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Original Scientific Research Study

INVESTIGATING THE ROLE OF ANTHROPOMETRIC AND PHYSICAL PERFORMANCE MEASURES ON TEAM SELECTION IN ELITE AND SUB-ELITE UNDER-20 GAELIC FOOTBALL PLAYERS

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BLUF

Simple physical performance measures can differentiate between elite and sub-elite under 20's Gaelic football players but these measures didn't distinguish elite starting players from those not selected to start the first game of the season.

ABSTRACT

The current study assessed the effect of anthropometry and physical performance measures on selection in under-20 (U20) Gaelic football players. Fifty-four (*n* = 54) U20 players (40 elite and 14 sub-elite) were assessed for measures of stature, body mass, sum of 7 skinfolds (SUM), estimated bodyfat percentage (BF%; Withers equation), countermovement jump (CMJ), standing broad jump (SBJ), reactive strength index (RSI), 5-20m sprint times and Yo-Yo intermittent recovery test level 2 (YYIRT2). Additionally, back squat, bench press and chin-up estimated 1 repetition maximums (1RM) and relative strength were assessed. Elite players had significantly less SUM (56.9mm ± 13.6, 79.6mm ± 33.3, 29%) and BF% (10% ± 2.3, 14% ± 5.9, 28%) than sub-elite players. Elite players had significantly better CMJ (51.0cm ± 7.1, 45.9cm ± 3.3, 11%), SBJ (2.37m ± 0.16, 2.1m ± 0.15, 12%), RSI (1.90 ± 0.38, 1.5 ± 0.33, 24%), 20m speed (2.86s ± 0.09, 2.95s ± 0.10, 3%), YYIRT2 distances (593m ± 200, 483m ± 121, 23%), relative back squat (1.46 ± 0.19, 1.34 ± 0.20, 9%) and chin-up strength (1.36 ± 0.10, 1.26 ± 0.13, 8%). Following preseason training, thirty-seven elite players were retested. Players selected (n = 15) to start the first game presented no significant differences ($p > 0.05$) pre or post preseason training to those not selected (n = 22). The current findings suggest that BF%, CMJ, SBJ, RSI, YYIRT2, 20m speed, relative squat and chin-up strength facilitate selection to an elite team and can distinguish elite and sub-elite players but doesn't differentiate starters from non-starters. Coaches should prioritise the development of jumping abilities, speed, fitness and relative strength with developing Gaelic football players.

Key Words - Gaelic games, performance testing, selection, team sport.

INTRODUCTION

Gaelic football is an intermittent team sport, involving high-intensity anaerobic movements (sprinting, accelerating, decelerating, change of direction, collisions) interspersed with lower intensity aerobic activities (walking and jogging) (9). During training and match-play, players must kick, catch, hand pass, tackle and block while moving at speed and evading physical contacts from the opposition (7). Within the playing structure of Gaelic football, sub-elite players represent their parochial clubs, while elite players are selected to represent their inter-county team (34). Similar to academies in professional soccer, underage inter-county development teams (U13-20 years) filter talented youngsters into senior teams (34), the U20 age-grade is the final stage of the Gaelic football athletic development pathway. Currently players face a particularly busy competition calendar, playing with their club, university and inter-county teams concurrently (7). Many talented U20 players transition into elite senior squads but the increased training volumes, running distances and physical demands required to play at the senior level increases the injury risk of these young and inexperienced players (25). It has been observed that greater physical capacities within athletes reduces the risk of injury occurrence (37). For example, players with greater repeated sprint ability, speed, lower body strength, higher aerobic capacity and more playing experience can tolerate larger workloads and have a reduced risk of injury (25). It is generally assumed that physical capacity improves as athletes mature (40), but limited evidence surrounding the physical capacity of U20 players makes this hypothesis unclear within Gaelic football populations.

Majority of the research analysing Gaelic football documents elite senior inter-county Gaelic footballer players but the U20 population remains unexamined. Therefore, coaches at the U20 level are forced to infer physical performance standards from senior data or similarly aged players from other team sports such as Australian football, rugby or soccer. Several studies have analysed the anthropometric and physical qualities of elite senior inter-county (20,38), collegiate (30) and youth (9) players but the U20 age grade is yet to be studied. Assessing the anthropometrical differences between playing levels can offer valuable insights into the key anatomical qualities that may discriminate elite from sub-

elite players (7). Furthermore, examining the physical qualities of U20 Gaelic football players will provide relevant normative data for S&C coaches who work with this population.

Previously, high-speed running has been shown to distinguish elite from sub-elite players in senior Gaelic football players. This suggests there may be a minimum level of fitness required to perform at the elite level (7). The Yo-Yo intermittent recovery test level 2 (YYIRT2), can differentiate between elite and sub-elite soccer (23) and Australian football (31) players. The YYIRT2 has been studied in elite senior Gaelic football teams (18,20,38), but these data have yet to be reported in an U20 population. Strength and power are also key determinants of sporting success (39), but little research has examined measures of maximal strength in elite Gaelic football players (20). Back squat 1 repetition maximum (1RM) influences team selection in semi-professional rugby league (ES=1.02) (14). Similarly, bench press strength discriminates between playing levels in elite junior rugby league (r = 0.80) (4) and influences selection to an elite U18s Australian football team (21). Likewise, Chin-up strength has a large effect on team selection (ES =1.26), in rugby league (14). These findings combined, suggest that repeated high intensity running ability and neuromuscular strength qualities may influence selection to elite development squads but the lack of relevant data is a challenge for coaches.

Sport-specific skills in combination with the necessary physical abilities determines selection to an elite team, comparing starters to non-starters allows coaches assess the relative importance of physical qualities within a team and highlight which qualities might influence selection in that team (13,14). Understanding the physical discrepancies between starters and non-starters will allow coaches to make more informed decisions when selecting players. Researchers have reported significantly different physical qualities between starters and non-starters in elite junior rugby, soccer and Australian football teams (13,27,45), but this is currently unexplored in Gaelic football. Starters tend to be older, taller and leaner than non-starters, while also displaying superior vertical jump abilities, greater leg strength, faster 10-40m speed times and cover larger distances in the YYIRT2 (13,27,45). Together, these findings suggest that particular anthropometric and physical qualities may influence selection to elite Gaelic football teams.

Profiling the physical abilities of developing Gaelic football players will provide coaches with normative data, identify which physical traits develop with age and how these traits may influence selection (40). Till et al. (40), reported that anthropometry, sprint speed, strength, power and aerobic capacity differentiated between playing levels across all age grades within rugby league players. Large effect sizes were observed in aerobic power (ES = 0.96) and liner sprint speeds over 10m (ES = 1.35), 20m (ES = 1.11) and 40m (ES = 0.92) when comparing elite junior rugby league players to sub-elite players (13), similar results have been presented in youth soccer (15) and elite U18 Australian football (21). These findings suggest that physical qualities are imperative to playing at an elite level in underage team sports.

Given the above, the aims of this study were twofold, firstly, to determine the differences in preseason physical performance measures between elite U20 inter-county and sub-elite U20 club level players. Secondly, to determine if physical performance measures following preseason training might influence selection to start the first game of the season. It was hypothesised that elite players would present taller and leaner physiques and superior jumping, speed, fitness and strength abilities in comparison to sub-elite players. Likewise, that starters would exhibit greater physical abilities than non-starters.

METHODS

Approach to the Problem

The current cross-sectional study investigated the effect of anthropometry and physical performance measures on selection in U20 Gaelic football players. Prior to preseason training, the physical testing results of elite players were compared to sub-elite players. Following preseason training, test results of players selected to play the first game of the season (starters) were compared to those not selected (non-starters). Sixteen anthropometrical and physical tests were used to compare differences in body mass (kg), stature (cm), sum of 7 skinfolds (mm; SUM), estimated body fat percentage (BF%; Withers equation), countermovement jump (CMJ; cm), standing broad jump (SBJ; m), reactive strength index (RSI), linear 5m - 20m speed (s), YYIRT2 (m), 3 repetition maximum (3RM; kg) and relative ($Kg \cdot Kg^{-1}$) back squat, bench press and chin-up strength.

Subjects

Forty elite U20 (mean ± SD age; 19.1 ± 0.6 years) and fourteen sub-elite U20 (19.2 ± 0.5 years) Gaelic football players participated in this study. All elite players were members of the same U20 inter-county squad. All sub-elite players were club level players invited for trials to the elite squad. Following 8 weeks of preseason training, all injury free elite players were retested under the original testing procedures and conditions to compare starters (n = 15) and non-starters (n = 22). Following ethical approval from the St Mary's School of Sport, Health and Applied Sciences, Twickenham, all eligible participants read and signed an informed consent form detailing the testing procedures, benefits and potential risks associated with the study. All participants were informed that they could withdraw from the study at any time and received detailed individualised feedback post-testing. Furthermore, all subjects completed a subjective wellness questionnaire prior to testing to evaluate subjective well-being and readiness to perform. To be eligible for inclusion in this study, all players were required to complete all initial anthropometric and performance tests, have five years Gaelic football playing experience, be over 18 years old, be deemed injury free and fit to perform by the team physiotherapist.

Procedures
All players completed the initial testing sessions on the same days and each testing battery was conducted over 2 days and separated by 48 hrs to limit accumulated fatigue effects. All testing and data collection was led by the lead researcher and took place indoors and at roughly the same time of day (17:00 – 21:00) to minimise external interferences and the influence of circadian rhythm variations on performance (11). Day 1 took place in a sports hall on a wooden sprung floor and day 2 in a University high-performance gym. Players were asked to refrain from intense physical exercise between testing sessions and the 24 hours prior to the initial testing session. Participants were allowed drink fluids and wore suitable sports clothing and footwear during testing. To maximise performance, participants were instructed to increases the consumption of slow digesting carbohydrates, lean protein and water 24 hours prior to each testing battery (17). The first testing battery was conducted prior to the beginning of preseason training (January 2018) and the second battery eight weeks later. After anthropometric assessments, a standardised "RAMP" warmup consisting of jogging, bodyweight movements and jumping exercises was led by the lead researcher, a UKSCA accredited coach (19). Tests were conducted in the stated sequence and alternated alphabetically by the first name of the athlete, except the YYIRT2 and strength testing, which were performed together as a group. This allowed optimal rest between tests and minimised cumulative fatigue impacting upon performance (33).

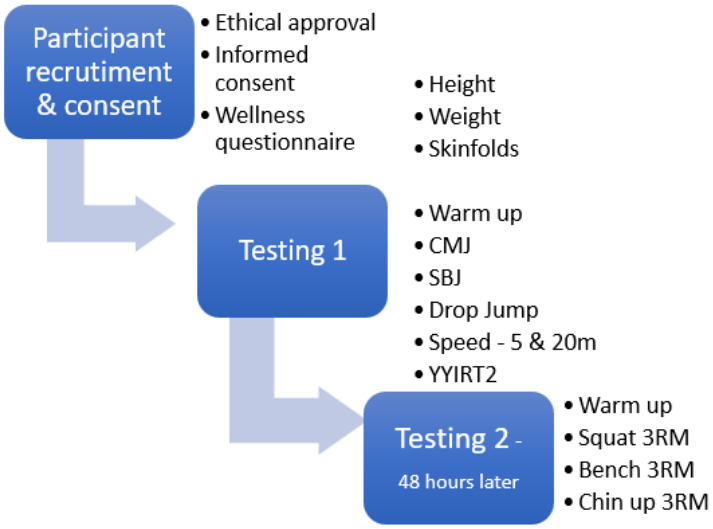


Figure 1 – Schematic of testing battery running order.

Anthropometry
All anthropometric measurements were taken prior to the warm-up and in accordance with the International Society for the Advancement of Kinanthropometry (ISAK) guidelines (28). Stature was measured to the nearest 0.01 m, using a stadiometer (Seca model 213, Hamburg, Germany) and body mass to the nearest 0.1 kg using a digital weighing scales (Seca model 875, Hamburg, Germany). Participants removed footwear, wore minimal clothes and stood in an anatomically neutral position with the head placed in the Frankfort plane during both measurements. Skinfold thickness measurement was conducted by a level 2 ISAK accredited tester, using a Harpenden skinfold callipers (Harpenden Instruments Ltd, England). The total millimetres of subcutaneous fat at seven sites (triceps, biceps, subscapular, supraspinale, abdominal, front thigh and medial calf) was measured (SUM), each site was measured twice, and the mean value was used for analysis. The typical error of measurement across the 7 sites was 3% and deemed acceptable (1). Estimated Body fat percentage was calculated using the Withers equation (43). The intraclass correlation coefficient (ICC) for stature, body mass and SUM have previously been reported, 0.99, 0.99, and 0.99 respectively (13).

Countermovement Jump
CMJ was used to assess vertical jumping capabilities using an Optojump photocell system (Microgate, Bolzano, Italy). In accordance with previous testing procedures, participants started in a standing position and were instructed to jump maximally as if "catching a ball overhead", while keeping the legs straight during the flight phase and landing with both feet dorsiflexed (2). Participants were allowed to self-select the level of arm swing, speed and depth of the eccentric phase. CMJ's incorporating an arm swing offer a more sport specific movement pattern and allow greater jump heights (10,24). Participants performed three jumps with a 30s rest interval between jumps and the best jump in centimetres was used for analysis. The opto-jump system has shown high reliability (ICC = 0.982) and intra-session reliability (ICC = 0.999) within male cohorts (2).

Standing Broad Jump (SBJ)
The SBJ was performed in line with established methods (9,24,29), subjects stood with toes on the start line, perpendicular to a standard measuring tape and were instructed to jump for maximal distance, using a simultaneous countermovement of the upper and lower appendages. Three trials were performed, with a 30s rest interval between trials and the furthest jump in meters, measured from the heel of the rear foot was used for analysis. The attempt was retaken if the subject didn't land in a stable bilateral position. The SBJ is deemed reliable (ICC = 0.95; CV = 2.4%) (29).

Reactive Strength Index (RSI)
Opto-jump propriety software (Opto-jump™ Next software, version 1.12) was used to calculate RSI (jump height in metres divided by ground contact time in seconds) from a standardised 0.3m drop jump. Participants were instructed to minimise ground contact time and maximise jump height, avoid jumping down or falling off the box, keep legs straight during the flight phase and absorb the landing with both feet dorsiflexed. To standardise the protocol and limit upper body involvement hands had to remain on hips throughout, otherwise the trial was deemed invalid and retaken. Participants performed 3 attempts, with a 30 second rest period, and the best result was used for analysis. This test is reliable and was conducted in line with previous testing procedures (ICC = 0.985) (16).

Linear Speed
Linear speed was assessed using an infrared timing system (Brower Timing Systems, Draper, USA) over 5m and 20m intervals. Distances were marked to the nearest 0.01m using a standard measuring tape and gates were placed at the start, 5m and 20m markers. Participants started in a stationary position on a start line and were instructed to start when ready, sprint through the 20m gates as fast as possible, to a coloured cone placed at 25m, to ensure subjects didn't decelerate early. Times were recorded to the nearest 0.01 second and the fastest score of three trials was used for analysis. Participants had a minimum of 3 minutes rest between trials. This test (ICC = 0.95) (38) and equipment shows high levels of reliability (CV = 1%) (41).

Yo-Yo Intermittent Recovery Test Level 2
The YYIRT2 consists of repeated 2 x 20m shuttles, separated by 10second rest periods, progressively increasing in speed and was performed in accordance with established testing procedures (23). The audio beeps were played via an iPhone 6s (Apple Inc., Cupertino, CA, USA) connected to a portable speaker (Turbosound, Partridge Green, United Kingdom). Failure to reach the line in time resulted in a verbal warning and the test was terminated when a subject failed to cross the line in time on two successive attempts or by volitional exhaustion. The total meters were recorded at the cessation of the test. The YYIRT2 has previously been shown to be a reliable measure within team sport cohorts (ICC = 0.93; CV = 7.1%) (12).

Strength Testing
Strength testing took place 48 hours later and consisted of a 3-repetition maximum (3RM) full depth back squat, bench press and weighted chin-up. Participants were fully explained the procedures, technical models and had performed the exercises as part of previous training programmes. Following a standardised bodyweight warmup, participants began lifting lighter weights for 8, 5 and 3 repetitions before increasing loads to a 3RM. 1 repetition maximums (1RM) were estimated using a 3RM correction factor (1.08) (3), estimated 1RMs and 1RM relative to body mass were used for analysis. Participants had a minimum of 3 minutes rest between heavy attempts and 20kg Eleiko weightlifting training barbells and plates (Eleiko Sport, Halmstad, Sweden) were used for all trials. During the back squat, subjects were required to "squat below parallel", ensuring the hip joint passed below the knees before returning to a standing position by extending the knee and hip joints. For the bench press to be considered a valid trial, participants feet had to remain in contact with the floor, glutes on the bench and finish the lift with arms fully extended after touching and not bouncing the barbell off their chest. Participants self-selected the hand spacing during the bench press. The 3RM chin-up was calculated as the subject's body mass in addition to the maximum load lifted for three repetitions. Beginning from a still hanging position, using an underhand grip, participants were instructed to concentrically flex the elbows and pull their chest to the bar before eccentrically lowering to a fully extended position. Verbal encouragement and loud music were used to enhance arousal and performances. The 3RM back squat, bench press, weighted chin-up are reliable in team sport athletes (ICC = 0.93, 0.88 and 0.82, CV = 2.3%, 2.2% and 4.3%) (14).

Training Programme
Following the initial testing session, all players selected to the elite squad trained for 8 weeks following a periodised concurrent programme. Training during this period consisted of 24 sessions, 13 gym, 8 pitch and 3 matches. Gym sessions were targeted towards neuromuscular strength and power development and consisted of hang power clean, back squat, split squat, bench press and chin-up exercises for 3-5 sets of 3-6 repetitions performed at 75-90% 1RM (32,35), lasting one hour with an average rate of perceived exertion (RPE) of 7. Pitch sessions incorporated Gaelic specific skills and high intensity interval training (HIT) and were 90 minutes with an average RPE of 7.5. HIT consisted of 15-second runs performed at 120% of individual maximal aerobic speed and interspersed with 15 seconds of rest for 2-3 sets of 8-12 repetitions (5). To minimise the interference effect, sessions targeting strength or aerobic qualities were separated by a minimum of 24 hours (36). Players also trained and played with their respective club and university teams during this period.

Statistical Analysis
Data were analysed using SPSS (Version 24; IBM Corporation, NY, USA) and presented as mean ± standard deviations. The data were screened for normality using the Shapiro-Wilk test, checked for homogeneity of variance using the Levine's test and sphericity using Mauchly's test of sphericity. Data met the assumptions of sphericity and parametric statistics. An independent t-test was performed to analyse the differences between playing level (elite vs sub-elite) (independent variables) and the physical performance measures (dependent variables). The repeated measures ANOVA (2x2) were used to compare the differences in physical qualities pre and post preseason training in starters and non-starters. Within-subject differences were analysed further using paired sample t-tests. Hedges' G effect size (ES)

statistic was used to assess the relative differences between elite vs sub-elite players, starters vs non-starters and pre vs post preseason performances independent of *p* values (8). Effect sizes of < 0.2, 0.2, 0.5, and >0.8 were denoted as *trivial, small, moderate,* and *large*, respectively (6). Significance was set at a level of $p \leq 0.05$ for all analysis.

RESULTS

The differences in preseason anthropometry and physical testing measures between elite and sub-elite U20 Gaelic football players are presented in Table 1. Elite players had significantly lower SUM (56.9mm ± 13.6, 79.6mm ± 33.3, 29%, *large*) and BF% (10% ± 2.3, 14% ± 5.9, 28%, *large*) than sub-elite players. In addition, elite players had significantly greater jumping performances CMJ (51.0cm ± 7.1, 45.9cm ± 3.3, 11%, *moderate*), SBJ (2.37m ± 0.16, 2.1m ± 0.15, 12%, *large*), RSI (1.90 ± 0.38, 1.5 ± 0.33, 24%, *large*), faster 20m speed (2.86s ± 0.09, 2.95s ± 0.10, 3%, *large*), larger YYIRT2 distances (593m ± 200, 483m ± 121, 23%, *moderate*), superior relative back squat (1.46 ± 0.19, 1.34 ± 0.20, 9%, *moderate*) and chin-up strength (1.36 ± 0.10, 1.26 ± 0.13, 8%, *large*). No significant differences ($p > 0.05$) were evident in 5m speed, back squat 1RM, bench 1RM, chin-up 1RM or relative bench press strength and effect sizes ranged from trivial to moderate (Range: ES = 0.16 - 0.53).

Table 1 - Preseason physical performance measures of elite and sub-elite U20 Gaelic football players.

	Elite (n = 40)	Sub-elite (n = 14)	Effect size	*Inference*
Age (y)	19.10 ± 0.63	19.22 ± 0.55	0.19	*Small*
Anthropometry				
Stature (m)	1.81 ± 0.05	1.81 ± 0.04	0.07	*Trivial*
Body mass (kg)	78.1 ± 6.6	82.1 ± 9.6	0.54	*Moderate*
Sum of 7 skinfolds (mm)	56.9 ± 13.6†	79.6 ± 33.3	1.10	*Large*
Body fat (%)	10.0 ± 2.3†	14.0 ± 5.9	1.09	*Large*
Jumping Ability				
CMJ (cm)	51.0 ± 7.1†	45.9 ± 3.3	0.79	*Moderate*
SBJ (m)	2.37 ± 0.16†	2.1 ± 0.15	1.58	*Large*
RSI (m·s-1)	1.90 ± 0.38†	1.5 ± 0.33	0.98	*Large*
Speed				
5m (s)	0.92 ± 0.04	0.94 ± 0.04	0.38	*Small*
20m (s)	2.86 ± 0.09†	2.95 ± 0.10	0.88	*Large*
YYIRT2				
Distance (m)	593 ± 200†	483 ± 121	0.59	*Moderate*
Strength				
Back squat 1RM (kg)	114 ± 16	109 ± 16	0.29	*Small*
Back squat RS ($kg \cdot kg^{-1}$)	1.46 ± 0.19†	1.34 ± 0.20	0.63	*Moderate*
Bench 1RM (kg)	77 ± 12	75 ± 15	0.16	*Small*
Bench RS ($kg \cdot kg^{-1}$)	0.99 + 0.14	0.92 ± 0.15	0.53	*Moderate*
Chin-Up 1RM (kg)	106 ± 11	103 ± 14	0.22	*Small*
Chin-Up RS ($kg \cdot kg^{-1}$)	1.36 ± 0.10†	1.26 ± 0.13	0.89	*Large*

Values presented as means ± SD.
† Significant differences ($p < 0.05$) between elite and non-elite players.
Effect sizes of <0.09, 0.10– 0.49, 0.50–0.79, and >0.80 considered trivial, small, moderate, and large, respectively.
CMJ = countermovement jump; SBJ = standing broad jump; RSI = reactive strength index; YYIRT2 = Yo-Yo intermittent recovery test level 2; 1RM = 1 repetition maximum; RS = relative strength.

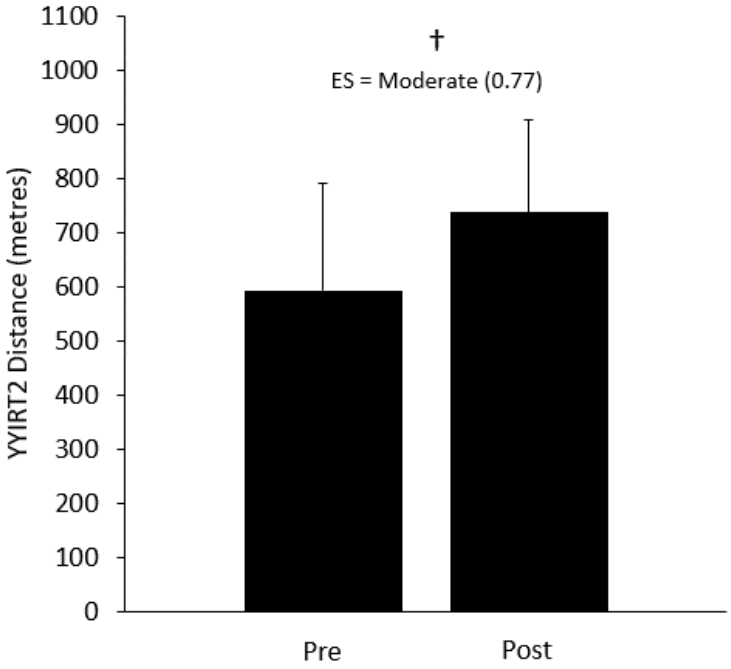
There were no statistically significant two-way interactions between performance variables and those selected to start the first game ($p > 0.05$). Within subject changes in performance variables are presented in Table 2. Following preseason training, starters significantly improved YYIT2 distances, (544m ± 201, 705m ± 137, 30%, *large*) and bench press 1RM (78kg ± 14, 88kg ± 13, 13%, *moderate*). Non-starters significantly improved YYIT2 distances (627m ± 194, 760m ± 190, 21%, *moderate*), back squat 1RM (112kg ± 14, 123kg ± 13, 9%, *moderate*), chin-up 1RM (105kg ± 11, 112kg ± 10, 7%, *moderate*) and relative back squat (1.44 ± 017, 1.54 ± 0.17, 7%, *moderate*) and relative chin-up (1.34 ± 0.11, 1.40 ± 0.09, 4%, *moderate*) strength.

Table 2 - Pre and post preseason physical qualities of starters and non-starters on an elite U20 Gaelic football team.

	Starters (n = 15)	Non-starters (n = 22)			Starters (n = 15)	Non-starters (n = 22)		
	Pre	**Pre**	**Effect size**	***Inference***	**Post**	**Post**	**Effect size**	***Inference***
Age (y)	19.3 ± 0.7	19.0 ± 0.6	0.33	*Small*	19.4 ± 0.67	19.2 ± 0.59	0.35	*Small*
Anthropometry								
Stature (m)	1.82 ± 0.1	1.81 ± 0.05	0.09	*Trivial*	1.82 ± 0.06	1.81 ± 0.05	0.06	*Trivial*
Body mass (kg)	78.6 ± 7.8	78.0 ± 5.5	0.09	*Trivial*	80.6 ± 7.1	79.8 ± 5.4	0.12	*Small*
Sum of 7 skinfolds (mm)	53.5 ± 8.8	58.7 ± 15.9	0.38	*Small*	52.6 ± 8.2	57.3 ± 16.9	0.33	*Small*
Body fat (%)	10.2 ± 3.0	10.0 ± 2.0	0.38	*Small*	9.3 ± 1.4	10.1 ± 2.9	0.33	*Small*
Jumping Ability								
CMJ (cm)	53.3 ± 7.5	50.2 ± 6.8	0.42	*Small*	54.7 ± 7.0	50.4 ± 6.5	0.63	*Moderate*
SBJ (m)	2.41 ± 0.15	2.37 ± 0.17	0.27	*Small*	2.47 ± 0.18	2.37 ± 0.16	0.54	*Moderate*
RSI ($m \cdot s^{-1}$)	2.02 ± 0.35	1.88 ± 0.37	0.38	*Small*	1.90 ± 0.31	1.82 ± 0.37	0.22	*Small*
Speed								
5m (s)	0.92 ± 0.03	0.92 ± 0.04	0.23	*Small*	0.91 ± 0.03	0.90 ± 0.03	0.13	*Small*
20m (s)	2.82 ± 0.09	2.88 ± 0.08	0.64	*Moderate*	2.85 ± 0.08	2.87 ± 0.08	0.29	*Small*
YYIRT2								
Distance (m)	544 ± 201	627 ± 194	0.41	*Small*	705 ± 137*	760 ± 190*	0.31	*Small*
Strength								
Back squat 1RM (kg)	116 ± 20	112 ± 14	0.24	*Small*	126 ± 18	123 ± 13*	0.25	*Small*
Back squat RS ($kg \cdot kg^{-1}$)	149 ± 0.22	1.44 ± 0.17	0.26	*Small*	1.58 ± 0.23	1.54 ± 0.17*	0.18	*Small*
Bench 1RM (kg)	78 ± 14	78 ± 11	0.02	*Trivial*	88 ± 13*	84 ± 11	0.37	*Small*
Bench RS ($kg \cdot kg^{-1}$)	1.00 ± 0.16	1.00 ± 0.13	0.03	*Trivial*	1.09 ± 0.12	1.05 ± 0.12	0.36	*Small*
Chin-Up 1RM (kg)	109 ± 12	105 ± 11	0.38	*Small*	115 ± 11	112 ± 10*	0.32	*Small*
Chin-Up RS ($kg \cdot kg^{-1}$)	1.39 ± 0.10	1.34 ± 0.11	0.46	*Small*	1.43 ± 0.08	1.40 ± 0.09*	0.34	*Small*

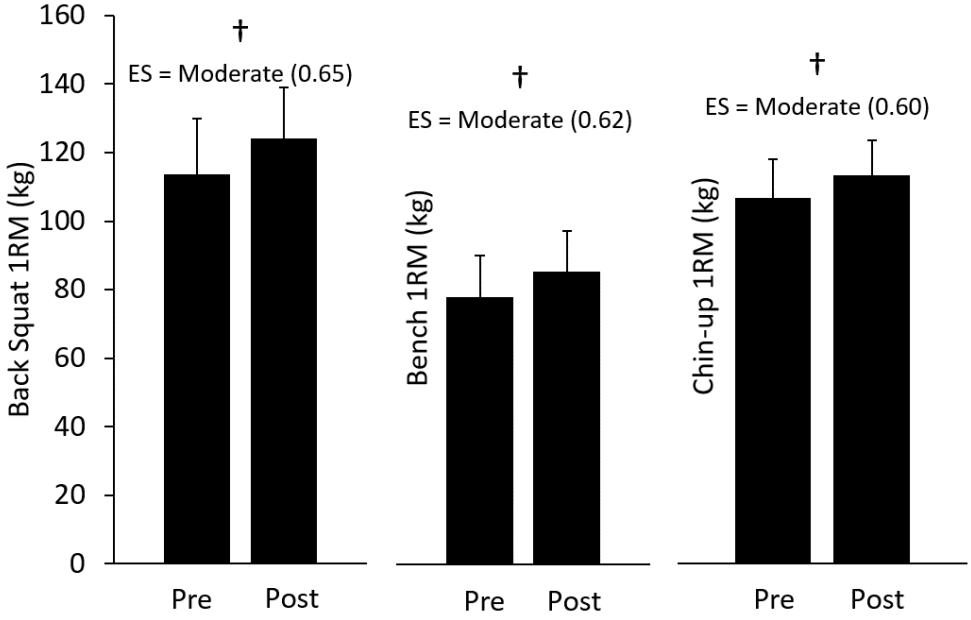
Values presented as means ± SD.
† Significant differences ($p < 0.05$) between starters and non-starters.
* Significant differences ($p < 0.05$) between pretests and posttests.
Effect sizes of <0.09, 0.10– 0.49, 0.50–0.79, and >0.80 considered trivial, small, moderate, and large, respectively.
CMJ = countermovement jump; SBJ = standing broad jump; RSI = reactive strength index; YYIRT2 = Yo-Yo intermittent recovery test level 2; 1RM = 1 repetition maximum; RS = relative strength.

The statistically significant changes in the elite squad's performance measures following preseason training are presented in Figures 2-4. The elite squad significantly improved YYIRT2 distances (+144m ± 131, 24%, *moderate*), back squat 1RM (+10kg ± 7, 24%, *moderate*), bench press 1RM (+7kg ± 7, 9%, *moderate*), chin-up 1RM (+7kg ± 5, 6%, *moderate*) and relative back squat (+0.09 ± 0.09, 6%, *small*), relative bench press (+0.07 ± 0.08, 7%, *moderate*) and relative chin-up (+0.05 ± 0.06, 4%, *moderate*) strength respectively. There were no significant changes ($p > 0.05$) in any other performance measure and effects sizes ranged from trivial to small (Range: ES = 0.02 - 0.29).



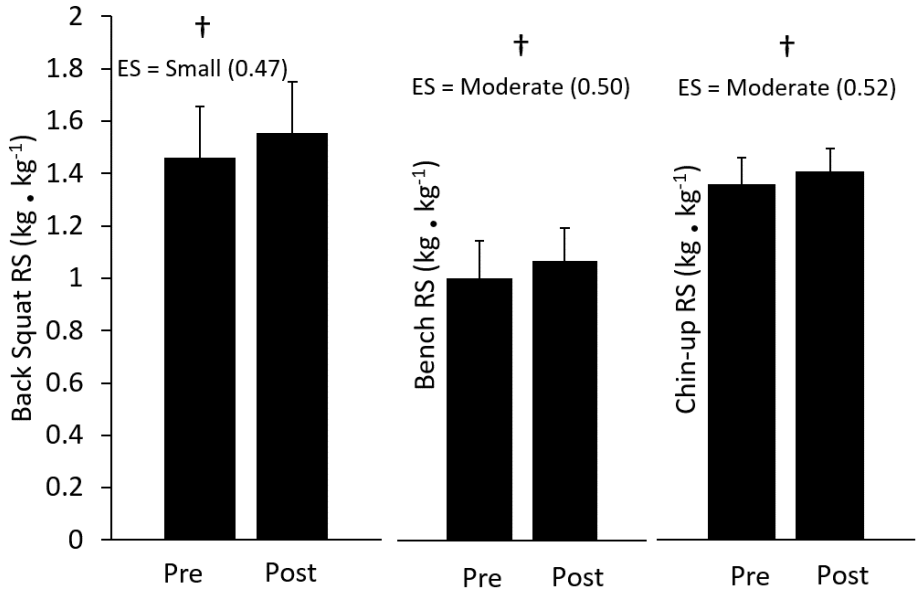
† Significant differences ($p < 0.05$) between pre-tests and post-tests.
ES = Effect sizes; YYIRT2 = Yo-Yo intermittent recovery test level 2.

Figure 2 – Changes in elite players repeated high-intensity running after 8 weeks of preseason training (*n* = 37). Values presented as means ± SD.



Values presented as means ± SD. † Significant differences ($p < 0.05$) between pre-test and post-test.
ES = Effect sizes; 1RM = 1 repetition maximum.

Figure 3 – Changes in elite players maximal strength after 8 weeks of preseason training (*n* = 37).



Values presented as means ± SD. † Significant differences ($p < 0.05$) between pre-test and post-test.
ES = Effect sizes; RS = relative strength.

Figure 4 – Changes in elite players relative strength after 8 weeks of preseason training (*n* = 37).

DISCUSSION

The aims of the current study were to determine the differences in preseason physical performance measures between elite U20 inter-county and sub-elite U20 club level players. Furthermore, to determine if physical performance measures following preseason training might influence selection to start the first game of the season. This study is the first to profile the preseason anthropometric and physical performance test results of U20 Gaelic football players and compare the physical qualities of an elite squad to age-matched sub-elite players. The findings presented may help coaches determine which physical qualities may contribute or hinder elite performance. The primary findings were that significant differences are evident in anthropometry and physical performance measures between those selected to an elite U20 Gaelic football squad and those not selected (i.e. sub-elite). The results demonstrate that elite U20 Gaelic football players are more powerful, leaner, faster, fitter and stronger than sub-elite players, suggesting that these physical characteristics may facilitate playing at the elite level. Interestingly, there were no significant differences between starters and non-starters in any anthropometric or physical performance measure, suggesting that once players develop elite level physical qualities, alternative skills and attributes contribute to team selection.

It was observed that elite players were significantly leaner than sub-elite players but not significantly different in body mass or stature. The findings support previous research which suggested that lean muscle mass discriminates elite from sub-elite Gaelic football players (7). This lean predisposition may contribute to other physical qualities and influence the superior jumping performances, faster sprint speeds and greater relative strength seen in the elite players. Therefore, coaches should endeavour to optimise body composition through training practices and nutritional strategies, these may include consistent educational work-shops, goal setting for players with regard to body composition and nutritional preparedness for training and match-play (7). Although there were no differences in stature between elite and sub-elite players, elite players had significantly better jumping abilities and reactive strength than sub-elite players. These findings are consistent with elite and sub-elite junior rugby league players (13) and highlight the importance of lower body power and reactive qualities in intermittent team sports. These superior performances may be attributed to the importance of jumping and catching in Gaelic football. Shovlin (38) hypothesised that the requirement to frequently contest aerial balls influenced greater vertical jumping abilities in Gaelic football players. With such a high priority placed on this specific skill set, it's logical that elite players demonstrate greater explosiveness (RSI), vertical (CMJ) and horizontal (SBJ) jumping abilities.

In addition to explosive qualities, the physical demands of Gaelic football require well-developed endurance and strength qualities (26). As hypothesised, elite U20 players presented significantly different YYIRT2 performances to sub-elite players, suggesting performance at the elite level requires superior levels of conditioning. Interestingly, absolute strength in the back squat, bench press and chin-ups were not significantly different between elite and sub-elite players. However, significant differences were evident in relative lower (back squat) and upper body (chin up) strength. Relative back squat strength relates to greater power and speed qualities in elite academy rugby league (22) but is unexamined in Gaelic football. Back squat strength has a strong correlation with jump and speed tasks and may have contributed to the elite players superior speed and jumping abilities (42). These findings are consistent with previous literature, where it has been demonstrated that endurance, strength and power characteristics influence selection to elite junior rugby league (13), soccer (15) and Australian football (21) teams.

This study reports the physical testing performances of those selected to start the first game of the season (starters) with those not selected (non-starters). Starters were taller, heavier, leaner and had superior performances in all tests except 5-m sprint and YYIRT2, suggesting physical qualities may have a minor effect on selection but there were no statistically significant differences in any variable when compared to non-starters pre and post preseason training (Table 2). Similar to the findings presented in this study, vertical jump, lower and upper body strength were non-significant between starters and non-starters in an elite Australian football team (45). The results imply that physical qualities are homogeneous among elite U20 Gaelic football players, suggesting that Gaelic football-specific skills, decision making and playing ability influences a manager's decision when selecting the starting team.

During the observed 8-week training period, some players were required to play with their respective club or university teams, thus limiting any standardisation of training loads. Furthermore, without a control group, it is difficult to make meaningful inferences regarding the effects of the training programme on physical adaptations. Despite this, YYIRT2 distances improved following preseason training (24%) (Figure 2) and the improvements in this study are in line with previously reported improvements in elite senior Gaelic football players, 31% (18) and 18% (38) respectively. The YYIRT2 scores reported in this study are lower than previously reported distances in elite senior players (985 - 1587m) (18,20,38) and suggests that repeated high-intensity intermittent running ability increases with age and playing experience (25). Although it must be noted, the preseason YYIRT2 scores reported are expected to increase further, over the course of the season (18,38). Additionally, all measures of absolute strength (Squat 1RM = 9%, Bench 1RM = 9%, Chin-up 1RM = 6%) and relative strength (Squat = 6%, Bench = 7%, Chin-up = 4%) concurrently improved. Likewise, professional soccer players made significant improvements in half back squat 1RM, bench press 1RM and YYIRT2 performances following an 8-week preseason concurrent training programme consisting of muscular strength training and high-intensity interval running (44). These findings suggest that elite team sports athletes can concurrently improve contrasting qualities during the preseason, provided training is organised appropriately.

In summary, the current study is the first to profile the anthropometric and physical performances measures of U20 Gaelic football players and found significant differences in preseason results between elite and sub-elite players. Body fat, jumping distances, explosiveness, speed, high intensity running ability and relative strength all improved with playing level. No significant differences were evident between starters and non-starters but, after 8 weeks of preseason training, elite players significantly improved YYIRT2 distances, back squat 1RM, bench press 1RM, chin-up 1RM and relative back squat, bench press strength respectively. This study found that specific physical tests (body fat, CMJ, SBJ, RSI, 20m speed, YYIRT2 distance, back squat and chin-up relative to bodyweight) can differentiate between elite and sub-elite players. Although, these physical tests didn't discriminate starters from non-starters. The findings presented in this study suggest lean muscle mass, power, speed, endurance and relative strength qualities facilitate playing at the elite level and effect squad selection. Once these physical attributes are present, the ability to execute Gaelic specific skills under pressure and in-game conditions dictate who is selected to start on an elite U20 Gaelic football team. The results presented may offer normative standards for coaches, but this study only presents the results of one elite U20 squad and should be interpreted accordingly. A standardised battery of fitness tests conducted with larger sample sizes, over multiple seasons with several teams and age grades will provide further insight regarding the effect of physical performance measures on team selection in Gaelic football.

PRACTICAL APPLICATIONS

Strength and conditioning coaches working with U20 Gaelic football players should use physical testing results to ascertain the physical discrepancies within the squad and inform training practices. Players with underdeveloped jumping abilities, speed, fitness and relative strength qualities may be limiting their potential to play at the highest level, therefore, coaches should prioritise the enhancement of these qualities in Gaelic football strength and conditioning programmes. Table 3 presents the physical qualities of one elite U20 Gaelic football team and provides coaches with normative data and age specific benchmarks. The demanding fixture schedule in elite Gaelic football may limit the contact time strength and conditioning coaches have with athletes, therefore, the development of relative strength and aerobic fitness should be emphasised during the preseason period. A concurrent muscular strength and high-intensity running programme can improve strength and endurance measures but contrasting qualities should be emphasised on separate days. Strength and conditioning coaches should liaise with skill coaches to create a training programme that incorporates the development of both Gaelic football skills and physical qualities, this may produce a synergistic effect and facilitate a larger transfer of physical qualities to game performances.

Table 3 - Post preseason physical qualities of an elite U20 Gaelic football team (n = 37).

	Minimum	Maximum
Anthropometry		
Stature (m)	1.71	1.93
Body mass (kg)	69.8	92.0
Sum of 7 skinfolds (mm)	35.8	104.2
Body fat (%)	6	18
Jumping Ability		
CMJ (cm)	40.8	68.8
SBJ (m)	2.14	2.82
RSI (m·s-1)	1.28	2.60
Speed		
5m (s)	0.84	0.96
20m (s)	2.71	3.04
YYIRT2		
Distance (m)	480	1160
Strength		
Back squat 1RM (kg)	95	162
Back squat RS (kg · kg^{-1})	1.13	2.00
Bench 1RM (kg)	65	113
Bench RS (kg · kg^{-1})	0.75	1.31
Chin-Up 1RM (kg)	97	137
Chin-Up RS (kg · kg^{-1})	1.27	1.64

CMJ = countermovement jump; SBJ = standing broad jump; RSI = reactive strength index; YYIRT2 = Yo-Yo intermittent recovery test level 2; 1RM = 1 repetition maximum; RS = relative strength.

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