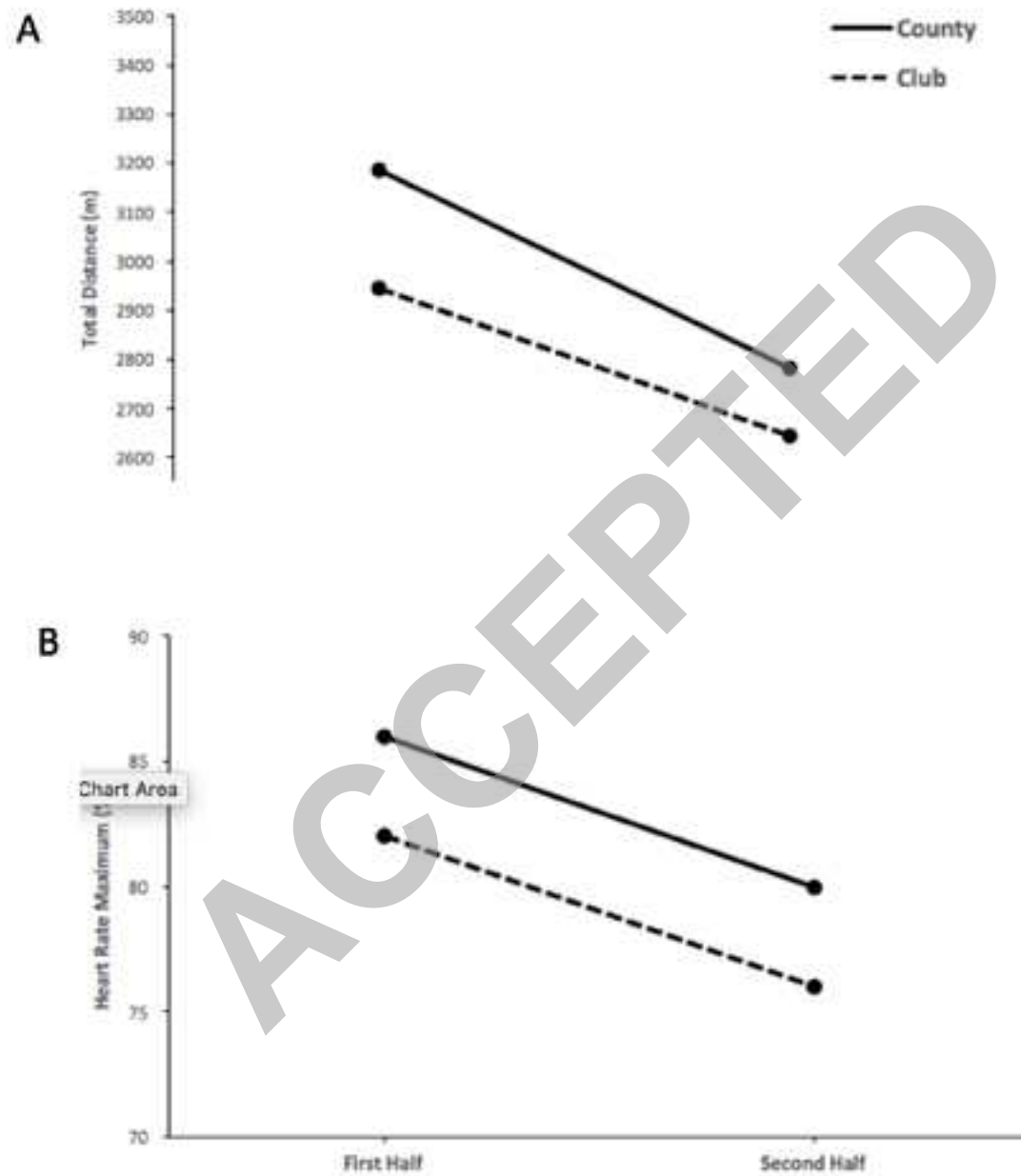Figure.1   Categorisation of playing positions

Figure.2   Effect of time on (A) total distance and (B) HR relative to playing level (*p*-value = 0.000)
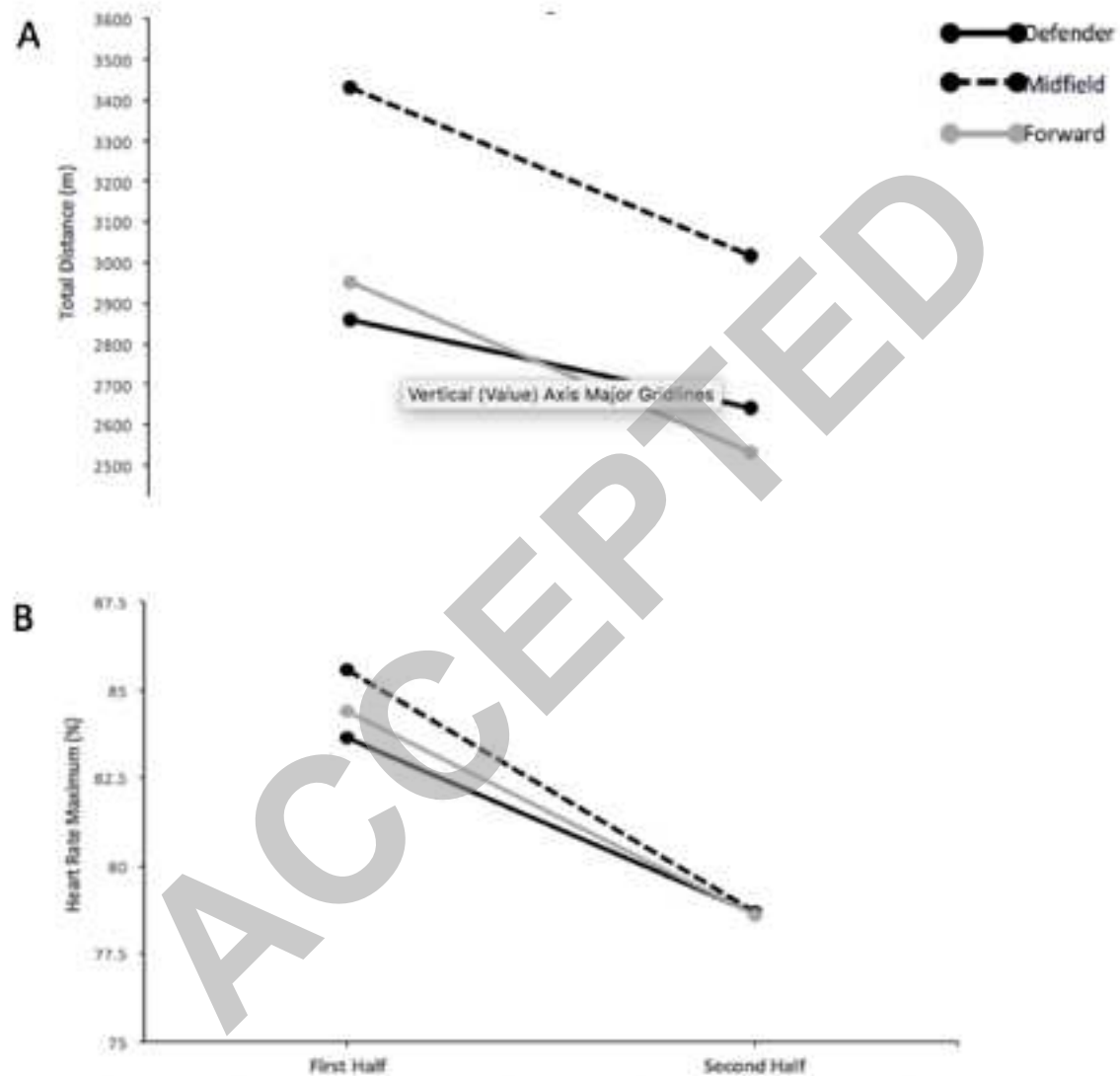
Figure.3   Effect of time on (A) total distance and (B) HR relative to playing position (*p*-value = 0.000)
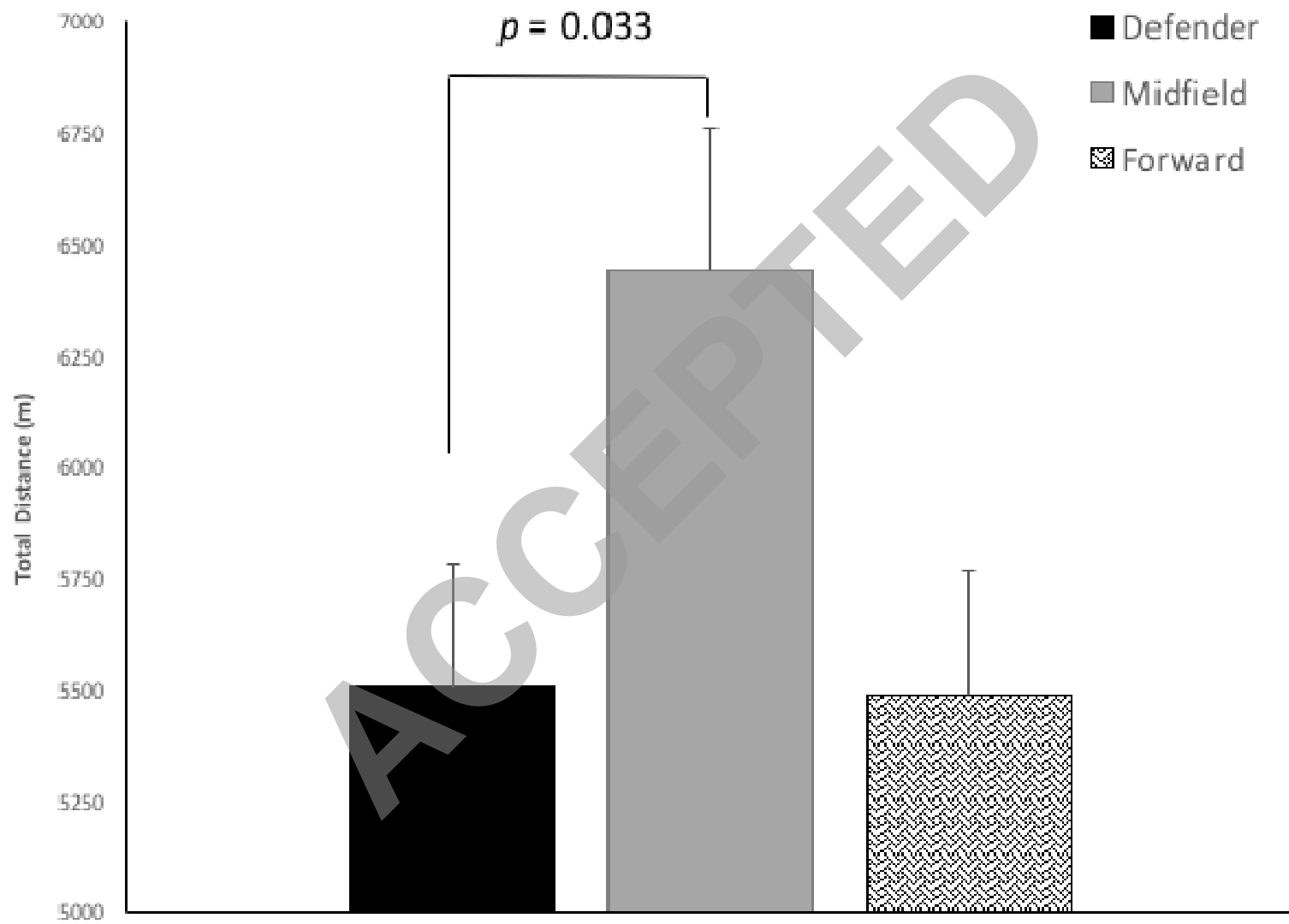
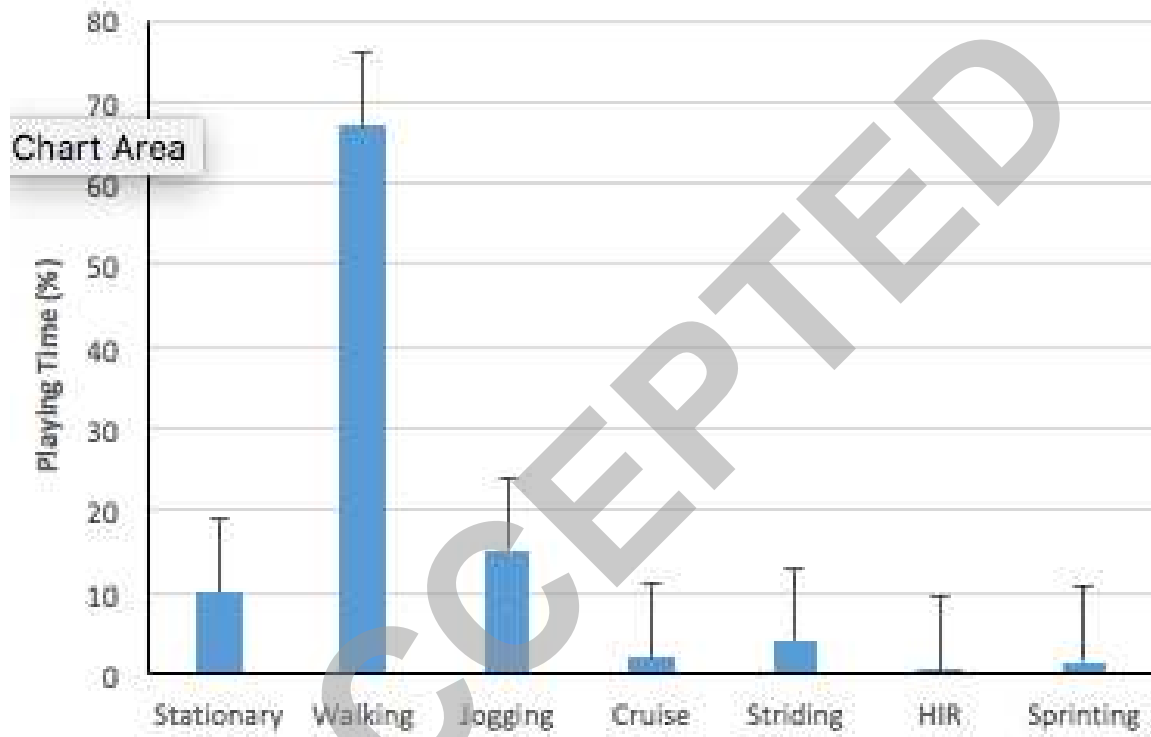Figure.4   Total distance covered during match play relative to playing position

Figure.5   Percentage playing time in each movement category