Fitness Profiling of Elite Level Adolescent Gaelic Football Players

Bryan D. Cullen,[1] Cathal J. Cregg,[1] David T. Kelly,[1] Sarah M. Hughes,[1,2] Pat G. Daly,[3] and Niall M. Moyna[1,2]

[1]School of Health and Human Performance, Dublin City University, Dublin, Ireland; [2]CLARITY, Center for Sensor Web Technologies, Dublin City University, Dublin, Ireland; and [3]Gaelic Athletic Association, Croke Park, Dublin, Ireland

Abstract

Cullen, BD, Cregg, CJ, Kelly, DT, Hughes, SM, Daly, PG, and Moyna, NM. Fitness profiling of elite level adolescent Gaelic football players. *J Strength Cond Res* 27(8): 2096–2103, 2013—The purpose of this study was to evaluate the anthropometric characteristics and fitness levels of elite level under 18 (U-18) Gaelic football players to establish normative centile scores for selected fitness parameters and to compare the physical and fitness characteristics relative to each playing position. A total of 265 male U-18 Gaelic football players (age: 16.96 ± 0.7 years; height: 178.11 ± 6.27 cm; weight: 72.07 ± 8.68 kg) participated in the study. According to positional roles, players were categorized as goalkeepers ($n = 13$), defenders ($n = 113$), midfielders ($n = 30$), and forwards ($n = 109$). Height and weight were measured, and skinfolds were taken before participants sequentially performed a sit and reach test (S&R), countermovement jump (CMJ), standing long jump (SLJ), 5- and 20-m speed test, and the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1). The percentage body fat was higher ($p < 0.01$) in goalkeepers than the other playing positions. Goalkeepers had a higher body mass index than defenders ($p < 0.05$) and forwards ($p < 0.01$). Midfielders and goalkeepers were taller ($p < 0.01$) and heavier ($p < 0.01$) than defenders and forwards. The total distance covered in the YYIRT1 was significantly lower ($p < 0.01$) in goalkeepers than the other playing positions. There was no significant positional difference in the performance scores in the S&R test, CMJ, SLJ, and 5- and 20-m running speed. The study findings indicate minimal differences in the anthropometric and physiological characteristics between playing positions in elite youth level Gaelic football players. The norm-referenced percentile scores will enable conditioning coaches to benchmark elite performance and design training programs.

Key Words fitness profile, position, assessment, speed, power

Introduction

Gaelic football is the most popular team sport in Ireland and is 1 of 5 games organized and promoted by the Gaelic Athletic Association (GAA). It can best be described as a hybrid of soccer, rugby, basketball, and Australian Rules football. It is a fast physical 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 (34). This involves kicking the ball from foot to hand while moving. Goalposts with a crossbar are located on both end lines. The primary objective of the team in possession is to create and exploit space to score. A team is awarded a point when the ball is kicked or hand-passed between the posts and over the crossbar. A goal is awarded when the ball crosses the end line between the goal posts and under the crossbar. Three points are awarded for a goal. When the opposition has possession, the primary aim is to decrease the space available to prevent them from scoring and to regain possession of the ball.

The physiological demands of any sport are determined largely by the activity patterns of the game. Similar to soccer and Australian Rules football, Gaelic football involves repeated, short-duration high-intensity bouts of anaerobic exercise interspersed with sustained light-to-moderate aerobic activity. Players typically work at 80% of maximum heart rate and cover an average distance of 8.5 km during competitive games (24,35). Important game activities such as winning possession of the ball, evading opponents, and breaking tackles involve single or repeated bouts of activity involving high running velocities and muscular power (Figure 1). The duration of these high-intensity activities are largely unpredictable because of the fact that they are

Address correspondence to Bryan D. Cullen, bryan.cullen2@mail.dcu.ie.

27(8)/2096–2103

Journal of Strength and Conditioning Research

© 2013 National Strength and Conditioning Association

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

imposed by the pattern of play and can vary greatly from player to player, from one game to another (Figure 2).

Optimal performance in Gaelic football requires that players develop the appropriate fitness attributes that allow them to cope with the physical demands of the game while maintaining technique and skill levels. A small number of studies have described the anthropometric and physiological characteristics of adult male Gaelic football players at club (12,23,33), collegiate (28), and intercounty level (4,12,23,27,42). Only 2 of these studies compared positional differences in anthropometric and physiological measures (28,42). Intercounty level goalkeepers were found to have a higher percentage body fat (%BF) than the other team positions (42). Collegiate level midfielders were significantly heavier than defenders and had significantly greater scores in tests of power, strength, and aerobic capacity than defenders and forwards (28).

In recent years, a greater emphasis has been placed on the conditioning of Gaelic football players at underage level. Many coaches now routinely assess selected fitness indices using a battery of field-based tests. In addition to being valid and reliable, the tests should ideally have accompanying norm-referenced performance standards to assist in the interpretation of scores. A percentile rank indicates the point in a distribution of scores below which a given percentage of the scores is found and can provide a norm-referenced interpretation of an individual score.

Although no information is currently available on adolescent Gaelic football players, research on elite youth players in rugby league, Australian Rules football, and soccer has consistently reported positional differences in anthropometric and physical fitness measures (13–15,31). Based on the nature of Gaelic football, it is hypothesized that midfielders would have the highest endurance capacity, whereas defenders and forwards would be expected to score best on tests of speed and power. The purpose of this study was to establish norm-referenced percentile scores for selected fitness indices across playing positions in elite, secondary school senior level (under 18 [U-18]) Gaelic football players.

Figure 1. Illustration of a player gathering possession.

Figure 2. Illustration of a player competing for aerial possession.

Methods

Experimental Approach to the Problem

A standard battery of field-based tests was selected to establish norm-referenced percentiles for anthropometric and fitness measures. Participants were members of secondary school senior (U-18) Gaelic football teams participating in the "A" level national championship. The A level championship is the highest standard of schools competition for U-18 Gaelic football players. Players were categorized as goalkeepers, defenders, midfielders, and forwards to compare positional differences in anthropometric and fitness levels.

Height and weight were measured, and skinfolds were taken before participants sequentially performed a sit and reach test (S&R), countermovement jump (CMJ), standing long jump (SLJ), 5- and 20-m speed test, and the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1). These tests are considered to be valid and reliable measures of body size, flexibility, jumping ability, speed, and endurance (2,19,26,37,39) and are the primary fitness attributes required for optimal performance in Gaelic football.

Flexibility can be defined as the ability to move a joint through its complete range of motion (1). Optimal flexibility may reduce the likelihood of musculoskeletal injuries in field-based players (43). The S&R is a commonly used test to measure hamstring flexibility and has previously been measured in adult Gaelic football players at collegiate and intercounty level (4,27,28). Performance in the CMJ test is a good indicator of lower-body muscular power and has been shown to correlate with traditional laboratory-based measures of

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

muscular power (9,18). Compared with the CMJ test, the SLJ test has a stronger correlation with tests of upper-body muscular strength among adolescents and was therefore included to provide a measure of whole-body muscular power (7).

Linear running speed over distances from 5 to 40 m has been identified as an important fitness characteristic of elite players in several field-based sports (13,16,32,36). The average distance per high-intensity effort in Gaelic football is 10.6–13.5 m (24,30). Elite level Australian Rules football players cover an average distance of 18.6 m per effort (10). The 5- and 20-m speed tests provide a measure of game-specific linear speed.

The YYIRT1 was designed to replicate the physiological strain of intermittent sports and provide a measure of a player's ability to perform repeated bouts of high-intensity intermittent exercise (2). In youth soccer, performance in the YYIRT1 has been found to correlate with the frequency of high-intensity running and sprinting, and total distance covered during a game (5,6).

Subjects

A total of 265 boys (mean ± *SD*; 17.0 ± 0.7 years) who were members of secondary school senior (U-18) Gaelic football teams participating in the A level national championship volunteered for the study. Participating schools included the 4 provincial winners and the national champions. Study participants had a minimum of 5 years playing experience. Teams trained on average 2 days per week and played a game on most weeks during the competitive season.

The sample included 13 goalkeepers, 113 defenders, 30 midfielders, and 109 forwards. The experimental procedures were approved by the University Research Ethics Committee. Subjects were provided with a plain language statement outlining the nature and demands of the study and the inherent risks. Written informed consent was obtained from each of the participants and their parents before participation. Subjects were advised that they could withdraw from the study at any time.

Procedures

Participating schools were contacted in writing to establish their willingness to participate in the study. A team of researchers made a single visit to each participating school within 2 weeks of their elimination from the provincial or national championship. Testing took place over a 2-hour period between 1400 and 1800 hours in a sports hall provided by the school. 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, appropriate footwear, and were permitted to drink water ad libitum during testing. Two weeks after the testing session, 7 participants from the same school repeated all assessments in the same order and under the same conditions.

Anthropometry

Height was measured to the nearest centimeter using a portable stadiometer (Leicester Height Measure; SECA, Birmingham,

Table 1. Anthropometric and physical fitness measures–combined and positional.*

Variable	Combined (n = 265)	Goalkeepers (n = 13)	Defenders (n = 113)	Midfielders (n = 30)	Forwards (n = 109)	Range
Age (y)	16.96 ± 0.70	17.15 ± 0.80	16.97 ± 0.71	17.27 ± 0.69	16.84 ± 0.66	16–18
Height (cm)	178.11 ± 6.27	182.50 ± 3.79	177.08 ± 5.72†‡	185.63 ± 5.64	176.57 ± 5.50†‡	163–201
Weight (kg)	72.09 ± 8.68	81.62 ± 13.65	71.03 ± 6.85†‡	80.67 ± 8.84	69.71 ± 7.44†‡	49–111
BMI (kg·m^{-2})	22.69 ± 2.15	24.52 ± 4.10	22.65 ± 1.88§	23.37 ± 1.96	22.34 ± 2.00‡	18–33
Sum of 3 SF (mm)	40.56 ± 13.48	57.04 ± 25.73	40.13 ± 12.88	42.26 ± 10.92	38.58 ± 11.24	17–119
Body fat (%)	9.48 ± 3.90	14.08 ± 7.00	9.36 ± 3.78‡	10.06 ± 3.23‡	8.90 ± 3.34‡	2–30
Sit and reach (cm)	21.87 ± 6.88	24.00 ± 8.34	22.83 ± 6.62	21.40 ± 7.04	20.75 ± 6.80	2–43
CMJ (cm)	43.32 ± 5.08	42.69 ± 5.12	43.51 ± 4.95	43.93 ± 6.31	43.03 ± 4.88	29–55
SLJ (cm)	198.23 ± 20.69	193.00 ± 25.21	199.37 ± 22.28	202.47 ± 19.73	196.51 ± 18.55	134–265
5 m (s)	1.13 ± 0.08	1.16 ± 0.67	1.13 ± 0.08	1.14 ± 0.09	1.13 ± 0.07	0.92–1.33
20 m (s)	3.22 ± 0.15	3.30 ± 0.14	3.21 ± 0.15	3.23 ± 0.15	3.21 ± 0.13	2.85–3.92
YYIRT1 distance (m)	1,464.75 ± 370.12	1,070.77 ± 401.71	1,498.41 ± 356.05‡	1,502.67 ± 327.45‡	1,466.42 ± 369.93‡	440–2,320

*Values are mean ± *SD*. CMJ = countermovement jump; SF = skinfolds; SLJ = standing long jump; YYIRT1 = Yo-Yo Intermittent Recovery Test Level 1.
†$p < 0.01$ vs. midfield players.
‡$p < 0.01$ vs. goalkeepers.
§$p < 0.05$ vs. goalkeepers.

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

United Kingdom). Body mass was obtained to the nearest 0.1 kg using a calibrated scale (Salter Academy Scale Kent, United Kingdom). Footwear was removed before both measurements. Body mass index (BMI) was calculated as body mass (in kilograms) divided by body height in square meters. Chest, abdomen, and thigh skinfold thickness were measured by an experienced tester using Harpenden Skinfold Calipers (Baty International, Ltd, West Sussex, United Kingdom). A minimum of 3 measurements were taken at each site. The average measurement of each individual site was selected for analysis. Measurements were taken following the guidelines outlined by the International Society for the Advancement of Kinanthropometry (21). Lean body mass was calculated using the Hume equation (20). Percentage body fat was calculated using the Jackson and Pollock equation (22).

Sit and Reach Test

Participants removed their shoes and sat on the floor with their legs fully extended and feet against a sit and reach box (Eveque Leisure Equipment, Ltd, Cheshire, United Kingdom). Placing one hand on top of the other and keeping their legs straight, participants reached forward as far as possible while sliding their fingers along the measurement scale on top of the sit and reach box. Participants were asked to hold the final position for 3 seconds, and measurements were recorded to the nearest centimeter. After a familiarization practice, each participant performed 3 trials with the best score recorded for analysis.

Countermovement Jump

A Takei jump mat (Takei Scientific Instruments, Tokyo, Japan) was used to measure vertical displacement during the CMJ. The Takei jump mat consists of a rubber circular base attached via a retractable cord to a jump belt with a digital read out. Vertical jump height is calculated based on cord displacement. Before the CMJ, participants stood upright with both feet on the jump mat. Using the cord wheel on the jump belt, the test administrator removed any slack from the cord. With their hands on their hips throughout the test, participants were instructed to flex their lower limbs and then immediately rebound in a maximal vertical jump with no pause between the eccentric and concentric phase and land with both feet in contact with the jump mat. No instruction was provided in terms of speed or depth of the countermovement. One practice jump was provided to familiarize participants with the test procedure. Participants performed 3 jumps separated by a 30-second rest period, and the best score was selected for analysis. After each jump, the score attained was provided to the participant for motivational purposes.

Standing Long Jump

Participants aligned themselves parallel to a measuring tape that was fixed to the ground with their toes in line with the

Table 2. Quintile values for anthropometric measures.

	Quintiles			
Variable	20	40	60	80
Height (cm)				
Combined	173.00	176.00	180.00	184.00
Goalkeeper	180.40	181.30	183.00	186.40
Defender	171.90	176.00	179.00	182.20
Midfielder	180.00	185.40	187.00	190.80
Forward	172.00	175.00	178.00	180.00
Weight (kg)				
Combined	65.00	70.00	74.00	79.00
Goalkeeper	73.60	74.00	80.40	91.20
Defender	65.00	69.00	73.40	76.20
Midfielder	74.00	77.40	83.60	88.40
Forward	64.00	68.00	72.00	75.00
Body mass index ($kg \cdot m^{-2}$)				
Combined	21.01	21.97	22.99	24.50
Goalkeeper	21.39	22.54	24.34	27.46
Defender	21.12	21.87	22.98	24.38
Midfielder	21.76	22.63	23.49	25.40
Forward	20.81	21.60	22.49	24.03
Body fat (%)				
Combined	12.23	9.66	8.00	6.35
Goalkeeper	18.02	15.81	12.57	6.77
Defender	12.22	9.60	8.11	6.30
Midfielder	12.51	10.46	9.27	7.10
Forward	11.37	9.33	7.47	6.23

Table 3. Quintile values for the S&R, CMJ, and SLJ assessments.*

	Quintiles			
Variable	20	40	60	80
S&R (cm)				
Combined	15.20	21.00	24.00	28.00
Goalkeeper	14.00	21.60	25.40	32.20
Defender	17.00	22.00	25.00	28.00
Midfielder	15.00	19.40	22.00	27.40
Forward	14.00	19.00	24.00	27.00
CMJ (cm)				
Combined	39.00	42.00	44.00	48.00
Goalkeeper	35.80	41.60	45.80	47.20
Defender	39.80	42.00	44.00	48.00
Midfielder	37.40	41.40	45.00	48.60
Forward	39.00	41.00	44.00	47.00
SLJ (cm)				
Combined	181.00	195.00	204.00	213.00
Goalkeeper	161.80	196.80	202.00	214.20
Defender	182.00	197.60	206.00	214.00
Midfielder	183.00	197.40	206.60	218.80
Forward	180.00	192.00	202.00	211.00

*S&R = sit and reach; CMJ = countermovement jump; SLJ = standing long jump.

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

zero reference point on the tape. When instructed, they performed a CMJ with arm swing to propel themselves horizontally forward as far as possible. No instruction was provided in terms of speed or depth of the countermovement. One practice jump was provided to familiarize participants with the test procedure. Participants performed 3 jumps, and the distance from the rear heel to the zero reference points was recorded in centimeter. A 30-second rest period was provided between jumps, and the best score was recorded for analysis. After each jump, the score attained was provided to the participant for motivational purposes.

Five- and Twenty-Meter Speed

A 10-minute warm up including jogging, striding, and dynamic movement patterns was completed before the sprint test. Wireless electronic timing gates (Fusion Sport International Queensland, Australia) were positioned on the starting line and at a distance 5 and 20 m from the start line. Participants placed their front foot on a marked line, 50 cm behind the first timing gate. Three trials were performed, and the times were recorded to the nearest millisecond. Each sprint was separated by a 3-minute recovery period.

Yo-Yo Intermittent Recovery Test Level 1

The YYIRT1 was administered according to the procedures outlined by Krustrup et al. (25). The test involves repeated pairs of 20-m runs at progressively increasing speeds controlled by audio bleeps. The rest interval between runs was 10 seconds in duration, during which time participants completed a 10-m (2 × 5-m) walk. Participants were instructed to commence each shuttle from a stationary position. The time required to complete each shuttle run was progressively decreased. Failure to complete a shuttle run in the required time resulted in a verbal warning, and a second offense resulted in termination of the test. The distance covered was recorded and represented the test score.

Statistical Analyses

Data were analyzed using SPSS (version 17.0; SPSS, Inc., Chicago, IL, USA). Descriptive statistics were calculated for all data (mean ± *SD*). One-way analysis of variance was used to determine mean differences between playing positions (goalkeeper, defense, midfield, and forward). Tukey's post hoc analysis was used to locate significant differences. Pearson correlations were used to determine the relation between selected fitness parameters. A probability of ≤ 0.05 was accepted for statistical significance. The reliability of each test was assessed by Cronbach's alpha and intraclass correlation coefficients (ICCs). A reliability coefficient >0.7 was deemed acceptable (11).

Results

The anthropometric measurements had high reliability values (alpha and ICCs): height ($\alpha = 0.99$, ICC = 0.99), weight ($\alpha = 0.99$, ICC = 0.99), BMI ($\alpha = 0.94$, ICC = 0.89), %BF ($\alpha = 0.91$, ICC = 0.84). All measure of physical fitness used in this study had high reliability values: S&R ($\alpha = 0.95$, ICC = 0.90), CMJ ($\alpha = 0.84$, ICC = 0.73), SLJ ($\alpha = 0.96$, ICC = 0.91), 5-m sprint ($\alpha = 0.99$, ICC = 0.96), 20-m sprint ($\alpha = 0.79$, ICC = 0.77), and YYIRT1 ($\alpha = 0.87$, ICC = 0.75).

Table 1 details the anthropometric and fitness measures for each positional group. The %BF was significantly higher ($p < 0.01$) in goalkeepers than any other position. Goalkeepers and midfielders were taller and heavier ($p < 0.01$) than defenders and forwards. Body mass index values were higher among goalkeepers than defenders ($p < 0.05$) and forwards ($p < 0.01$). The total distance covered in the YYIRT1 was significantly lower ($p < 0.01$) among goalkeepers than the other positions. There was no significant difference in any other measures of physical fitness between playing positions. Quintiles scores for anthropometric and performance measures are outlined in Tables 2–4.

There was an inverse relation between %BF and performance in the CMJ ($r = -0.200$, $p < 0.01$), SLJ ($r = -0.235$,

Table 4. Quintile values for 5- and 20-m speed and YYIRT1 assessments.*

	Quintiles			
Variable	20	40	60	80
5-m speed (s)				
Combined	1.19	1.15	1.12	1.07
Goalkeeper	1.22	1.17	1.16	1.09
Defender	1.19	1.14	1.12	1.06
Midfielder	1.20	1.16	1.13	1.07
Forward	1.19	1.15	1.11	1.07
20-m speed (s)				
Combined	3.33	3.25	3.18	3.10
Goalkeeper	3.43	3.37	3.24	3.15
Defender	3.33	3.25	3.18	3.09
Midfielder	3.36	3.29	3.17	3.09
Forward	3.32	3.26	3.17	3.10
YYIRT1 (m)				
Combined	1,120.00	1,400.00	1,560.00	1,800.00
Goalkeeper	552.00	1,048.00	1,240.00	1,416.00
Defender	1,240.00	1,400.00	1,560.00	1,800.00
Midfielder	1,208.00	1,416.00	1,584.00	1,752.00
Forward	1,120.00	1,440.00	1,600.00	1,800.00

*YYIRT1 = Yo-Yo Intermittent Recovery Test Level 1.

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

$p < 0.01$), and YYIRT1 ($r = -0.283$, $p < 0.01$), respectively. Percentage body fat was significantly related to sprint performance in the 5-m ($r = 0.148$, $p < 0.05$) and 20-m ($r = 0.197$, $p < 0.05$) tests. Performance in the CMJ was inversely related to 5-m ($r = -0.234$, $p < 0.01$) and 20-m ($r = -0.435$, $p < 0.01$) sprint times. Performance in the SLJ was inversely related to 5-m ($r = -0.322$, $p < 0.01$) and 20-m ($r = -0.456$, $p < 0.01$) sprint times.

Discussion

This is the first study to describe the physical and fitness profile of elite level adolescent Gaelic football players. There were significant positional differences in anthropometric measurements. Goalkeepers covered significantly less distance than all other positions during the YYIRT1. We hypothesized that midfielders would have the highest endurance capacity, whereas defenders and forwards would score best on tests of speed and power. Considering that there were no significant positional differences in any of the other physical fitness tests, it appears that the physiological demands of match play at youth level are similar regardless of position.

The anthropometric profiles of Gaelic football players in this study are broadly similar to soccer players, rugby league backs, and Australian Rules football players at youth level (14,15,41). There is anecdotal evidence that the SLJ test is less popular in the assessment of youth players in team-based sports making it difficult to draw comparisons between Gaelic football players and other sports codes. This study also found that Gaelic football players compare favorably with youth rugby league and soccer players in tests of 20-m speed and muscular power (CMJ) (14,15). However, in comparison with elite youth Australian Rules footballer players, adolescent Gaelic football players covered considerably less distance in the YYIRT1 (40). A larger playing surface and greater duration of games may explain the increased capacity of Australian Rules football players to sustain high-intensity intermittent exercise.

Goalkeepers were taller and heavier than defenders and forwards. Assigning physically larger players to the goalkeeping position is not unique to Gaelic football. Professional and youth soccer goalkeepers were also found to be taller and heavier than other positional groups (15,38,44). Although physically larger athletes are undoubtedly better equipped to deal with aerial threats, there are other important characteristics of successful goalkeepers, such as agility and reaction speed, which should be considered in the selection process.

Midfielders in this study were taller and heavier than defenders and forwards. Similarly, McIntyre and Hall also found that collegiate level midfielders are significantly heavier than defenders (28). Midfielders are required to contest kick-outs in a crowded midfield area (Figure 2). Unlike Australian Rules football where a free kick or "mark" is awarded for a clean catch from a kick, midfielders in Gaelic football are required to break tackles and distribute possession upon landing. The present findings indicate that height and physical mass may be distinguishing characteristics between midfielders and other outfield positions among elite adolescent Gaelic football players.

The fact that goalkeepers had the highest %BF is consistent with previous studies involving senior intercounty Gaelic football players and soccer players at both professional and youth level (15,38,42). The similar anthropometric characteristics between defenders and forwards may be due in part to the fact that man-on-man marking is the standard defensive tactic used by Gaelic football coaches. Defenders are ideally of a similar size and stature to offensive opponents to track their movements and contest possession. Collegiate level defenders and forwards have also been found to have similar anthropometric characteristics (28).

Performance in the S&R test is broadly similar between the adolescent players in this study and collegiate level Gaelic football players (28). In contrast, S&R scores are up to 8 cm higher among elite level, senior intercounty players than collegiate level players (4). Similar to previous studies involving collegiate level players (28), there were no significant positional differences in hamstring flexibility. The fact that the average S&R score in this study compares poorly with age-related norms for the test (17) suggests that elite level adolescent Gaelic football players need to develop lower back and hamstring flexibility.

A major role of midfielders is to win primary possession from kick-outs. This requires being able to jump vertically from a stationary position. McIntyre and Hall (28) found that collegiate level midfielders had a greater vertical displacement in a vertical jump test than defenders and forwards. In contrast, we found no positional differences in the jump test scores among elite level U-18 Gaelic football players. The fact that collegiate level competition involves a greater degree of player specialization may help to explain these differences.

Among professional soccer players, fullbacks and midfielders cover significantly greater distances in the YYIRT1 than central defenders and forwards (29). The similar score in the YYIRT1 among all outfield players indicates that the ability to perform high-intensity intermittent exercise is an important fitness attribute for optimal performance in Gaelic football. Not surprisingly, goalkeepers covered significantly less distance in the YYIRT1 than each of the other playing positions. At youth soccer level, it is common for physically larger players to be selected for the goalkeeper position largely because of inferior fitness levels rather than superior goalkeeping skills (15). This may also occur in Gaelic football given the anthropometric and fitness profile of goalkeepers found in this study.

The inverse relation between body fat and the vertical and horizontal jump test scores is not surprising considering that excess body fat acts as dead weight when the body is lifted against gravity. Sporis et al. (38) also found an inverse

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

relation between body fat and performance in the CMJ test among elite soccer players. Vertical jump height is also been shown to be related to running velocity over distance between 5 and 30 m (8). Although performance scores in the jump tests were significantly related to both 5- and 20-m sprint times in this study, they accounted for ≤20% of the variation in sprint performance, suggesting that there are other significant factors affecting sprint performance. Speed in any sport is relative to the distance run. Sprint performance over a distance of 10 and 20 m is largely determined by acceleration (3). The strong positive relation between 5- and 20-m sprint time highlights the importance of acceleration to overall 20-m sprint performance among adolescent Gaelic football players.

In summary, the uniform nature of the physical fitness profiles across the different playing positions indicates that muscular power, speed, and endurance are key attributes for adolescent Gaelic football players, regardless of playing position. The poor correlation between anthropometric measures and physical fitness test scores suggests that anthropometric profiles should only be considered from a tactical perspective when selecting teams.

There are a number of limitations to this study. Testing took place in 19 different venues nationwide making it impossible to standardize the testing surface. Players were advised not to perform any strenuous exercise for 24 hours before testing. However, we had no control over their external commitments and were reliant on the honesty of participants. Motivation levels among participants may have been slightly diminished because of the fact that schools were tested within 2 weeks of their exit from the championship.

Practical Applications

This is the first study to provide normative data on the anthropometric and fitness profile of elite level adolescent Gaelic football players. The norm-referenced percentile scores will allow coaches compare the anthropometric and fitness profile of secondary school U-18 Gaelic football players participating in the A level national championship. Coaches at youth level may use this information to benchmark elite performance and set realistic performance standards.

Acknowledgments

This study was funded by Comhairle Laighean, Cumann Lutchleas Gael, and Science Foundation Ireland.

References

1. American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins, 2000.
2. Bangsbo, J, Iaia, FM, and Krustrup, P. The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Med* 38: 37–51, 2008.
3. Brechue, WF, Mayhew, JL, and Piper, FC. Characteristics of sprint performance in college football players. *J Strength Cond Res* 24: 1169, 2010.
4. Brick, N and O'Donoghue, P. Fitness profiles of elite players in hurling and three football codes: Soccer, rugby union and Gaelic football. In: The Proceedings of the Fifth World Congress on Science and Football. Reilly, T, Cabri, J, and Araujo, D, eds. London, UK: Routledge, 2005. pp. 166.
5. Castagna, C, Impellizzeri, F, Cecchini, E, Rampinini, E, and Alvarez, JCB. Effects of intermittent-endurance fitness on match performance in young male soccer players. *J Strength Cond Res* 23: 1954, 2009.
6. Castagna, C, Manzi, V, Impellizzeri, F, Weston, M, and Barbero Alvarez, JC. Relationship between endurance field tests and match performance in young soccer players. *J Strength Cond Res* 24: 3227, 2010.
7. Castro-Piñero, J, González-Montesinos, JL, Mora, J, Keating, XD, Girela-Rejón, MJ, Sjöström, M, and Ruiz, JR. Percentile values for muscular strength field tests in children aged 6 to 17 years: Influence of weight status. *J Strength Cond Res* 23: 2295, 2009.
8. Cronin, JB and Hansen, KT. Strength and power predictors of sports speed. *J Strength Cond Res* 19: 349–357, 2005.
9. Davis, DS, Briscoe, DA, Markowski, CT, Saville, SE, and Taylor, CJ. Physical characteristics that predict vertical jump performance in recreational male athletes. *Phys Ther Sport* 4: 167–174, 2003.
10. Dawson, B, Hopkinson, R, Appleby, B, Stewart, G, and Roberts, C. Comparison of training activities and game demands in the Australian Football League. *J Sci Med Sport* 7: 292–301, 2004.
11. DeVellis, RF. *Scale Development: Theory and Applications.* London, UK: Sage Publications, Inc, 2011.
12. Doran, DA, Donnelly, JP, and Reilly, T. Kinanthropometric and performance characteristics of Gaelic games players. In: *Kinanthropometry VIII.* T Reilly and M Marfell-Jones, eds. London, UK: Routledge, 2003.
13. Gabbett, T, Kelly, J, Ralph, S, and Driscoll, D. Physiological and anthropometric characteristics of junior elite and sub-elite rugby league players, with special reference to starters and non-starters. *J Sci Med Sport* 12: 215–222, 2009.
14. Gabbett, TJ. A comparison of physiological and anthropometric characteristics among playing positions in junior rugby league players. *Br J Sports Med* 39: 675, 2005.
15. Gil, SM, Gil, J, Ruiz, F, Irazusta, A, and Irazusta, J. Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. *J Strength Cond Res* 21: 438, 2007.
16. Gravina, L, Gil, SM, Ruiz, F, Zubero, J, Gil, J, and Irazusta, J. Anthropometric and physiological differences between first team and reserve soccer players aged 10-14 years at the beginning and end of the season. *J Strength Cond Res* 22: 1308, 2008.
17. Heyward, VH. *Advanced Fitness Assessment and Exercise Prescription.* Champaign, IL: Human Kinetics Publishers, 2006.
18. Hoffman, JR, Epstein, S, Einbinder, M, and Weinstein, Y. A comparison between the Wingate anaerobic power test to both vertical jump and line drill tests in basketball players. *J Strength Cond Res* 14: 261–264, 2000.
19. Hopkins, WG, Schabort, EJ, and Hawley, JA. Reliability of power in physical performance tests. *Sports Med* 31: 211–234, 2001.
20. Hume, R. Prediction of lean body mass from height and weight. *J Clin Pathol* 19: 389, 1966.
21. International Society for the Advancement of Kinanthropometry. *International Standards for Anthropometric Assessment.* International Society for the Advancement of Kinanthropometry, 2001.
22. Jackson, AS and Pollock, ML. Generalised equation for predicting body density of men. *Br J Nutr* 40: 497–504, 1978.

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.

23. Keane, S, Reilly, T, Borrie, A, Reilly, T, Bangsbo, J, and Hughes, M. A comparison of fitness characteristics of elite and non-elite Gaelic football players. In: *Science and Football III*, Reilly, T, Bangsbo, J and Hughes, M, eds. London, UK: Taylor & Francis, 1997, pp. 3–6.
24. Keane, S, Reilly, T, and Hughes, M. Analysis of work-rates in Gaelic football. *Aust J Sci Med Sport* 25: 100–102, 1993.
25. Krustrup, P, Mohr, M, Amstrup, T, Rysgaard, T, Johansen, J, Steensberg, A, Pedersen, PK, and Bangsbo, J. The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Med Sci Sports Exerc* 35: 697, 2003.
26. Markovic, G, Dizdar, D, Jukic, I, and Cardinale, M. Reliability and factorial validity of squat and countermovement jump tests. *J Strength Cond Res* 18: 551, 2004.
27. McIntyre, MC. A comparison of the physiological profiles of elite Gaelic footballers, hurlers, and soccer players. *Br J Sports Med* 39: 437, 2005.
28. McIntyre, MC and Hall, M. Physiological profile in relation to playing position of elite college Gaelic footballers. *Br J Sports Med* 39: 264, 2005.
29. Mohr, M, Krustrup, P, and Bangsbo, J. Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci* 21: 519–528, 2003.
30. O'Donoghue, P and King, S. Activity profile of men's Gaelic football. In: *Science and Football V: The Proceedings of The Fifth World Congress on Science and Football*, Reilly, T, Cabri, J and Araujo, D, eds. London, UK: Routledge, 2005. pp. 205–210.
31. Pyne, D, Gardner, A, Sheehan, K, and Hopkins, W. Positional differences in fitness and anthropometric characteristics in Australian football. *J Sci Med Sport* 9: 143–150, 2006.
32. Pyne, DB, Gardner, AS, Sheehan, K, and Hopkins, WG. Fitness testing and career progression in AFL football. *J Sci Med Sport* 8: 321–332, 2005.
33. Reeves, S and Collins, K. The nutritional and anthropometric status of Gaelic football players. *Int J Sport Nutr Exerc Metab* 13: 539, 2003.
34. Reilly, T and Doran, D. Science and Gaelic football: A review. *J Sports Sci* 19: 181–193, 2001.
35. Reilly, T and Keane, S. Estimation of physiological strain on Gaelic football players during match-play. In: *Science and Football IV: Proceedings of Fourth World Congress of Science and Football*, Spinks, W, Reilly, T and Murphy, A, eds. London, UK: Routledge, 2002. pp. 157–159.
36. Sierer, SP, Battaglini, CL, Mihalik, JP, Shields, EW, and Tomasini, NT. The National Football League Combine: Performance differences between drafted and non-drafted players entering the 2004 and 2005 drafts. *J Strength Cond Res* 22: 6, 2008.
37. Slinde, F, Suber, C, Suber, L, Edwén, CE, and Svantesson, U. Test-retest reliability of three different countermovement jumping tests. *J Strength Cond Res* 22: 640, 2008.
38. Sporis, G, Jukic, I, Ostojic, SM, and Milanovic, D. Fitness profiling in soccer: Physical and physiologic characteristics of elite players. *J Strength Cond Res* 23: 1947, 2009.
39. Sporis, G, Vucetic, V, Jovanovic, M, Jukic, I, and Omrcen, D. Reliability and factorial validity of flexibility tests for team sports. *J Strength Cond Res* 25: 1168, 2011.
40. Veale, JP, Pearce, AJ, and Carlson, JS. The Yo-Yo Intermittent Recovery Test (Level 1) to discriminate elite junior Australian football players. *J Sci Med Sport* 13: 329–331, 2010.
41. Veale, JP, Pearce, AJ, Koehn, S, and Carlson, JS. Performance and anthropometric characteristics of prospective elite junior Australian footballers: A case study in one junior team. *J Sci Med Sport* 11: 227–230, 2008.
42. Watson, AW. Physical and fitness characteristics of successful Gaelic footballers. *Br J Sports Med* 29: 229, 1995.
43. Witvrouw, E, Danneels, L, Asselman, P, D'Have, T, and Cambier, D. Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players. *Am J Sports Med* 31: 41, 2003.
44. Wong, DP and Wong, SHS. Physiological profile of Asian elite youth soccer players. *J Strength Cond Res* 23: 1383, 2009.

Copyright © National Strength and Conditioning Association Unauthorized reproduction of this article is prohibited.