PHYSIOLOGICAL PROFILE AND ACTIVITY PATTERN OF MINOR GAELIC FOOTBALL PLAYERS

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ABSTRACT

Cullen, BD, Roantree, M, McCarren, A, Kelly, DT, O'Connor, PL, Hughes, SM, Daly, PG, and Moyna1, NM. Physiological profile and activity pattern of minor Gaelic football players. *J Strength Cond Res* 31(7): 1811–1820, 2017—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 analyzed during 17 official 15-a-side matches using global positioning system technology (SPI Pro X II; GPSports Systems, Canberra, Australia) 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 ($\dot{V}O_2$max) and peak HR (HRmax). Players covered a mean distance of 5,774 ± 737 m during a full 60-minute match. The mean %HRmax and %$\dot{V}O_2$max observed during the match play were 81.6 ± 4.3% and 70.1 ± 7.75%, respectively. The playing level had no effect on the 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 in the forward position. Time had a significant effect ($F_{(1,39)} = 33.512$, p-value $= 0.000$, and $\eta_P^2 = 0.462$) on distance covered and %HRmax, both of which showed a reduction between playing periods. Gaelic football is predominantly characterized 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, heart rate, Gaelic games

INTRODUCTION

Gaelic football is the most popular team sport in Ireland, and 1 of 5 games organized and promoted by the Gaelic Athletic Association (GAA). Community-based clubs are the cornerstone of the GAA, and competitions are organized 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 intercounty 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 more than 1 million viewers (22).

Gaelic football is a field-based contact game played between 2 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 (40). The primary objective of the team in possession is to create and exploit space 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

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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 (18). The quantitative measurement of player movement patterns has been greatly improved by advances in time motion analysis (43). Originally developed as a military tool, global positioning system (GPS) has become increasingly popular among sport scientists as a method of tracking movement patterns in many field-based team sports (1,8,15,25,47). 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 ($>20 \cdot \text{km} \cdot \text{h}^{-1}$), particularly on nonlinear paths (13,23,45,48,49). 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 (12,29,37,46).

Obtaining physiological data in a competitive environment is limited by the rules and regulations of competition (26). 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 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 (19,20).

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 (21,30,32,36,42) and only 1 study has involved players ≤ 18 years (39). Reilly et al. (39) evaluated the physiological demands and activity patterns during match play in youth (U-15) Gaelic football players. The study found that players performed at an intensity equating to 85% of HR maximum (HRmax) and covered an average distance of 5,732 ± 1,047 m during 60-minute competitive matches. There was a significant reduction in distance covered between the first and second minute 30-minute period of match play. A reduction in high-intensity activity between the first and third quarter and between the first and final quarter of match play was also reported.

The purpose of this study was to describe the movement patterns, HR 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 hypothesized that the total distance covered and overall physiological demands would be the 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 halves.

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

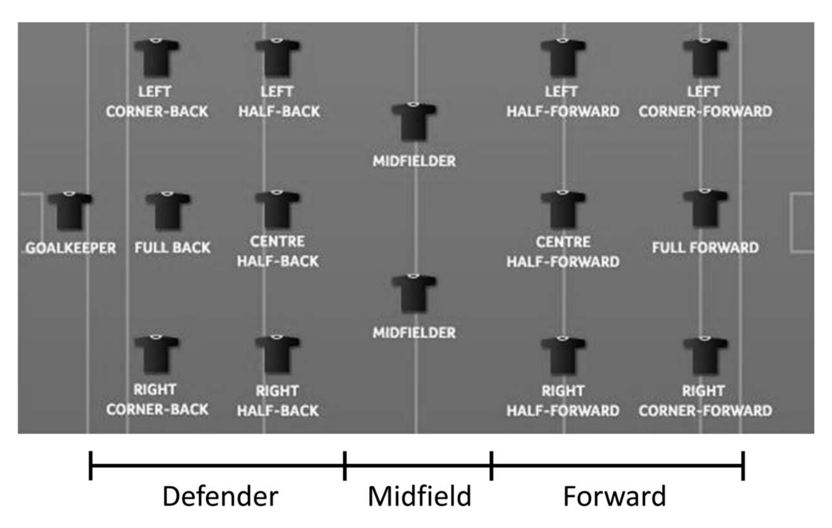

Figure 1. Categorization of playing positions.

Subjects

A total of 85 U-18 Gaelic football players (17.57 ± 0.53 yrs.)

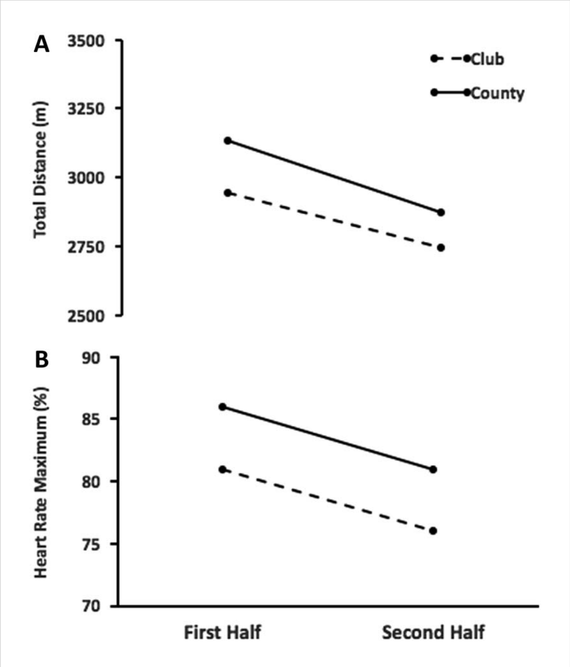

Figure 2. The effect of time on (A) total distance and (B) heart rate relative to the playing level.

representing 6 different teams (3 club level and 3 county level) were monitored during 17 competitive games (8 club level and 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 before 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 × 80–90 m) and consisted of two 30-minute periods with a 10-minute half-time interval. Thirty minutes before the start of each game, 10 outfield players were fitted with a portable 10-Hz GPS device (SPI Pro X II, weight 76 g; size 48 × 20 × 87 mm; GPSports Systems Ltd., Canberra, Australia) in the upper thoracic region. A HR telemetry system (Polar Team Pro, Polar Precision Performance SW 3.0; Polar Electro, 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, CA, USA) that was used to manually record the exact start and end times 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, USA). Analysis was undertaken using a specifically designed computer software analysis program (Java 1.6; Sun Microsystems, Santa Clara, CA, USA).

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 were stored on a receiver that was attached to an elastic strap and placed around the participant's chest. Testing took place mid-week during a 2-hour period between the hours of 16:00 and 20:00. Participants were requested to abstain from strenuous physical activity for at least 24 hours and fast for 3 hours before testing. Participants wore loose sports clothing and appropriate footwear, and were permitted to drink water ad libitum before testing.

Anthropometry

Height was measured to the nearest centimeter using a portable stadiometer (model 707 balance scales; Seca GmbH, Hamburg, Germany). Body mass was obtained to the nearest 0.1 kg using a calibrated scale (model 707 balance scales). Footwear was removed before both measurements. The body mass index was calculated as body mass in kilograms divided by squared body height in meters. Harpenden skin fold calipers (Baty International Ltd., West Sussex, United Kingdom) 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 (27). Body density was calculated using the Jackson and Pollock equation (28) and body fat was determined using the Siri equation (42).

Cardiorespiratory Assessment

Maximal oxygen uptake ($\dot{V}O_2max$) was assessed on an automated treadmill (Woodway ELG55) using an incremental protocol. The protocol consisted of initial 4 × 4-minute stages. The initial treadmill velocity was set at $6.0 \cdot km \cdot h^{-1}$ and was increased by $2.0 \cdot km \cdot h^{-1}$ at the end of each stage. Treadmill velocity remained constant after the fourth stage, and the

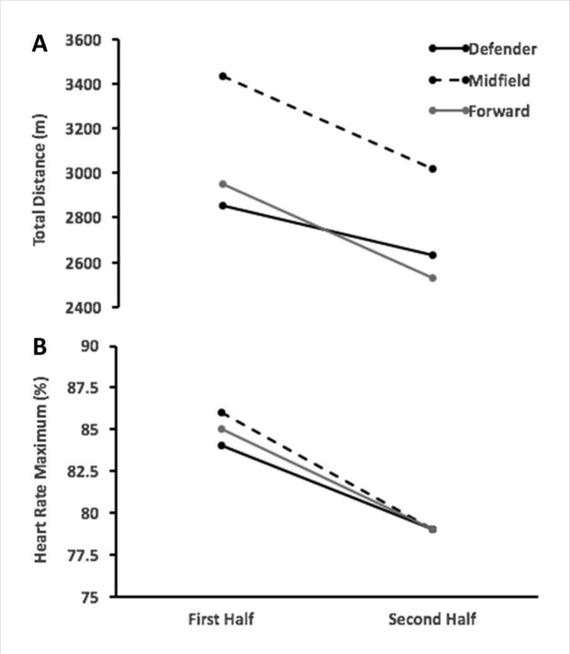

Figure 3. The effect of time on (A) total distance and (B) heart rate relative to the playing position.

treadmill gradient was increased by 2% in the initial minute after the fourth stage and at 2-minute intervals thereafter, until volitional exhaustion. Expiratory gases were measured using a Sensormedics Vmax 229 Metabolic System (Sensormedics Corp., Yorba Linda, CA, USA), and the HR was continually measured using a wireless telemetry system (Polar Team Pro, Polar Precision Performance SW 3.0). $\dot{V}O_2$max was determined by averaging the 3 highest consecutive 20-second 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 seconds using a wireless team system (Polar Team Pro, Polar Precision Performance SW 3.0). The data were 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 categorized as walking ($0–6 \cdot km \cdot h^{-1}$), jogging ($6–12 \cdot km \cdot h^{-1}$), cruise running ($12–14 \cdot km \cdot h^{-1}$), striding ($14–18 \cdot km \cdot h^{-1}$), high-intensity running ($18–20 \cdot km \cdot h^{-1}$), and sprinting ($\geq 20 \cdot km \cdot h^{-1}$). The speed thresholds for each category are similar to that reported by Cunniffe et al. (15). Entry into a speed zone was recognized and recorded when a player maintained the relevant running velocity for ≥2 seconds. The frequency, duration, and distance covered in each speed zone were evaluated.

Statistical Analyses

Data were analyzed using SPSS (IBM SPSS Statistics v21). Descriptive statistics (mean ± *SD*) was calculated for all data. A multivariate analysis of variance was conducted using the multivariate general linearized model (GLM) to examine the effect of the level and position on distance and HR during match play. Estimated oxygen uptake was highly correlated with HR (Pearson's correlation coefficient = 0.49, $p = 0.001$) and therefore excluded from analysis. Data were tested for normality and homogeneity using the Shapiro-Wilk's statistic and Box's test of equality of covariance matrices, respectively. All assumptions were met for the analysis of distance and HR as the dependent variables. A GLM was therefore conducted with level and position as the between-subject effects and with 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 $\alpha = 0.05$ 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 a dependent variable, with position, level, and the interaction between level and position as the main factor levels. Initial analysis using a Shapiro-Wilk's test revealed considerable nonnormality 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 between jogging and cruise running (Pearson's correlation = 0.377, $p = 0.009$) were both significantly correlated. The researchers therefore felt it prudent not to use a multivariate analysis of variance/GLM analysis due considerable violations of the theoretical assumptions that underpin each model. As the count of each movement types was available, a repeated measures GLM analysis with a Poisson link function was deemed appropriate. Each movement type was analyzed 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 ± 737 m and performed at 81.6 ± 4.3% HRmax/70.1 ± 7.75% $\dot{V}O_2$max during 60-minute competitive match play. The multivariate results using Philai's Trace, Wilks λ, Hoteling's Trace, and Roy's

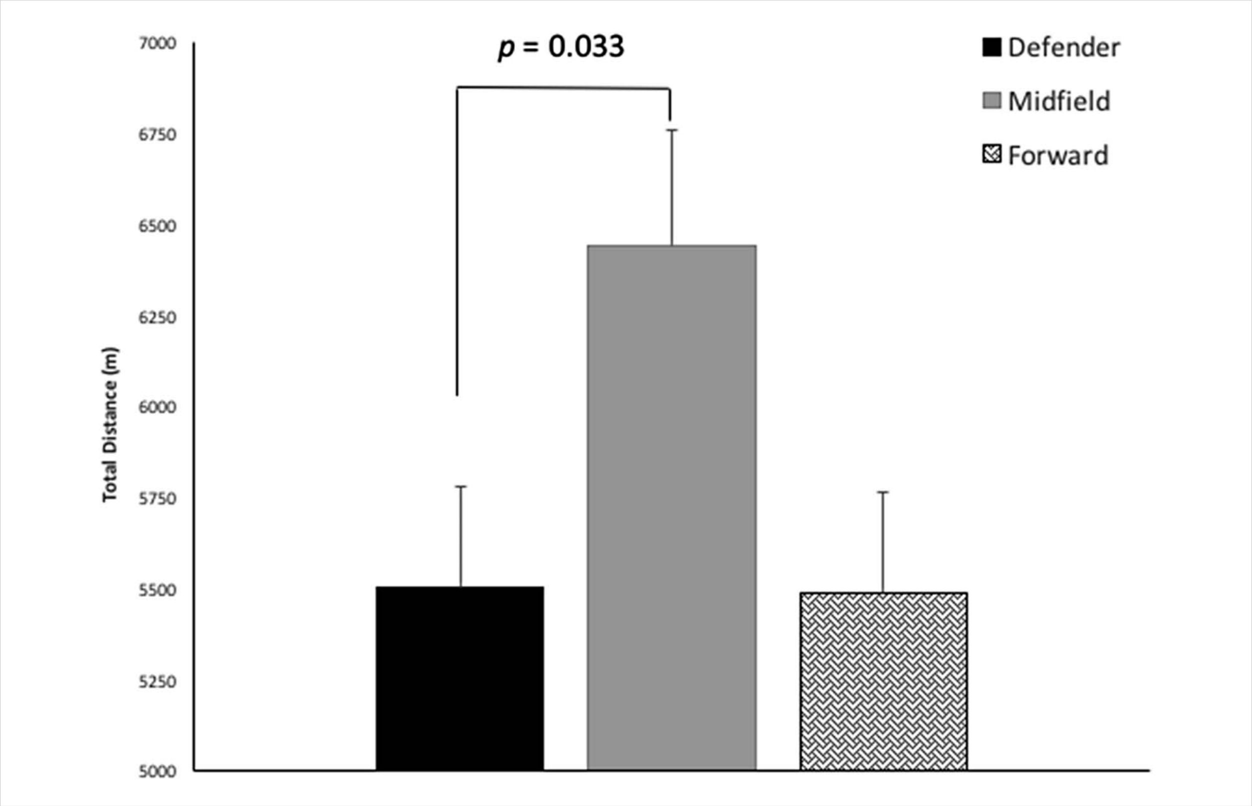

Figure 4. Total distance covered during match play relative to playing position.

largest root demonstrated that time had a significant effect $F_{(1,39)} = 33.512$, p-value $= 0.000$, and partial eta squared (η^2_P) $= 0.462$ on distance and HR (Figures 2 and 3). There were no significant interaction effects between time and the level, $F_{(1,39)} = 0.592$, p-value $= 0.446$, $\eta^2_P = 0.015$ or position, $F_{(2,39)} = 0.017$, p-value $= 0.983$, $\eta^2_P = 0.001$, variables. The 3-way interaction between time, level, and position was also insignificant, $F_{(2,39)} = 0.324$, p-value $= 0.725$, $\eta^2_P = 0.016$.

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; $\eta^2_P = 0.153$. The level variable ($F_{(1,39)} = 2.574$, $p = 0.117$, $\eta^2_P = 0.062$) and the interaction between the level and position variables ($F_{(2,39)} = 0.197$, $p = 0.822$, $\eta^2_P = 0.010$) were insignificant. Univariate post hoc analysis revealed that midfield players covered significantly ($p = 0.033$ adjusted for a Bonferroni correction factor [3 pairwise comparisons], least significant difference p-value $= 0.011$) greater distance than defenders during match play (Figure 4).

Table 1 outlines the mean frequency, duration, and distance covered of each movement category during each half of play during a full 60-minute 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).

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

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 HR 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.

The mean distance covered by U-18 players in this study is similar to that reported in younger (U-15) Gaelic football players (39). Elite adult Gaelic football players cover 8.5 km during 70-minute matches (30). However, the duration of adult matches is 10 minutes greater than underage matches. When expressed relative to the total minutes 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 minutes of match play by elite soccer players of a similar age to the participants in this study ranges from 7.6 to 8.8 km (11,26). Relative to the total minutes 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 (7,10,16,17,38) cover the most distance during match play. It was hypothesized 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. (39) who found that among 15-year-old Gaelic football players, midfield players cover a greater distance than defenders and forward players. 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 (6–8,11,38,39) 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 (35). The accumulation of blood lactate and/or membrane acidosis after periods of high-intensity activity may also contribute to temporary fatigue during match play (31). 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 fibers are completely glycogen depleted post game (31). 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.

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*.

To date, research in Gaelic football has failed to provide common and clearly defined movement categories between studies (30,32,36,39). The allocation of movement categories in this study were based on the work of Cunniffe et al. (15) involving rugby union players. The classification of sprinting ($\geq 20 \cdot \text{km} \cdot \text{h}^{-1}$) in the present study corresponded with the average peak running speed of $22 \cdot \text{km} \cdot \text{h}^{-1}$ obtained from maximal 20-m linear speed data in U-18 Gaelic football players (14). 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. Six percent of playing times was categorized as moderate intensity (cruise running/striding) and only 2% of playing time was spent performing high-intensity running and sprinting. Reilly et al. (39) used comparable speed zones in their description of U-15 Gaelic football players and reported similar findings with 88% of the total playing time constituting low-intensity activity. Similarly, moderate- and high-intensity activity represented 8 and 4.2% of playing time, respectively. Together these findings highlight that Gaelic football is predominantly characterized by light aerobic walking or jogging interspersed with short duration high-intensity running. Several researchers have undertaken similar studies in other field-based sports (6–8,9–11,16,34,38,44). 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 (7,16,17), U-18, and elite adult female Gaelic football players (32,39). Studies in elite adult Gaelic football players have provided conflicting results (30,36). 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). By contrast, Reilly et al. (39) found that midfield players perform a significantly greater amount of sprints than players positioned in the full-back and full-forward lines. The conflicting findings may be explained by the marginally higher

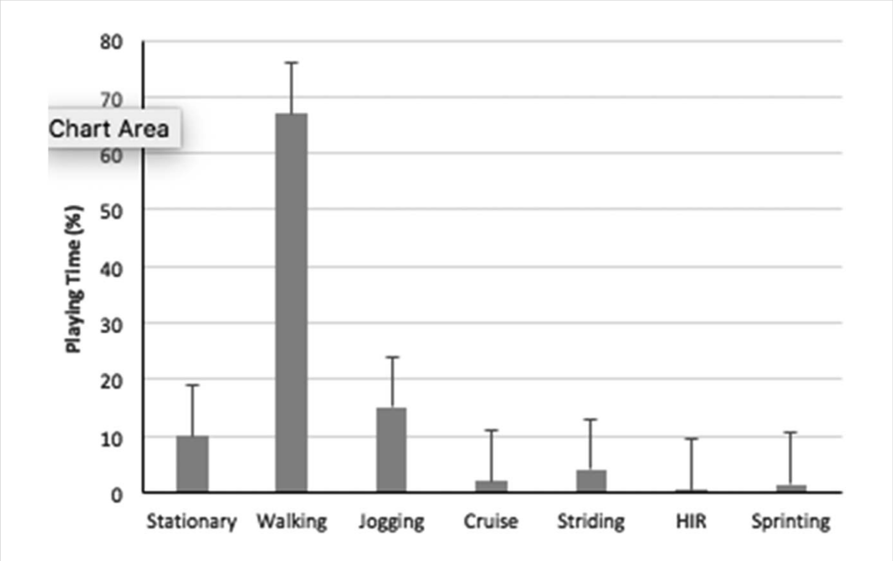

Figure 5. Percentage playing time in each movement category. HIR = high-intensity running.

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

	Playing position		
Variable	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 ± 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 ± 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 ± 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 ± 33.83‡	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.
‡$p = 0.003$ vs. forward.

TABLE 3. Anthropometric and physiological characteristics relative to playing position.*†

Variable	Combined ($n = 63$)	Playing position Defender ($n = 27$)	Midfield ($n = 11$)	Forward ($n = 25$)
Age (y)	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 ($kg \cdot m^{-2}$)	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
$\dot{V}O_2$max ($ml \cdot kg^{-1} \cdot min^{-1}$)	57.83 ± 5.6	59 ± 4.78	58.32 ± 3.62	56.35 ± 6.85

*BMI = body mass index.
†Values are mean ± *SD*.

threshold for sprinting activity (≥ 22 vs. $\geq 20 \cdot km \cdot h^{-1}$) and broader categorization of playing positions by Reilly et al (39).

A greater amount of low-to-moderate activity was performed by midfield players compared with 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 toward their own goal to assist teammates create and/or prevent scoring opportunities. It is likely that a large proportion of the low-to-moderate intensity running performed by midfield players occurs after these phases of play when returning to their position in the central area of the field.

Heart rate is generally considered a valid indicator of exercise intensity and has been widely used in the study of field-based team sports (15,33,45). The mean HRmax of 82% in the present study is comparable with elite youth, club, and county adult Gaelic football players (21,39,41). It was hypothesized that the physiological demands during match play would be the 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 HR 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 (2,5). By 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 (21,41). 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.

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 (4,21,44). 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 can affect the cardiovascular response during match play and subsequently the linearity of the HR-$\dot{V}O_2$ relation (4).

Gaelic football is predominantly characterized 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-to-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 the total distance and increased frequency of walking.

There are a number of limitations to this study. Firstly, data were 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 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 Applications

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 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 endeavor to include a broader categorization of playing positions than the present study.

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