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The physiological demands of Gaelic football

Geraint Florida-James and Thomas Reilly
Centre for Sport and Exercise Sciences, School of Human Sciences, Liverpool John Moores University, Liverpool, UK

Match-lay demands of Gaelic football and fitness profiles were assessed at club competitive level. English Gaelic football club championship players (n = 11) were assessed for anthropometry, leg strength and time to exhaustion on a treadmill run. A similar test battery was administered to a reference group of University competitive soccer players (n = 12). Heart rate was recorded during match-play using radio telemetry and blood lactate concentrations were determined at half-time and after full-time. No differences ($p>0.05$) were observed between the Gaelic and soccer players in: body mass (70.7±10.3 vs 76.6±10.3 kg); height (176±5.9 vs 177.7±6.4 cm); leg to trunk ratio (0.53±0.01 vs 0.54±0.03); adiposity (12.2±2.1 vs 13.5 ± 3.2 % body fat); mean somatotype (2.8 − 4.3−2.0 vs 2.4−4.2−2.4); leg strength measures; and performance on the treadmill. The percentage muscle mass values were lower for the Gaelic players compared to the soccer players (41.9±5.4 vs 47.3±5.2 %; $p>0.005$). For the Gaelic and soccer players, respectively, mean heart rate recorded during each half of match-play were (157±10 and 158±12 beats/min) and (164±10 and 157 ± 11 beats/min), whilst blood lactates measured at the end of each half, were (4.3 ± 1 and 3.4±1.6 mmol/l) and (4.4±1.2 and 4.5±2.1 mmol/l). Gaelic footballers at English club championship level seem to exhibit similar fitness profiles, and are subject to broadly similar physiological demands as University-level competitive soccer players.

Keywords: anthropometry, blood lactate, heart rate, isokinetic

In Gaelic football each team has 15 players but the pitch is about 40% longer than a soccer field. The ball can be played with the hands and feet and scoring is much more frequent than in soccer or rugby. Gaelic football, although widely practised throughout Ireland and in a number of other countries around the world, suffers from a lack of experimentation and research. The few studies that have appeared in the literature have concentrated on fitness profiles of Gaelic players[1–2], task analysis[3] and work rate[1]. There would appear to have been no systematic assessment of the physiological performance demands of Gaelic football match-play.

The ball is very rarely out of play in Gaelic football for long periods, especially since the introduction of the 'new rules' in 1990, allowing players fewer respites during a match[3]. The players are required to run repeatedly, with or without the ball, to jump to catch the ball or to give or receive a pass. The physiological demands on a player are governed by the irregular changes of pace and anaerobic efforts, that are superimposed on a backdrop of sustained light to moderate aerobic activity[4].

Figure 1. Contesting possession

The purposes of the present study were: (1) to investigate the physiological demands of Gaelic football match-play; (2) to obtain fitness profiles of English club Gaelic footballers; (3) to compare the results of parallel observations in a reference group of soccer players.

Materials and methods

Eleven male Gaelic players, seven from 'John Mitchels' Gaelic Football club, Liverpool, all of whom played in the 1991 Lancashire under-21 club championship final and four from the Gaelic football side at Liverpool John Moores University volunteered to participate in the study. Additionally, 12 male student soccer players from the University of Liverpool and Liverpool John Moores University's representative sides constituted a comparison group. The study took place during the English Gaelic Athletic Association's competitive season, which coincides with the English soccer season.

Address for correspondence: Professor Thomas Reilly, Centre for Sport and Exercise Sciences, School of Human Sciences, Liverpool John Moores University, Mountford Building, Byrom Street, Liverpool, L3 3AF, UK

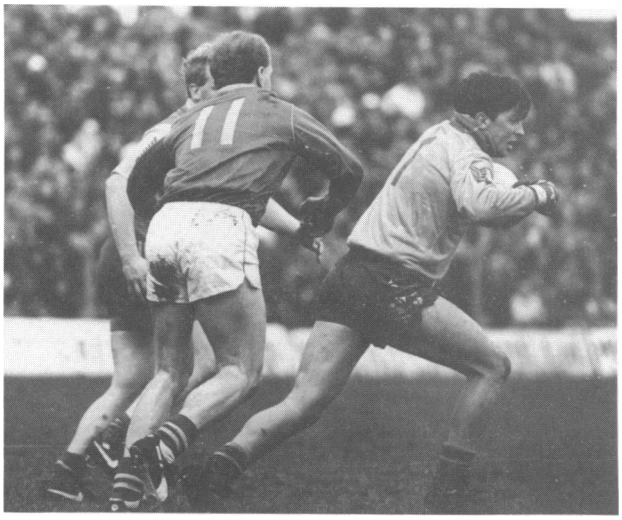


Figure 2. Contesting possession

Figure 3. Kicking and movement

The research design embraced two strands, that is: (1) measurement in the laboratory; and (2) observations in field conditions. Anthropometric measurements were taken from the subjects, to provide estimates of leg to trunk ratio, adiposity — conventionally referred to in terms of percentage body fat[2], muscle mass[5] and somatotype[6]. Additionally, leg strength was measured using the Lido Classic (Loredan, Davis, CA, USA) isokinetic machine. For the strength parameter, maximum flexion and extension movements were performed in three consecutive efforts at the following speeds: 1.047, 3.14, 5.24 rad/s. The subject performed a maximal oxygen consumption ($\dot{V}O_{2\,max}$) test to voluntary exhaustion on a motor-driven treadmill (Quinton, Seattle, USA). Heart rate was recorded every 5 s during this test. The exercise intensity was increased every 3 min and the $\dot{V}O_2$ was measured every 20 s using an on-line gas analysis system (Cardiokinetics Ltd, Salford, UK). The $\dot{V}O_2$ was not measured in the soccer group but was estimated from the time to exhaustion on the treadmill using the same protocol as was used for the Gaelic players[7]. The $\dot{V}O_{2\,max}$ was estimated using the regression equation relating $\dot{V}O_{2\,max}$ and endurance time obtained on the Gaelic players.

Heart rates were monitored and recorded throughout a match situation using short range radio telemetry (Polar Sport Tester PE-3000 Kempele, Finland) for nine Gaelic players and eight soccer players. This was achieved over six competitive Gaelic football matches and five competitive soccer matches, two players being monitored in the one match in six instances. Fingerprick blood samples were taken at half-time and at full-time, within 3 min of the end of play for measurement of blood lactate concentration. Blood samples were analysed using an Analox GM7 micro-stat analyser (Analox Instruments Ltd., London, UK).

Analysis of variance and Student t-tests were employed in order to determine whether the Gaelic footballers experienced a similar physiological load to that of their soccer counterparts in match-play. Unpaired t-tests were used to compare the mean values of the anthropometric variables between the Gaelic footballers and the soccer players. A p value of 0.05 or less was taken to indicate significance.

Results

There were no significant differences ($p>0.05$) in the physical characteristics of the groups, save for the percentage muscle mass values (*Table 1*). These

Figure 4. Jumping to contest possession

showed the soccer players had a higher percentage muscle mass ($p<0.005$) than the Gaelic players.

Table 2 includes the mean peak torques achieved by the two groups on both the right and left legs. The values are not gravity-corrected but this would have little impact on the observations and no impact on the comparisons. The differences in the two groups proved to be non-significant. The mean time to exhaustion on the treadmill test was 10.1(±1.8) min for the Gaelic footballers and 10.7(±1.6) min for the soccer players, this difference being non-significant. The $\dot{V}O_{2max}$ of the Gaelic footballers was 52.6(±4.0) ml/kg/min whilst that estimated for the soccer players was 54.4(±3.5) ml/kg/min. The maximal heart rates attained on the treadmill test were 198(±13) and 191(±6) beats/min for the Gaelic footballers and soccer players respectively.

Table 1. Characteristics of soccer (n = 12) and Gaelic football (n = 11) players

	Soccer	*Gaelic football*
Variable	*Mean**	*Mean**
Age (years)	21.4(1.4)	21.3(2.3)
Body mass (kg)	76.6(10.3)	70.7(7.7)
Height (cm)	177.7(6.4)	176(5.8)
Leg/trunk ratio	0.54(0.03)	0.53(0.01)
% Body fat	13.5(3.2)	12.2(2.1)
†% Muscle mass	47.3(5.2)	41.9(5.4)
Somatotype		
Endomorphy	2.8(0.9)	2.4(0.4)
Mesomorphy	4.3(1.4)	4.2(1.4)
Ectomorphy	2.0(0.8)	2.4(1.0)

*All values are mean(s.d.); †Significant ($p < 0.005$)

The mean heart rates recorded in the first and the second halves of the soccer matches and the Gaelic football matches proved to be similar for both games (*Table 3*), varying about an overall mean of 159(±3) beats/min for both halves and all of the matches. There was an average drop of 7 beats/min from the first to the second halves for the soccer players, although this was not significant. The difference in mean heart rates were similar for the first half and the second half in the Gaelic footballers. The difference of 7 beats/min between the mean heart rates for the first half in the soccer matches compared to the first half in the Gaelic matches was not significant. Additionally, the difference between the mean heart rates for the second half of the soccer matches and that of the Gaelic matches was non-significant. The mean heart rates expressed as a percentage of maximal heart rates recorded in the laboratory were 86% for the first half and 82% for the second half for the soccer players and 81% for both the first and the second halves for the Gaelic players (*Table 3*). The physiological load, expressed as a percentage of the subjects' $\dot{V}O_{2max}$ playing Gaelic football was calculated to be 72% in both the first and the second halves.

The treadmill velocity invoking a heart rate response (V-Match H.R.) equivalent to the mean heart rate recorded throughout the soccer and Gaelic matches is included in *Table 3*. The mean heart rate observed during play in the respective matches was interpolated to the values for heart rate and velocity for the treadmill run test.

The mean concentration of lactate during match-play was marginally higher at the end of each half for the soccer players compared to the Gaelic players (*Table 3*), and marginally higher at the end of the first half compared to the second half for the Gaelic players. These differences did not reach significance.

Table 2. Mean (±SD) peak torques (Nm) for knee extension and flexion of soccer and Gaelic players

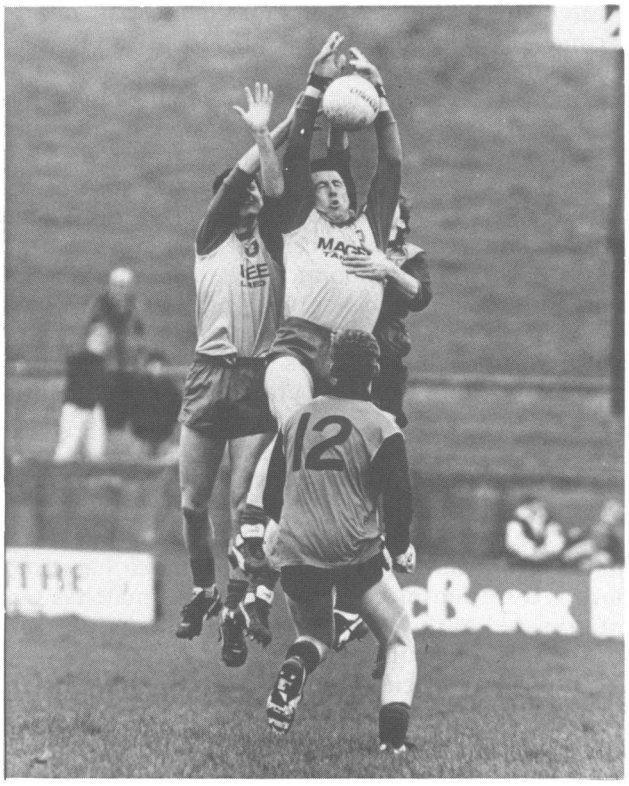
	Angular velocity (rad/s)					
	1.047		*3.14*		*5.24*	
	Ext	*Flx*	*Ext*	*Flx*	*Ext*	*Flx*
Soccer (right knee)	247(±61)	164(±38)	148(±32)	109(±24)	52(±16)	44(±12)
Gaelic football (right knee)	201(±47)	142(±38)	115(±27)	93(±21)	47(±19)	40(±13)
Soccer (left knee)	246(±37)	161(±31)	128(±29)	106±15)	50(±14)	37(±9)
Gaelic football (left knee)	199(±61)	142(±28)	115(±28)	95(±16)	54(±26)	44(±19)

Table 3. Physiological responses to match-play

	Soccer		*Gaelic football*	
	1st half	*2nd half*	*1st half*	*2nd half*
Mean heart rate (beats/min)	164(±10)	157(±11)	157(±10)	158(±12)
% Max. heart rate	86	82	81	81
Running velocity equivalent of mean match heart rate (V-Match HR) (m/s)	3.14(±0.56)	2.88(±0.74)	2.81(±0.46)	2.77(±0.60)
Blood lactate (mmol/l)	4.4(±1.2)	4.5(±2.1)	4.3(±1.8)	3.4(±1.6)

Discussion

This study confirmed that English Gaelic football club players exhibit broadly similar physical and fitness characteristics and experience a similar physiological load during match-play, as do English soccer players during University competitions. The physical characteristics of the Gaelic players were comparable to those reported by Watson for county players[8]. Higher values for mean height and body mass have been reported for the teams playing in the 1989 All-Ireland Gaelic football final than were found in this study[4]. This would suggest that successful élite teams on average tend to possess taller and heavier players than those successful at a club competitive level. In both Watson's[8] study and this study the estimated percent body fat values were well below the 16% fat content of body weight for the average male in his early twenties[4]. Whilst recognizing the limitations of doubly indirect methods of body composition analysis, especially in males[9], present observations nevertheless suggest that having a relatively low percentage body fat measure compared to the 16% population average, is characteristic of playing Gaelic football successfully at competitive levels.



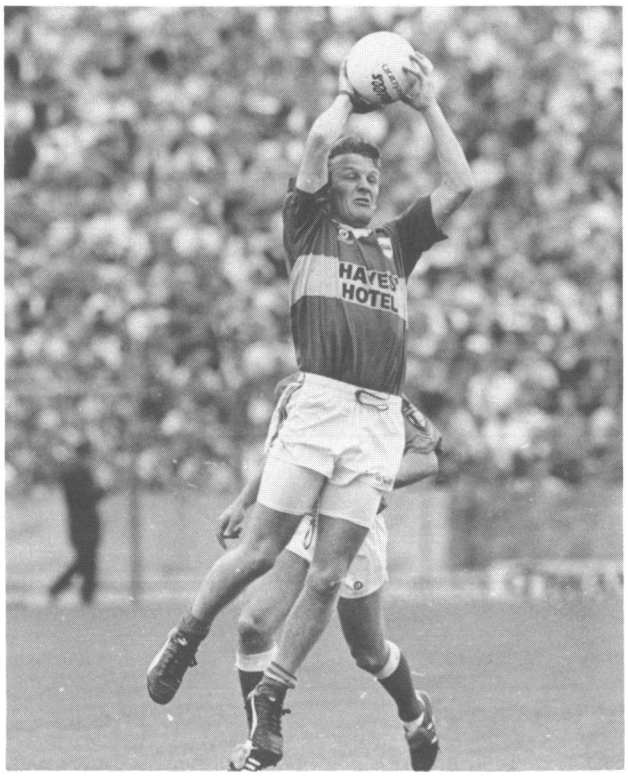


Figure 5 & 6. Illustrating the muscular strength required when tackling and breaking away from opponents

The percentage muscle mass of the soccer players in this study was significantly higher (by 5.4%) than that of the Gaelic players. The estimated adiposity measures were similar but the 5.9 kg greater average body mass of the soccer players did not reach statistical significance. The difference in muscle mass would amount to 6.6 kg, which accounts for all the difference in body mass. The Gaelic players' figure was close to the 40% muscle mass value reported for males in the normal population[5]. There was a trend toward greater leg strength in the soccer players but this was consistent only for right knee extension. It is possible that the punt and drop-kicking styles of kicking which predominate in Gaelic football do not require leg muscle strength (and hence promote leg muscle mass) as do the ground kicks used in soccer[10–11]. Gaelic football requires a large amount of upper body action, particularly through tackling by shoulder charging, high catching, and lifting and carrying of the ball. The somatotype observed for the Gaelic players may have reflected a well-developed upper body musculature since the somatotype rating of mesomorphy did not differ from the soccer players. The overall tendency towards mesomorphy in the two groups further underlined the bias towards mesomorphy, reported both in the soccer literature[12] and in the Gaelic football literature[4]. The extent to which specific musculature development occurs in the lower and upper body should be examined in players at the highest level for the two football codes.

The mean time to exhaustion for the soccer players and Gaelic players on the treadmill was similar, suggesting that the two groups of subjects were matched on their aerobic fitness level. Others have shown that the time to exhaustion on an incremental treadmill test is highly correlated with maximal oxygen uptake[7–13], an observation utilized in this study. Hence, it was suggested that the additional 30 min of competition time that the soccer players sustain during matches, does not have a significant effect in increasing their aerobic fitness level, compared to the Gaelic players. The directly measured mean $\dot{V}O_{2\,max}$ of the Gaelic players was comparable with values reported in the soccer literature which range between 50–70 ml/kg/min[7] but

were higher than the 47.6(±5.3) ml/kg/min reported by Kirgan and Reilly[14] for English club Gaelic players. The Gaelic players in that study were less successful competitively than the players in the present study. The moderately high mean values obtained for both present groups would suggest that there is a sustantial contribution from aerobic power to playing both University soccer and Gaelic football at club level.

The mean heart rates during each half of the matches for both groups corresponded to 86% and 82% of the peak heart rate, respectively, for the soccer players and 81% of the peak heart rate in both halves for the Gaelic players. These findings parallel reports in the soccer literature of 80% of peak heart rate over the two halves[4] and 86.7% (first half) and 84.4% (second half)[15]. A fall in heart rate from the first half to the second half in soccer would support the theory that soccer players become fatigued as the second half progresses, and consequently their work rate decreases[16]. The similar mean heart rate over the two halves as shown for the Gaelic football matches would not necessarily imply an absence of fatigue as the second half progressed, since the heart rate can be affected by thermal stress and cardiovascular drift, as well as work rate. The playing time is 30 min shorter in Gaelic football and so muscle glycogen stores would not be taxed to the same extent as during a 90 min soccer match. It was estimated that the Gaelic players exercised at 72% of their maximal aerobic power in both halves and aerobically trained athletes could be expected to sustain this intensity for 60 min without distress. Nevertheless, the results of this study suggest that the strain on the circulatory system whilst playing either soccer or Gaelic football is sufficiently high to provide a good training stimulus[4].

The mean blood lactate levels found in this investigation were slightly above the level at which steady state exercise might be sustained for 90 min or so[4]. These blood lactate values were consistent with the view that blood lactate levels do not rise appreciably during soccer. This view could be extended to Gaelic football from the results of the present study. It is thought that, as in soccer, the periods of walking and jogging in Gaelic football allow the players to metabolize lactate effectively and quickly correct temporary acid-base disturbances, enabling blood lactate concentrations to return rapidly to low to moderate levels, after high intensity runs.

This research has shown that English club Gaelic football is played at a level which evokes similar physiological responses to those observed in English University standard soccer. Apart from the greater muscle mass of the soccer sample, the anthropometric profiles of the Gaelic footballers resembled those of the soccer players. It is recommended that élite Gaelic footballers playing at All-Ireland championship level should be assessed in future research to establish any unique physiological or anthropometric characteristics of the game's top players.

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