International Journal of Strength and Conditioning

Daly, L. S., Cregg, C. J., Forde, D., Catháin, C, Ó., Kelly, D. T. (2025). Profiling the Physical Conditioning Attributes of Young Male Gaelic Football Players: From Adolescence to Adulthood. International Journal of Strength and Conditioning
https://doi.org/10.47206/ijsc.v5i1.456

Profiling the Physical Conditioning Attributes of Young Male Gaelic Football Players: From Adolescence to Adulthood

Lorcan S Daly[1,2,3]*, Cathal J Cregg[4], Daniel Forde[4], Ciarán Ó Catháin[1,2] and David T Kelly[1,2]

[1]Department of Sport and Health Sciences, Technological University of the Shannon, Ireland, [2]SHE Research group, Technological University of the Shannon, Ireland, [3]Sport and Human Performance Research Centre, University of Limerick, Ireland, [4]Connacht GAA Centre of Excellence, Ireland

*Corresponding Author: lorcan.daly@tus.ie

ABSTRACT

This study assessed the anthropometry and physical conditioning attributes of young male inter-county (national level) Gaelic football players, comparing possible differences according to age category (under-14 [U14] to under-21 [U21]) and position. In total, 3547 assessments were undertaken in 2588 players across a 10-year period (2013 to 2023). Assessments included anthropometry (stature, body mass, sum of 3 skinfolds), flexibility (sit and reach test), muscular power (countermovement jump and standing long jump), running speed (5-m and 20-m), muscular endurance (maximum push ups) and aerobic capacity (yo-yo intermittent recovery test level 1 [YYIRT1]). Increases were demonstrated when comparing age categories from U14 to U21 for anthropometry (e.g., height [cm] +5.7%), muscular power (e.g., Standing long jump [cm] +16.1%). running speed (e.g., 5 m speed [s] -4.8% from U14 to U20), running momentum (e.g., 20 m momentum [kg.ms-1] +41.5% from U14 to U20), muscular endurance (push-ups [n] +107.7%), flexibility (sit and reach [cm] +36.0%) and aerobic capacity (YYIRT1 [m] +42.3%). When comparing positions, goalkeepers and midfielders were taller and heavier than backs and forwards, respectively. Additionally, midfielders displayed superior aerobic conditioning when compared with other positions, while goalkeepers displayed significantly lower aerobic conditioning. These findings offer comparative data of young Gaelic football players from varying age categories (U14 to U21) which are further classified according to positions. Practitioners may utilize this data to inform player identification processes, characterise position-specific benchmarks and monitor physiological adaptations in young players.

Keywords: team sport; long term athletic development; physiological adaptation; maturation; youth athletes

INTRODUCTION

Gaelic Football is a team sport native to Ireland which is played on a grass-based pitch (≈ 85 m in width and 135 m in length) with two sets of 15 players. Games are 60 minutes in duration at underage and club (sub-elite) levels, and 70 minutes at adult male inter-county (elite) level, which are characterised as 'developmental' and 'national' levels, respectively, in the McKay[1] framework. Competitive match-play is characterised by technically demanding skills, complex tactical decision-making and intense physiological and mechanical demands[2-4], wherein the actions performed are often unpredictable and vary substantially in both intensity and duration[3,5,6]. For instance, male players competing in the under-18 (U18) category spend ≈85% of playing time at lower intensities (jogging, walking or stationary) whilst intermittently undertake high-intensity bouts of running, sprinting, cutting/pivot manoeuvres, changes of pace and physical contests for possession interspersed with sequences of incomplete recovery[5]. This intermittent pattern of activity results in an average in-game total distance of 5774±737 m and high speed distance (≥5.5 $m.s^{-1}$) of 376±40 m[5]. These demands likely elicit high cardiopulmonary loads, mechanical strain and impose a major burden on oxidative, glycolytic and phosphagen energy systems, collectively imposing marked perturbations to skeletal muscle metabolic homeostasis[7,8]. Indeed, this has been reported in similar team sports, wherein match-play has resulted in (i) pronounced depletion of creatine phosphate and glycogen stores[8,9], (ii) significant fluid loss[10], (iii) exertional hyperthermia[11] and (iv) considerable neuromuscular fatigue and muscle damage[12]. Together, the stressors encountered during match-play underline the importance of well-developed physical conditioning as a means to tolerate the multifactorial metabolic and mechanical challenges imposed[7], reduce the likelihood of sustaining injury[13] and perform effectively[14]. Moreover, young players' competitive seasons have become extended and are increasingly saturated with training sessions and matches, in tandem with prevalent multi-team and multi-sport activity[4,15], which may periodically exceed psychophysiological allostasis if tissue damage, fatigue and substrate depletion are not adequately compensated[12,16].

Given the importance of physical conditioning for young Gaelic football players, as evidenced by differences reported in muscular strength, power and aerobic function when comparing playing standards[17], maturation status[18] and progression to adult competition[19], studies outlining these characteristics[18-20] remain few. Notably, young club (sub-elite) and inter-county (elite) level Gaelic players were reported to display similar flexibility and countermovement jump scores, whilst the elite level players demonstrated superior standing long jump scores[18,20]. When viewed collectively however, these studies utilised different tests used to assess aerobic capacity and running speed, consequently preventing their accurate comparison[18,20]. Of note, when benchmarked against the same tests, previously examined national level under-18 players[20] presented with similar anthropometric, physiological and performance characteristics to age matched athletes from other team sports, e.g., soccer and rugby union[21,22]. Additionally, there were minimal between-position differences evident in physiological or performance attributes among the cohort[20], which contrasts findings in similarly aged rugby union[23], Australian rules[24] and soccer[25] players, and adult Gaelic football players[26]. This may imply that young male Gaelic football players display uniformity in physical conditioning attributes across outfield positions, or perhaps any differences were not detectable in the studies sample (*n*=265)[20].

In light of the available literature, it can be reasonably inferred that the provision of a more comprehensive body of results characterising the physiological profiles of a wider range of players, would elicit valuable diagnostic information to (i) contextualize the design of training methods and/or loads, (ii) quantify relevant short- and long-term adaptations to training, (iii) inform decision making processes (such as optimal playing position, team rotations and player selection) and (iv) elicit guidance for talent development pathways. As participation and professionalism in the sport continues to grow[15], the importance of these factors increases. Importantly, existing research in Gaelic games has demonstrated differences between components of fitness according to both age and playing standard, whereby national level and/or older players have demonstrated superior physical conditioning than developmental level and/or younger players[18-20], a premise supported by data in other team sports[27,28]. Since many of the physiological, mechanical and performance attributes previously mentioned align with the incremental trajectory of maturation into adulthood[29], it is vital that appropriate pathways are maintained to foster ongoing physical, tactical, technical and phyco-social development with this in mind, such that player progression and retention is maximised[30,31].

To address the underlined gaps in the literature and develop a holistic outline of young male Gaelic football players' physiological and performance attributes across the developmental pathway, large samples across multiple teams are required to accurately depict the variance observed across age categories. Determining such an account will provide new knowledge which will add much needed context for practitioners working within the domain and have important implications for training prescription and monitoring processes. Therefore, this study aimed to profile the fitness components of young male Gaelic footballers across (i) age categories (U14 to U21) and (ii) playing positions.

METHODS

Experimental and Participant Overview

A total of 2588 young male players (mean age

±SD: 15.4±1.3 y) participated in a longitudinal study across a 10-year period between 2013 and 2023, wherein 3547 assessments were undertaken. All players participated in a national level Gaelic football development programme (i.e., all inter-county development players from one province) (U14 to U20) within their county and were assessed for anthropometrical and physical characteristics during the first competitive phase of the year each season. Consequently, each participant theoretically could have had a maximum of seven testing points in the present study (assessed in seven consecutive years). Summarised, a total of 3547 data points from 2588 unique players were recorded. Herein, there were 1898 players with one testing point, 482 with two, 154 with three, 42 with four, and 11 with five. Players were assessed each year based on their age category: U14 (*n*=288; 13.8±0.4 y), U15 (*n*=1197; 14.6±0.5 y), U16 (*n*=1066; 15.3±0.5 y), U17 (*n*=492; 16.1±0.5 y), U18 (*n*=332; 16.9±0.6 y), U20 (*n*=88; 18.3±0.9 y) and U21 (*n*=84; 19.3±0.7 y) and can be seen in table 1. Participants were also categorized as goalkeepers, defenders, midfielders and forwards to compare positional differences (table 1). In instances where a player was reported to play for more than one position, between position comparisons were omitted. Previous research[5,12,32] and the physical demands of Gaelic football match-play[5,20] guided the selection of the anthropometric and physical conditioning measures assessed during the testing protocol (figure 1). Participants were instructed to refrain from strenuous exercise for at least 48 h before the test sessions and to consume their normal pre-training diet before the test session. All participants and their parents or legal representatives were fully informed about the aim and the procedures of the study before giving their written informed consent. The Ethics Committee of the Technological University of the Shannon approved the present study approved the present study. Participants were advised that they could withdraw from the study at any time.

Procedures

All testing sessions followed the same standardized sequence: (i) height and body mass measurements, (ii) sit and reach, (iii) skinfold assessments, (iv) jump tests, (v) maximum push-ups, (vi) speed tests, and finally (vii) the Yo-Yo intermittent recovery test level 1 (YYIRT1). Body mass and height were measured to the nearest 0.1 cm and 0.1 kg respectively, using a portable scales and stadiometer (Seca 707 Scales, Hamburg, Germany). Players' skinfold thickness was measured at three anatomical sites (chest, abdomen and thigh) using a skinfold callipers (Baty,

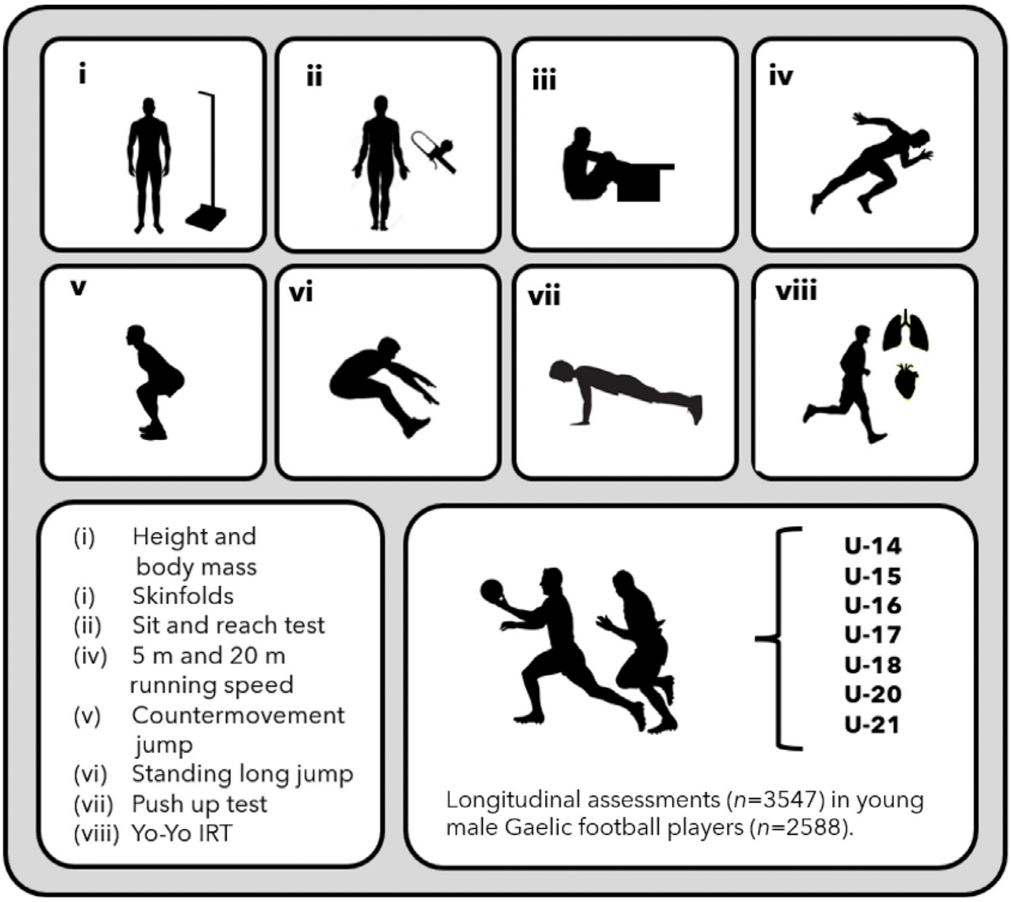

Figure 1. Schematic overview of study design and procedures.

UK) as described in previous methods[5,20]. Here, three measurements for each skinfold on the right side of the body were obtained to the nearest 0.2 mm using the International Society for the Advancement of Kinanthropometry (ISAK) protocols. The median of triplicate measurements was used for all subsequent analysis. Pilot testing was conducted to verify the reliability of anthropometric measurements performed by three assessors[12] Intra-rater reliability was evaluated through four repeated skinfold assessments per each assessors, with the technical error of measurement below 5%, consistent with recommended standards[12,20]. Inter-rater reliability was not presently assessed, which represents a limitation of the study. Nevertheless, all assessors followed standardized procedures in accordance with ISAK protocols to minimize variability, and this was reflected in the high intra-rater reliability. Sum of three skinfolds (Σ3 SF) was calculated by adding all sites together. Body density was determined using the Siri equation and percentage body fat was calculated according to the equations previously described by Jackson and Pollock[5,20].

Flexibility was assessed using the Sit-and-Reach (SAR) test[5,20]. Participants removed their shoes and sat on the floor with their legs fully extended and feet against the sit and reach box (Eveque Leisure Equipment, Ltd, Cheshire, United Kingdom). Of note, all SAR tests were conducted before any warm-up activity. 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 centimetre. After one familiarization practice, each participant performed 3 trials with the best score recorded for analysis.

Upper-body muscular endurance was assessed using a push-up test. The player began in a prone position with their hands on the floor, thumbs shoulder-width apart and elbows fully extended. Keeping the back and body straight the player descended to the tester's flat hand, placed on the floor below the player's sternum, and then ascended until the elbows were fully extended. If participants did not reach the flat hand, the rep was not counted and they were instructed to attempt again with correct form. Participants maintained this movement, without rest, until fatigue prevented rate compliance at which point additional encouragement was provided to the point of either cessation of upward movement or complete collapse[33]. The test was scored as the maximum number of push-ups performed before failure (i.e., inability to lock out elbows on the ascent and/or complete a rep).

Jump performance and running speed were conducted as per Cullen et al[5,20]. Jump performance was assessed using the counter-movement jump (CMJ) and the standing long jump (SLJ) and recorded using an OptoJump (MicroGate, Italy). The optojump has demonstrated high levels of validity and reliability, e.g., intraclass correlation coefficients of 0.997-0.998[34]. For the CMJ, the arms were kept in the akimbo position to minimise their contribution to the vertical jump. The SLJ required participants to perform a countermovement jump with arm swing to propel themselves horizontally forward as far as possible. For each jump test, one practice jump was provided to familiarize participants with the test procedure. If any player had continual increments in jump height across the 3 jumps, a 4th attempt was permitted. The highest or longest of all recorded jumps was used for further analysis and longest for CMJ and SLJ, respectively (to 0.1 cm). For the CMJ, mean power in Watts was calculated as per Degens et al[35]. Firstly, jump velocity (m.s^{-1}) was determined as follows:

$$v = a * t_f/2$$

Where v was velocity, a was gravitational acceleration (9.81 m.s^{-1}) and tf was flight time. Next, mean power (W) during the countermovement jump was estimated as follows:

$$W = \text{body mass} * a * v$$

After completing the push-up and jump tests, and prior to the running speed and YYIRT1 assessments, all participants performed a standardized warm-up based on a modified and shortened version of the Gaelic 15 protocol (excluding strength exercises), followed by 3–5 minutes of rest. The Gaelic 15 is a structured dynamic warm-up designed to improve movement efficiency and reduce injury risk, incorporating running drills, mobility work, and sport-specific speed and change-of-direction activities. Participants running speed was recorded to the nearest millisecond over 5 m and 20 m using SMARTSPEED wireless electronic timing gates (Typical error <0.03 s)[36] (Fusion Sport International, Queensland, Australia) on an indoor track. The participants were instructed to start by placing forward their dominant foot on a mark 30 cm behind the starting line. Timing gates were placed at the starting line, 5 m line and the 20 m line. Participants completed three runs using runners for footwear, with the best time recorded as their result.

The YYIRT1 has been demonstrated to be valid and reliable and was used to assess field-based invasion team sport-specific endurance and administered according to the procedures outlined previously[5,20,37]. The test involves repeated pairs of 20-m runs at progressively increasing speeds controlled by audio bleeps with a rest interval between runs of 10-seconds. The time required to complete each shuttle run was progressively decreased and the distance (m) covered was recorded and represented the test score. Following the running speed tests, minimal activity was undertaken, (i.e., a ≈ 50 m walk) before the Yo-Yo test commenced. All participants began the Yo-Yo test simultaneously as a group (on average ≈ 20 players), and verbal encouragement was provided throughout by coaches (≈ 2-3 present) and researchers (≈ 2-3 positioned as YYIRT1 markers) to support maximal effort.

Statistical analysis

Descriptive statistics were reported as mean±SD, distribution clouds, percentiles and via raw data points. All analyses and subsequent data visualization were conducted on RStudio (version 4.1.0, RStudio).

RESULTS

Players' age, anthropometric and body composition measurements can be seen in table 1, whilst flexibility, muscular power, running speed, muscular and aerobic conditioning measurements can be seen in table 2. As there was some variability in the number of tests completed (for instance, an injured player may have not undertaken all of the tests), the raw data points are also included in figures 1 to 5.
Raw data points, percentiles and probability distribution of players' (i) body fat and fat free mass can be seen in figure 2, (ii) Yo-Yo Intermittent Recovery Test and maximum push up values can be seen in figure 3, (iii) countermovement and standing long jump values can be seen in figure 4, (iv) running speed over 5 and 20 m can be seen in figure 5 and (v) running momentum over 5 and 20 m can be seen in figure 6. Further overview of the participant numbers for each test and a written overview of the percentiles can be seen at the following open-source link: https://rb.gy/pvhda8.

DISCUSSION

The present study assessed the anthropometry, body composition and physiological attributes of young male Gaelic football players from different age categories and positions and presents the largest such sample available in the sport to date. The players' anthropometric and body composition characteristics (height, body mass and fat free mass) and physical conditioning (muscular power, muscular endurance, aerobic capacity, flexibility and running speed) were improved with advancing age for all groups. Nevertheless, greater homogeneity was evident from under-18 onwards, a phenomenon axiomatic with natural maturation processes[38,39]. When comparing playing positions, there were differences observed in anthropometric and physical condition, wherein the goalkeepers and midfielders generally tended to be taller and heavier than the backs and forwards, respectively (table 1). Additionally, midfielders tended to display superior aerobic conditioning when compared with all the other positions, while goalkeepers typically displayed lower aerobic capabilities than outfield positions (figure 3).

Players' stature, body mass and fat free mass was greater with increasing ages into late adolescence, consistent with prior reports[18,38], likely resulting from maturation, natural physical development and possible responses to resistance exercise. There were notable positional differences for height and body mass, whereby midfielders and goalkeepers were taller and heavier than forwards and backs respectively (table 1), reflecting prior findings in Gaelic football[5,20,40]. This may be logical given the advantages of a taller and larger frame in these positions, whereby capacity to save goals and/or compete for primary possession in the air from kick outs are key attributes[20]. Body composition demonstrated large variability, as indicated by the large standard deviations for body fat (%) for each age category and positional sub-groups, respectively (table 1). Positional differences were evident to a greater extent, whereby goalkeepers demonstrated greater skinfolds and body fat measurements (figure 2), a finding in line with earlier data[20,40]. This may in part be attributed to the disparity in metabolic loads faced by goalkeepers when compared to outfield players during training and match-play, which are substantially lower[41]. With respect to the outfield players in particular, adipose tissue may negatively impact players' capacity to run, jump and change direction/pace against the forces of gravity[2,42], increase the

Table 1. Age, anthropometric and body composition measurements.

		Age (y)	Height (cm)	Body mass (kg)	FFM (kg)	Σ3 SF (mm)	Body fat (%)	Sit and reach	Yo-Yo IRT1 (m)
Under-14	*n*	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Combined	288	13.8 ± 0.4	171.1 ± 7.2	57.6 ± 8.5	51.2 ± 8.3	28.3 ± 12.8	7.2 ± 3.5	17.8 ± 6.3	1189.6 ± 388.7
Goalkeepers	13	13.8 ± 0.4	172.7 ± 4.8	60.4 ± 5.6	54.6 ± 0.3	49.5 ± 16.3	13.0 ± 4.2	18.0 ± 7.6	872.7 ± 414.1
Defenders	71	13.8 ± 0.4	169.9 ± 5.8	56.5 ± 7.6	53.4 ± 6.2	22.7 ± 7.7	5.6 ± 2.1	18.2 ± 5.8	1194.9 ± 388.4
Midfielders	24	13.9 ± 0.3	176.6 ± 5.2	64.2 ± 6.3	61.8 ± 0.0	39.0 ± 0.0	10.0 ± 0.0	17.4 ± 7.4	1398.3 ± 437.6
Forwards	75	13.8 ± 0.4	170.2 ± 8.	56.1 ± 9.3	44.6 ± 9.2	25.6 ± 10.2	6.6 ± 2.7	17.5 ± 6.3	1166.6 ± 335.5
Under-15									
Combined	1115	14.6 ± 0.5	174.0 ± 6.8	62.1 ± 8.6	56.0 ± 6.8	33.0 ± 14.6	8.9 ± 4.0	20.0 ± 6.9	1209.0 ± 390.2
Goalkeepers	70	14.5 ± 0.5	176.5 ± 6.0	68.4 ± 9.5	59.2 ± 6.4	51.8 ± 25.4	13.8 ± 6.5	18.6 ± 6.8	833.9 ± 322.3
Defenders	382	14.6 ± 0.5	173.0 ± 5.6	61.0 ± 7.3	55.5 ± 5.8	31.5 ± 11.8	8.5 ± 3.3	20.5 ± 7.0	1232.3 ± 365.1
Midfielders	107	14.6 ± 0.5	181.2 ± 5.2	69.1 ± 6.2	62.2 ± 5.1	33.3 ± 14.6	9.2 ± 4.4	21.4 ± 7.4	1378.1 ± 466.2
Forwards	394	14.6 ± 0.5	172.6 ± 7.1	60.2 ± 8.7	54.6 ± 7.	31.2 ± 12.1	8.4 ± 3.3	19.3 ± 6.6	1205.7 ± 357.6
Under-16									
Combined	1033	15.3 ± 0.5	177.1 ± 6.2	66.8 ± 8.3	60.5 ± 6.2	32.8 ± 14.0	8.9 ± 3.7	23.0 ± 7.1	1371.8 ± 414.7
Goalkeepers	64	15.4 ± 0.5	180.0 ± 6.1	76.8 ± 8.7	64.0 ± 7.6	48.6 ± 24.5	13.0 ± 6.2	22.1 ± 7.3	987.3 ± 307.5
Defenders	345	15.3 ± 0.5	176.0 ± 5.4	68.9 ± 7.3	59.7 ± 5.4	29 .7 ± 10.4	8.0 ± 2.9	22.9 ± 7.5	1418.6 ± 400.0
Midfielders	107	15.4 ± 0.5	183.3 ± 5.1	74.4 ± 6.7	66.2 ± 5.0	33.8 ± 14.0	9.1 ± 3.6	23.7 ± 6.3	1416.2 ± 488.7
Forwards	318	15.3 ± 0.5	175.6 ± 5.9	68.1 ± 7.7	64.0 ± 7.6	32.7 ± 12.3	8.9 ± 3.4	23.0 ± 6.9	1379.5 ± 386.3
Under-17									
Combined	446	16.1 ± 0.5	178.3 ± 6.0	70.1 ± 8.0	63.1 ± 6.3	34.8 ± 28.8	9.0 ± 3.9	23.0 ± 7.1	1516.5 ± 377.5
Goalkeepers	22	16.1 ± 0.3	181.7 ± 6.5	76.8 ± 8.7	65.1 ± 6.8	45.2 ± 17.7	11.7 ± 4.5	22.1 ± 7.3	1102.9 ± 239.3
Defenders	136	16.1 ± 0.5	177.0 ± 5.0	68.9 ± 7.3	62.6 ± 5.8	38.6 ± 42.1	9.6 ± 4.9	22.9 ± 7.5	1534.1 ± 389.6
Midfielders	43	16.2 ± 0.5	183.8 ± 6.5	74.4 ± 6.7	68.0 ± 6.9	31.4 ± 7.9	8.6 ± 2.3	23.7 ± 6.3	1703.2 ± 426.2
Forwards	149	16.1 ± 0.5	177.4 ± 5.6	68.1 ± 7.7	61.9 ± 6.4	30.7 ± 12.7	8.4 ± 3.4	23.0 ± 6.9	1499.8 ± 326.0
Under-18									
Combined	362	16.9 ± 0.6	179.8 ± 5.8	72.1 ± 7.4	65.6 ± 5.6	31.7 ± 13.1	8.7 ± 3.6 f	24.8 ± 7.1	1628.2 ± 359.4
Goalkeepers	25	16.8 ± 0.6	182.9 ± 4.5	78.5 ± 9.2	68.9 ± 5.0	42.8 ± 19.6	11.7 ± 5.1	23.3 ± 7.2	1418.7 ± 321.7
Defenders	128	16.9 ± 0.6	178.6 ± 5.2	70.5 ± 6.4	64.7 ± 5.3	29.6 ± 11.7	8.1 ± 3.2	25.6 ± 7.0	1655.2 ± 354.0
Midfielders	33	16.9 ± 0.6	186.0 ± 4.2	77.6 ± 6.7	70.8 ± 4.8	31.1 ± 13.9	8.5 ± 3.8	26.2 ± 7.1	1647.6 ± 302.7
Forwards	118	16.8 ± 0.6	178.7 ± 5.6	70.9 ± 6.8	64.6 ± 5.5	31.9 ± 11.6	8.7 ± 3.3	24.0 ± 7.2	1631.5 ± 379.8
Under-20									
Combined	73	18.3 ± 0.9	182.1 ± 6.8	78.6 ± 8.5	68.5 ± 6.4	38.5 ± 15.8	10.6 ± 4.3	26.1 ± 8.1	1575.6 ± 397.0

		Age (y)	Height (cm)	Body mass (kg)	FFM (kg)	Σ3 SF (mm)	Body fat (%)	Sit and reach	Yo-Yo IRT1 (m)
Goalkeepers	4	18.3 ± 1.0	182.5 ± 7.8	85.8 ± 12.7	70.0 ± 5.5	63.3 ± 22.6	17.3 ± 5.6	21.4 ± 10.7	906.7 ± 151.4
Defenders	12	18.2 ± 0.8	180.1 ± 4.1	78.9 ± 6.3	76.9 ± 6.7	40.1 ± 15.7	11.2 ± 4.3	28.6 ± 6.8	1696.7 ± 393.2
Midfielders	9	18.3 ± 0.7	191.7 ± 3.6	84.4 ± 8.2	67.1 ± 5.2	31.8 ± 11.2	8.8 ± 3.0	25.5 ± 11.0	1645.7 ± 419.8
Forwards	22	18.3 ± 1.0	179.2 ± 5.3	74.6 ± 6.8	70.0 ± 5.5	35.9 ± 12.4	9.9 ± 3.5	25.8 ± 7.1	1578.9 ± 328.9
Under-21									
Combined	84	19.3 ± 0.7	180.8 ± 6.3	77.2 ± 8.1	69.6 ± 6.3	34.8 ± 12.4	9.8 ± 3.4	24.0 ± 6.1	1691.8 ± 337.1
Goalkeepers	7	19.1 ± 0.9	186.0 ± 2.8	83.3 ± 10.6	72.6 ± 6.4	44.3 ± 24.3	12.3 ± 6.3	22.9 ± 5.0	1220.0 ± 230.1
Defenders	30	19.3 ± 0.7	179.4 ± 4.8	76.0 ± 6.6	68.9 ± 5.5	32.5 ± 10.0	9.2 ± 2.8	24.6 ± 6.2	1818.0 ± 286.8
Midfielders	10	19.4 ± 0.5	189.7 ± 2.5	84.3 ± 3.2	75.1 ± 3.1	40.7 ± 11.8	10.9 ± 3.6	24.8 ± 8.0	1630.0 ± 204.8
Forwards	28	19.4 ± 0.7	178.0 ± 6.0	74.6 ± 8.3	67.6 ± 6.8	32.9 ± 9.4	9.4 ± 2.7	23.3 ± 5.7	1738.8 ± 338.9

Table 2. Flexibility, muscular power, running speed, muscular and aerobic conditioning measurements.

		CMJ H (cm)	CMJ (W)	SLJ	5 m speed	20 m speed	5 m Mom (kg.s^{-1})	20 m Mom (kg.s^{-1})	Push ups
Under-14	*n*	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Combined	187	28.8 ± 4.8	271.2 ± 59.1	188.9 ± 19.1	1.19 ± 0.06	3.36 ± 0.13	248.2 ± 32.0	352.3 ± 45.0	18.2 ± 10.0
Goalkeepers	13	27.7 ± 5.5	280.6 ± 45.1	187.3 ± 23.4	1.22 ± 0.04	3.43 ± 0.13	250.5 ± 22.2	357.8 ± 30.6	18.3 ± 9.7
Defenders	71	28.5 ± 4.1	265.6 ± 38.1	188.7 ± 18.2	1.19 ± 0.06	3.39 ± 0.14	235.4 ± 30.5	331.8 ± 42.2	18.3 ± 10.6
Midfielders	24	30.6 ± 5.5	313.7 ± 43.1	196.8 ± 19.7	1.18 ± 0.05	3.27 ± 0.09	270.4 ± 31.8	387.6 ± 39.3	20.7 ± 11.5
Forwards	75	28.7 ± 5.1	266.1 ± 50.9	186.8 ± 18.7	1.19 ± 0.05	3.36 ± 0.13	252.5 ± 31.8	359.2 ± 44.5	17.2 ± 8.9
Under-15									
Combined	1115	29.5 ± 4.7	299.5 ± 47.1	193.4 ± 21.7	1.20 ± 0.07	3.33 ± 0.15	270.0 ± 40.2	389.8 ± 53.5	20.5 ± 8.4
Goalkeepers	70	27.4 ± 5.1	312.8 ± 47.4	186.3 ± 25.0	1.16 ± 0.06	3.32 ± 0.13	291.7 ± 45.3	402.0 ± 57.9	16.2 ± 8.2
Defenders	382	30.0 ± 4.2	297.3 ± 42.1	195.0 ± 20.7	1.21 ± 0.07	3.33 ± 0.15	260.9 ± 36.4	379.0 ± 48.7	21.2 ± 8.7
Midfielders	107	30.4 ± 5.4	335.4 ± 40.8	200.1 ± 22.6	1.16 ± 0.06	3.23 ± 0.13	311.5 ± 26.5	443.1 ± 33.1	20.2 ± 8.2
Forwards	394	29.2 ± 4.7	289.4 ± 47.8	191.4 ± 21.1	1.21 ± 0.07	3.35 ± 0.15	263.6 ± 38.4	380.3 ± 52.3	20.5 ± 8.2
Under-16									
Combined	1033	31.1 ± 4.6	329.5 ± 45.9	203.1 ± 20.1	1.15 ± 0.07	3.24 ± 0.12	305.1 ± 38.8	430.5 ± 46.6	25.9 ± 9.1
Goalkeepers	64	29.1 ± 4.5	354.1 ± 48.4	195.2 ± 21.8	1.16 ± 0.09	3.33 ± 0.17	327.8 ± 28.5	456.7 ± 30.6	19.7 ± 9.0
Defenders	345	31.6 ± 4.4	326.1 ± 40.7	202.7 ± 20.7	1.15 ± 0.08	3.24 ± 0.11	299.4 ± 39.1	423.4 ± 43.6	26.8 ± 8.9 ††
Midfielders	107	32.1 ± 5.1	365.4 ± 42.9	205.1 ± 21.9	1.13 ± 0.08	3.21 ± 0.14	317.3 ± 31.6	446.0 ± 33.3	25.2 ± 9.3 †
Forwards	318	30.7 ± 4.4	319.3 ± 42.8	201.0 ± 20.3	1.15 ± 0.05	3.24 ± 0.11	304.1 ± 40.8	429.4 ± 53.4	26.3 ± 8.8 ††

		CMJ H (cm)	CMJ (W)	SLJ	5 m speed	20 m speed	5 m Mom (kg.s^{-1})	20 m Mom (kg.s^{-1})	Push ups
Under-17									
Combined	446	33.2 ± 4.6	360.9 ± 49.3	210.4 ± 20.1	1.19 ± 0.06	3.26 ± 0.12	296.7 ± 30.9	433.6 ± 43.7	28.9 ± 9.2
Goalkeepers	22	32.4 ± 5.3	385.2 ± 60.0	208.7 ± 22.5	1.22 ± 0.06	3.34 ± 0.15	325.7 ± 32.8	476.3 ± 47.5	23.3 ± 6.7
Defenders	136	32.9 ± 4.9	350.6 ± 45.8	210.8 ± 20.0	1.20 ± 0.07	3.27 ± 0.13	286.1 ± 30.1	419.3 ± 40.3	28.1 ± 9.3
Midfielders	43	34.3 ± 5.7	387.8 ± 49.4	215.6 ± 21.2	1.20 ± 0.06	3.27 ± 0.14	315.0 ± 25.3	461.3 ± 34.9	28.7 ± 8.9
Forwards	149	33.2 ± 3.7	350.2 ± 44.0	208.8 ± 19.5	1.18 ± 0.05	3.25 ± 0.11	295.7 ± 28.1	431.0 ± 41.3	30.5 ± 9.2
Under-18									
Combined	362	33.8 ± 4.7	369.6 ± 42.6	215.6 ± 18.7	-	-	-	-	30.3 ± 9.5
Goalkeepers	25	32.6 ± 4.8	396.2 ± 50.0	215.0 ± 21.9	-	-	-	-	26.8 ± 8.3
Defenders	128	34.3 ± 5.0	363.7 ± 41.6	216.4 ± 17.5	-	-	-	-	31.4 ± 10.4
Midfielders	33	33.5 ± 5.5	395.6 ± 39.0	216.8 ± 21.8	-	-	-	-	26.5 ± 6.4
Forwards	118	33.6 ± 4.0	362.6 ± 40.0	214.6 ± 18.4	-	-	-	-	31.1 ± 9.1
Under-20									
Combined	73	36.6 ± 4.2	427.1 ± 50.5	220.7 ± 17.8	1.18 ± 0.06	3.20 ± 0.09	339.3 ± 37.6	498.1 ± 51.5	36.1 ± 13.9
Goalkeepers	4	35.1 ± 4.5	422.4 ± 48.9	216.8 ± 15.6	1.17 ± 0.01	3.22 ± 0.04	372.7 ± 85.4	540.2 ± 110.5	22.3 ± 8.2
Defenders	12	36.4 ± 3.8	469.4 ± 41.3	218.7 ± 14.4	1.17 ± 0.06	3.18 ± 0.10	339.4 ± 28.8	497.2 ± 39.5	40.5 ± 14.8
Midfielders	9	35.9 ± 2.6	408.9 ± 51.8	239.4 ± 7.6	1.17 ± 0.04	3.21 ± 0.05	378.5 ± 15.9	554.1 ± 31.3	37.7 ± 19.1
Forwards	22	37.5 ± 5.2	422.4 ± 48.9	215.8 ± 18.8	1.19 ± 0.07	3.22 ± 0.11	319.0 ± 30.8	471.1 ± 42.3	35.7 ± 10.6
Under-21									
Combined	84	34.5 ± 4.8	400.1 ± 52.1	219.4 ± 21.0	-	-	-	-	37.8 ± 13.2
Goalkeepers	7	31.7 ± 5.7	414.3 ± 64.9	213.6 ± 25.4	-	-	-	-	22.2 ± 11.5
Defenders	30	35.9 ± 4.8	403.2 ± 47.9	225.5 ± 18.4	-	-	-	-	38.2 ± 13.4
Midfielders	10	34.3 ± 6.5	430.8 ± 35.4	217.9 ± 20.3	-	-	-	-	40.0 ± 7.4
Forwards	28	34.0 ± 3.7	385.1 ± 56.2	215.0 ± 22.1	-	-	-	-	40.8 ± 12.6

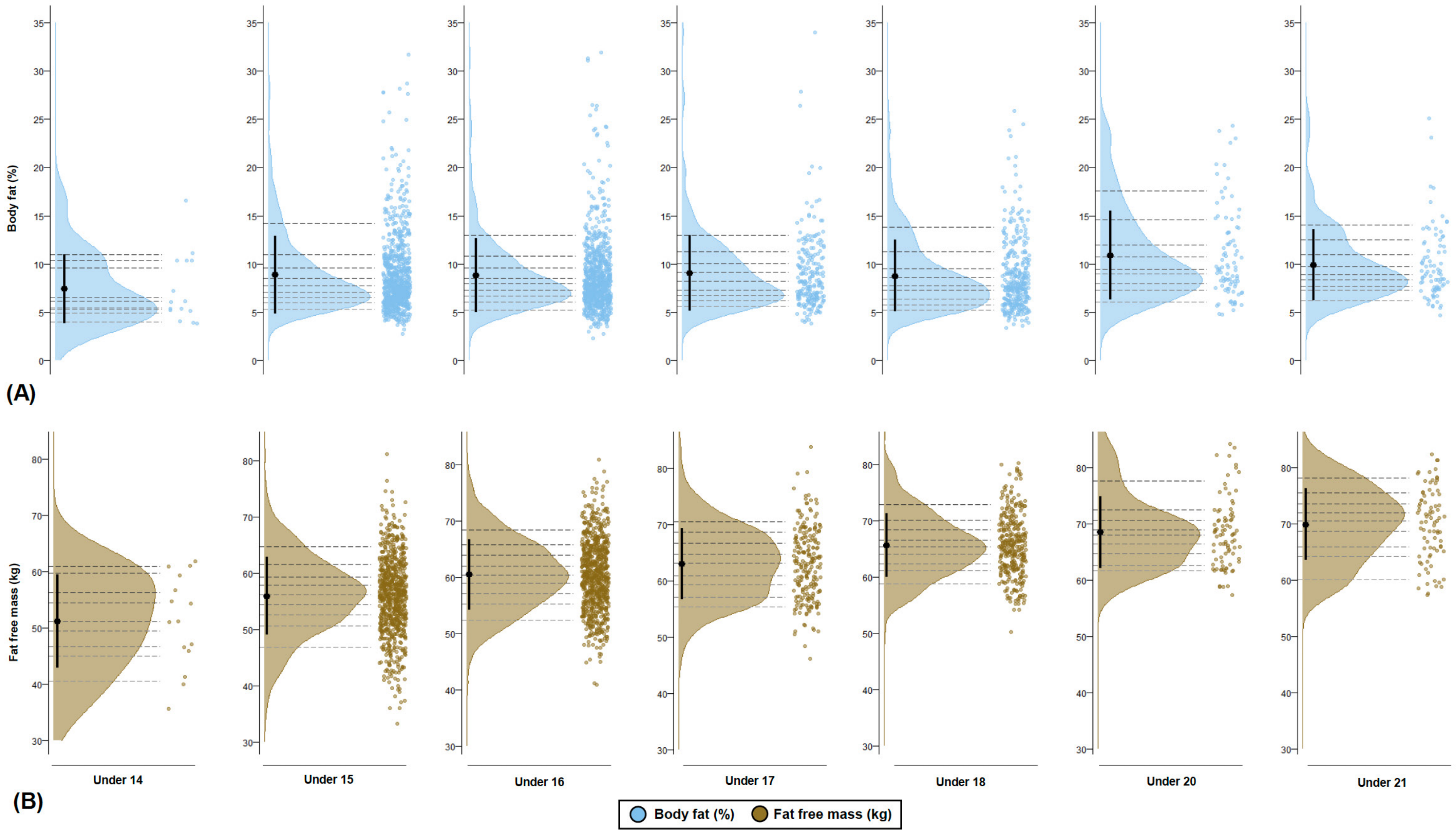

Figure 2. Raincloud plot displaying players' body fat (%) and fat free mass (kg) values. The cloud represents probability density and point and error bars towards their base represent the mean ±SD. Percentile values ranging from (10th to the 90th percentile) are represented by dashed lines, with the darkest line corresponding to the 90th percentile (highest value) and the lightest shading indicating the 10th percentile (lowest value). The shading intensity of the dashed lines gradually deepens as percentiles increase from 10th to 90th.

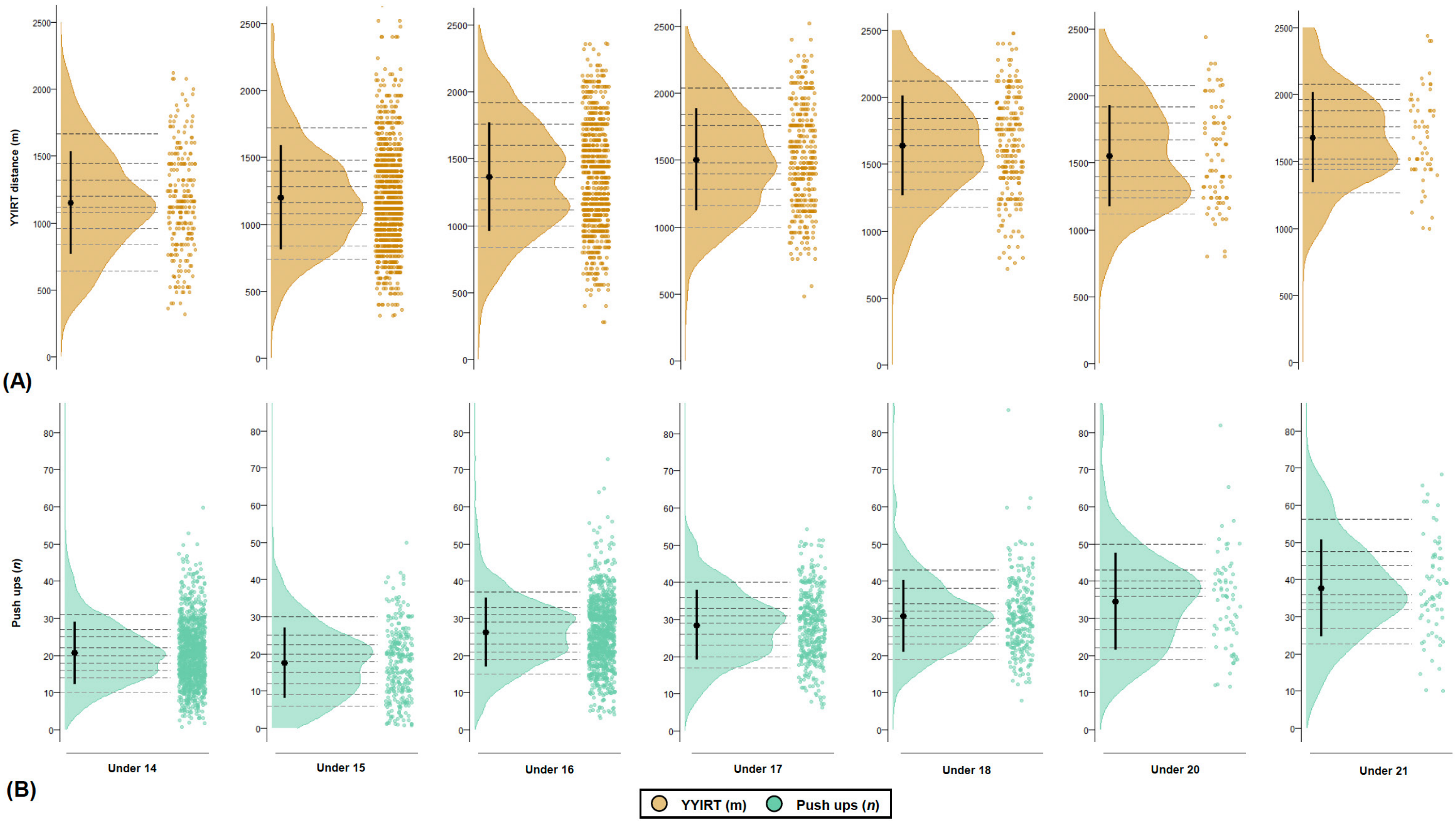

Figure 3. Raincloud plot displaying players' Yo-Yo intermittent recovery test (m) and maximum push up (n) values. The cloud represents probability density and point and error bars towards their base represent the mean ±SD. Percentile values ranging from (10th to the 90th percentile) are represented by dashed lines, with the darkest line corresponding to the 90th percentile (highest value) and the lightest shading indicating the 10th percentile (lowest value). The shading intensity of the dashed lines gradually deepens as percentiles increase from 10th to 90th.

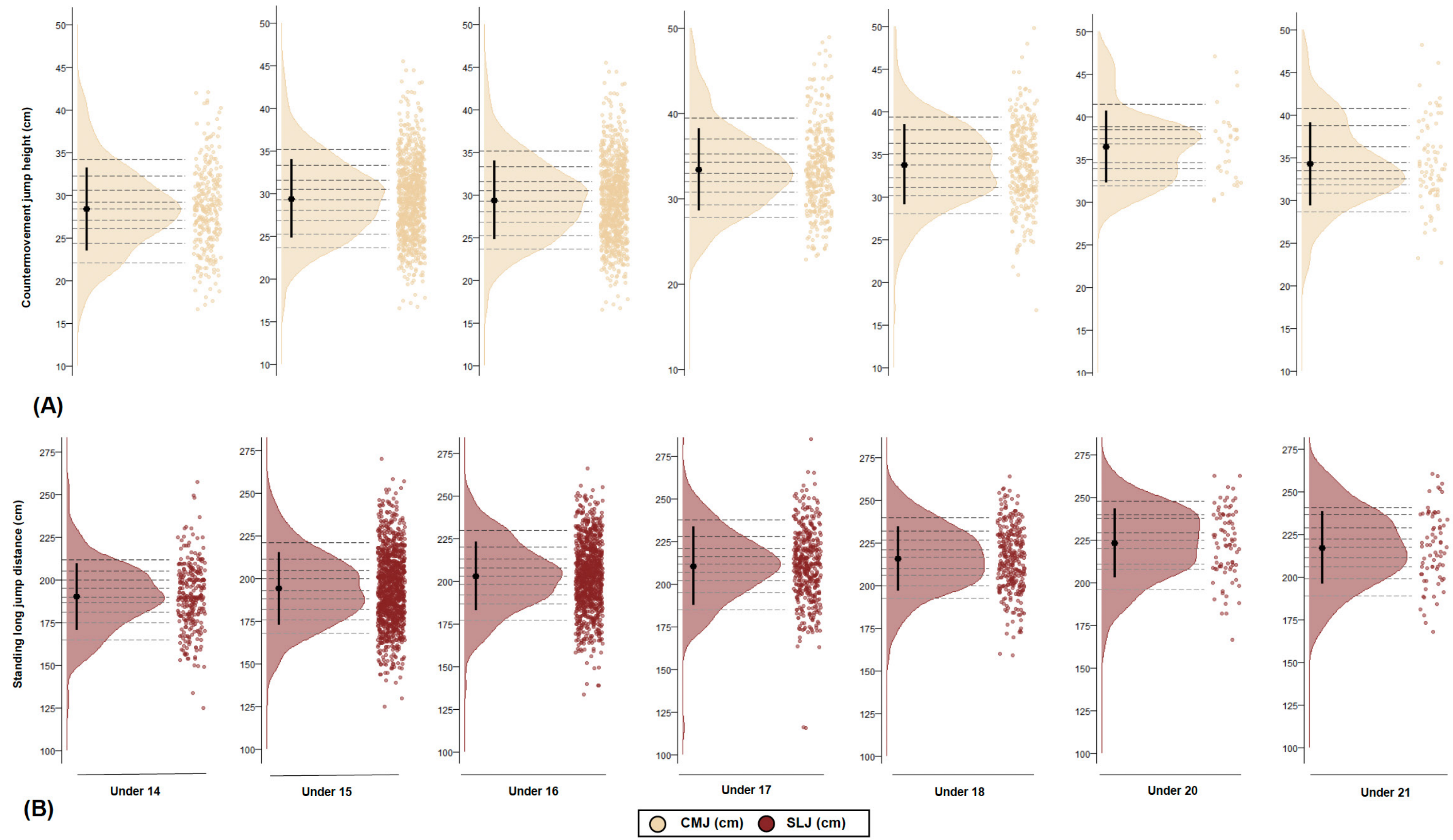

Figure 4. Raincloud plot displaying players' (A) countermovement jump height (cm) and (B) standing long jump distance (cm) values. The cloud represents probability density and point and error bars towards their base represent the mean ±SD. Percentile values ranging from (10th to the 90th percentile) are represented by dashed lines, with the darkest line corresponding to the 90th percentile (highest value) and the lightest shading indicating the 10th percentile (lowest value). The shading intensity of the dashed lines gradually deepens as percentiles increase from 10th to 90th.

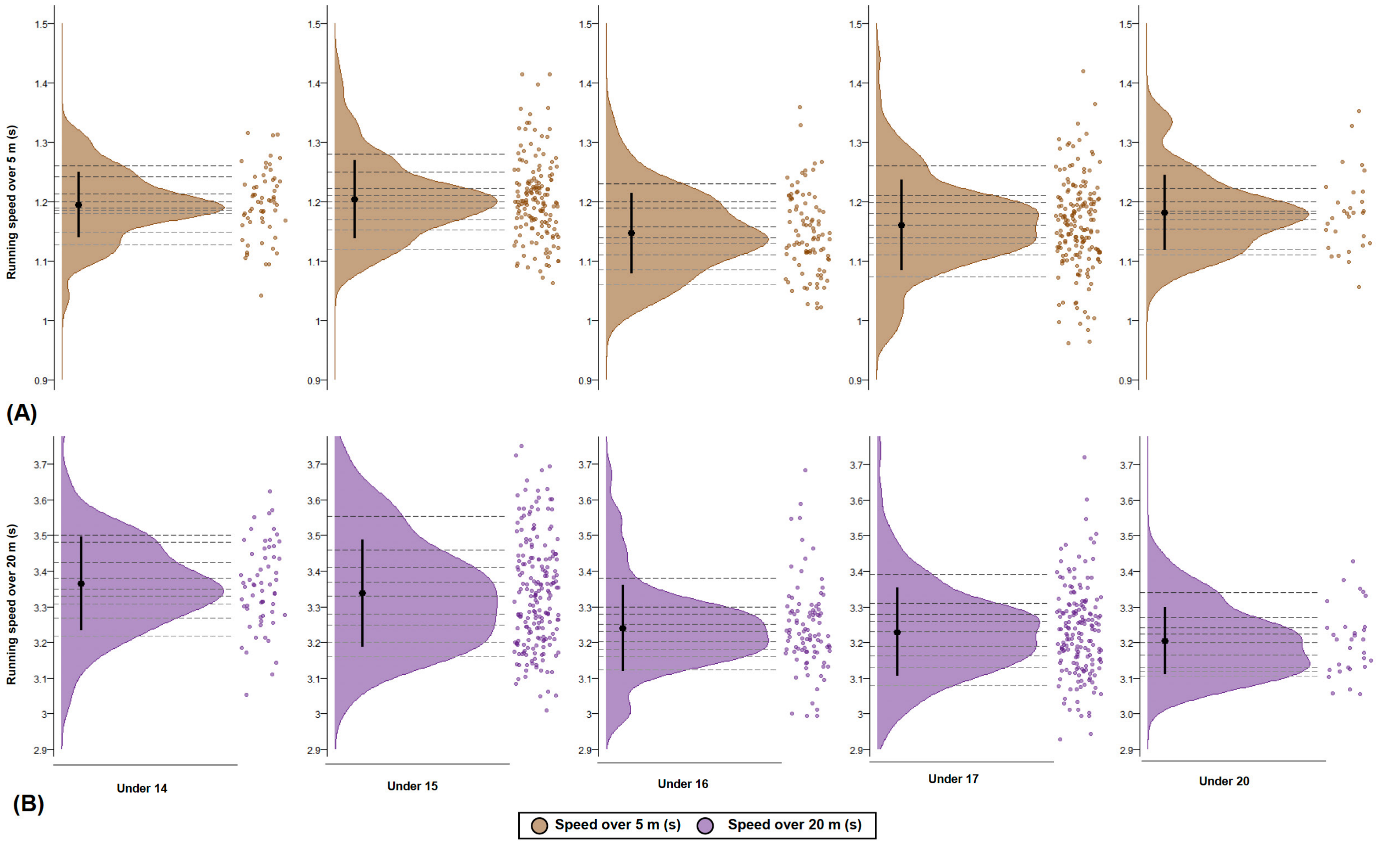

Figure 5. Raincloud plot displaying players' running speed (s) over (A) 5 m and (B) 20 m. The cloud represents probability density and point and error bars towards their base represent the mean ±SD. Percentile values ranging from (10th to the 90th percentile) are represented by dashed lines, with the darkest line corresponding to the 90th percentile (highest value) and the lightest shading indicating the 10th percentile (lowest value). The shading intensity of the dashed lines gradually deepens as percentiles increase from 10th to 90th.

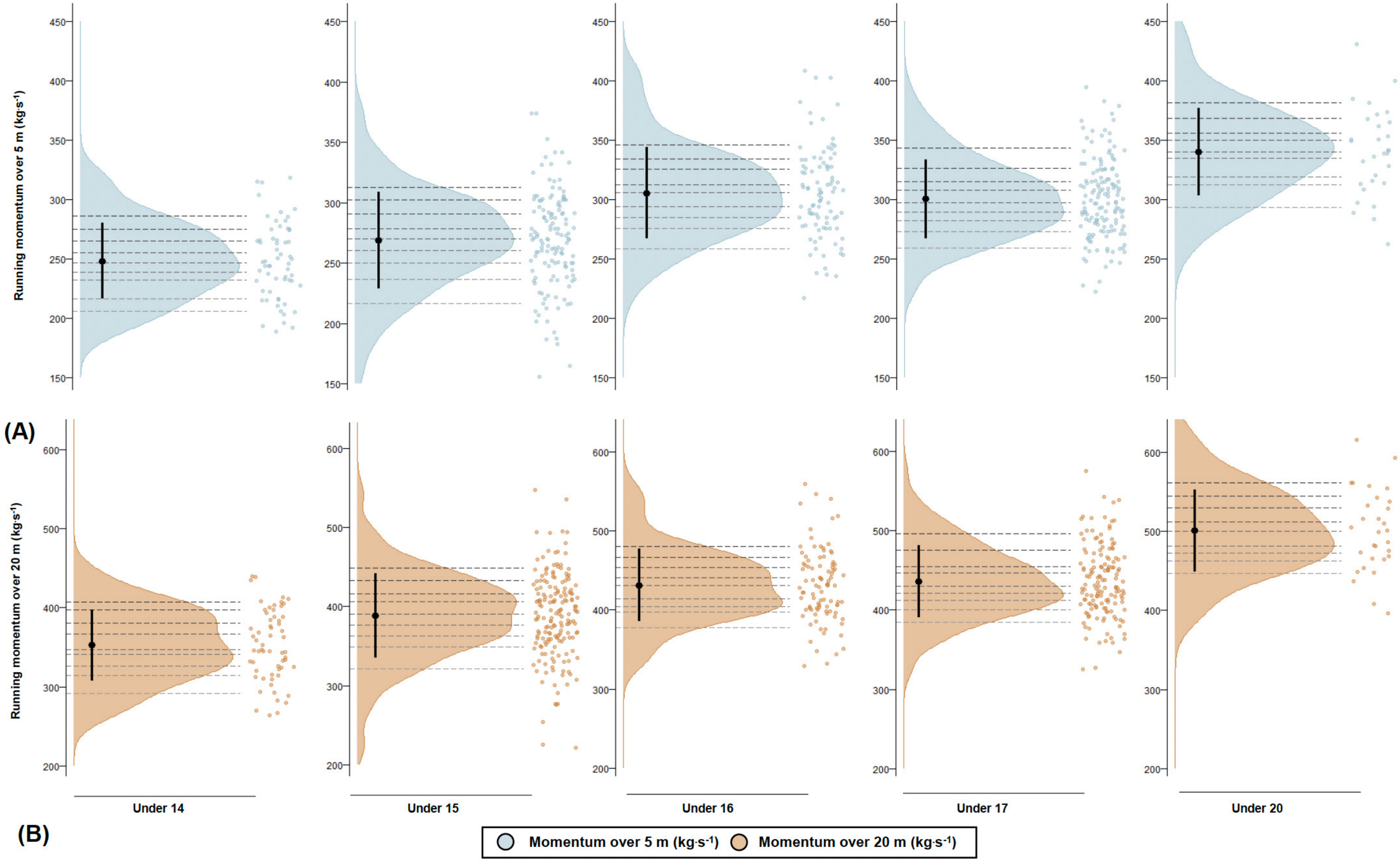

Figure 6. Raincloud plot displaying players' running momentum (kg.s^{-1}) over (A) 5 m and (B) 20 m. The cloud represents probability density and point and error bars towards their base represent the mean ±SD. Percentile values ranging from (10th to the 90th percentile) are represented by dashed lines, with the darkest line corresponding to the 90th percentile (highest value) and the lightest shading indicating the 10th percentile (lowest value). The shading intensity of the dashed lines gradually deepens as percentiles increase from 10th to 90th.).

energetic cost of locomotion[42] and impede their capacity to dissipate metabolically generated heat during training/competition[42,43]. Further, fat free mass values progressed with advancing age categories (figure 1) which coheres with expected maturation processes[38,39].

The current players' aerobic capacity, as assessed by the YYIRT1, showed increases in the older categories, with similar results from U18 onwards. Importantly, given the increases in body mass throughout these age categories (up until U20), it is conceivable that the changes in absolute aerobic function were larger in magnitude than those reflected by the current YYIRT1 improvements. More specifically, it's possible here for instance that absolute $\dot{V}O_{2max}$ (ml.min^{-1}) may have improved to a much greater extent than relative $\dot{V}O_{2max}$ (ml.kg.min^{-1}), whereby players who display a similar YYIRT1 score in the presence of a larger body mass are almost certainly improving their absolute aerobic capacity (e.g., $\dot{V}O_{2max}$ [ml.min^{-1}])[38,44]. Indeed, a number of age categories displayed similar YYIRT1 scores in conjunction with increases in body mass, supporting this hypothesis[38]. Although midfield players typically exhibited larger YYIRT1 distances than other outfield positions (table 1), these differences were generally small in magnitude, reflecting earlier work in U18 Gaelic football players[20]. Certainly, a well-developed aerobic system is necessary for players to sustain the large competitive workloads encountered (≈100 m.min^{-1})[5,32], and replete the anaerobic fuel stores which become intermittently taxed during bouts of high intensity actions[45]. Further, athletes with a superior aerobic capacity may be better equipped to meet a larger proportion of bioenergetic demands faced through the oxidation of fatty acids as fuel, consequently reducing dependence on carbohydrate-driven glycolysis and possibly limiting the degradation of glycogen[46]. Although glycogen depletion at the global or whole muscle may remain moderate following team sport match-play, marked reductions in subcellular regions or at single-fibre levels have been reported, and these reductions may interfere with calcium kinetics and excitation contraction coupling[9,46]. Subsequently, localized reductions in muscle glycogen during Gaelic football match-play may contribute to fatigue development, and this premise highlights the importance of appropriate nutritional intake and aerobic fitness as protective moderators[46,47]. It is important for practitioners to note that the YYIRT1 is underlined not only by aerobic capabilities, but by a range of integrative factors, such as anaerobic qualities and the neuromuscular capability to repeatedly perform sharp changes of direction[48], which all contribute to the YYIRT1 test results[48]. Overall, the YYIRT1 scores presented in the current cohort were similar to age matched Gaelic football players[19], lower than age matched elite level soccer players (-23.4% at U15)[49] and superior to elite rugby union players (+10.4 to 34.2%)[44] and provide a valuable benchmark for young developmental and/or national players.

Muscular power and endurance progressed with advancing age categories, with larger increments observed for the younger age categories. This is evidenced by improvements in the number of push-ups completed, and SLJ distance and CMJ height/mean power (table 2). These findings are consistent with trends in rugby league[38] and soccer[50], although the CMJ height values were moderately lower than previously reported soccer academy players (≈-7%)[39] and netball players (≈-16%)[51]. Of note, the magnitude of improvements for momentum and CMJ average power was larger as the age categories progressed, similar to prior work in rugby league[44]. Whilst running speed and countermovement jump height may be more similar between age categories (table 2), coaches may use both relative (e.g., jump height) and absolute (e.g., mean force/power) measures such to account for the increases in body mass and obtain a comprehensive overview of players' neuromuscular development[44]. Given the high mechanical loading faced by Gaelic football players when accelerating, decelerating and changing direction during training and matches[5,32], well-developed neuromuscular attributes are undoubtedly underpinning attributes[14].

Alongside muscular power, running speed and momentum are conceivably pivotal performance determinants, such as for creating/defending scoring attempts, generating separation/space in attack and contesting for possession[32,52,53]. In the current analysis, running speed was generally similar between age categories (with some small improvements evident [table 2]). This trajectory of progression is comparable to data in rugby union[44] but contrasts other findings in soccer, whereby a greater magnitude of consistent improvements were reported[39]. Additionally, the 5 m and 20 m running speed times are similar to earlier data in age-matched Gaelic football[20] and slightly slower than elite level soccer[39], netball[51] and Australian rules players[54]. In contrast, running momentum demonstrated more robust increases when comparing categories (figure 5), implicating a larger magnitude of locomotor improvements than when viewing running speed alone. This findings implies the utility of monitoring players body mass and running speed for additional momentum computation, and complements similar observations in rugby union[44].

In Gaelic football, upper body neuromuscular characteristics also bear a plausible influence upon performance, for instance, during contests for possession, man marking roles or propulsion/ balance during locomotion and changes of pace/ direction[2,12]. In support, soccer training, which conceivably involves much less upper body activation when compared with Gaelic football, has demonstrated high glycogen turnover and metabolic perturbations in the upper body during small sided games[9]. Collectively, whilst neuromuscular properties of the lower body are likely of principal importance in Gaelic football, the development and monitoring of upper body power/endurance should nonetheless also be considered by practitioners. Accordingly, the present data provide normative measures with which to do so. In the current sample, the number of push ups demonstrated large increases when comparing categories during the development pathway (figure 2), and coheres with earlier research[55,56]. Notably, the present cohort performed less push ups than previously reported age matched means in elite soccer[55] and rugby league[56] (-13.0 to -42.7%, respectively). Nevertheless, these earlier studies employed push up tests to 90-degree elbow bend[55,56] and the larger range of motion currently used, wherein players chests descending to a flat hand, limits direct comparison.

LIMITATIONS AND FUTURE RECOMMENDATIONS

In summation, this study provides a thorough overview of the physiological and performance attributes of national level male Gaelic football players (U14 to U21), outlining useful norms for practitioners and explicating the contemporary developmental pathway of this population. Whilst these findings reported are substantiated from a large sample and provide novel insights, various limitations persist and require consideration. Foremost, the present study was limited to male players, and findings cannot be generalized to female players. Secondly, the study did not assess maturation status which is likely to result in the non-linear development of players anthropometric and physiological attributes[38,57]. Notably, recent work in Gaelic football specifically has shown that (i) early maturing players tend to display superior physical conditioning attributes when compared with their late maturing counterparts[57] and (ii) significant maturation biases exist across youth talent development pathways[58]. Consequently, it remains unclear to what extent the current results may be moderated by maturation effects, and future work should incorporate gold-standard and/ or comparable assessments (e.g., Khamis-Roche method)[57,58].

Thirdly, although linear sprint speed and momentum were examined, other locomotor characteristics such as a direct measurement of acceleration, force velocity profile, deceleration and change of direction were not examined[59]. Future work should therefore seek to profile these qualities. Finally, the true relevance of the physiological testing battery with respect to practitioners' and stakeholders' outcomes of interest, such as match performance, training/match-play work capacity, player selection and progression to elite level adult squads, remains unknown. A superior understanding of these areas would permit stronger inferences to be drawn, where practitioners seeking to enhance development and/or performance could intervene with greater confidence. All considered, future work should build upon the current analysis and seek to (i) conduct similar research in female players[18], (ii) examine possible changes during the competitive season and (ii) assess if training/match-play external loads increase with age/maturation, and if these possible increases associate with the physiological attributes.

PRACTICAL APPLICATIONS

In Gaelic football, numerous physiological and performance attributes are ancillary to high performance and resilience to injury. Accordingly, appropriate development of young players' neuromuscular, physiological and mechanical properties may serve as a key progenitor to a long and successful career in the sport. The present findings offer comparative data of Gaelic football players from different annual-age categories (i.e., under-14 to under-21) which are further classified according to positions. Coaches and strength and conditioning staff may utilize this data to inform player identification processes, assess individuals' strengths and weaknesses for tailored training prescription, characterise position-specific benchmarks for their squads, and monitor players' physiological adaptations as they transition from adolescence to adulthood. Practitioners should note that certain anthropometric and physiological attributes, such as height, body mass, fat free mass, countermovement jump force, running momentum and muscular endurance, tend to increase more rapidly during younger age categories, and become more homogeneous in latter age categories. On the other hand, measures such as skinfolds, running speed and aerobic capacity may not exhibit as consistent changes between seasons by comparison, and future work is needed to examine the possibility that within-season progress that may revert to similar levels at the start of a preseason phase, as demonstrated in adult Gaelic football[60] and other team sports[38,44]. It is also noteworthy to recognize that midfielders and goalkeepers generally display a larger physique, and midfielders display superior aerobic capacities when compared with backs and forwards, respectively. Understanding these differences can aid coaches in identifying players suited for specific positions and inform training prescription accounting for these differences. Ultimately, considerable variability was evident among players, and thus, tracking the development of physical conditioning and body composition measures on an individual and longitudinal basis seems prudent for optimal development and performance.

ACKNOWLEDGEMENTS

The authors would like to thank the players, parents and coaches who participated in this study for their cooperation and commitment. We also wish to sincerely thank Seamus Burns for assistance with data collection.

DATA AVAILABILITY STATEMENT

To ensure full transparency, all raw data points are presented in the figures within this manuscript, along with their distribution clouds, percentiles, and the mean and standard deviations. Additional data, including an overview of participant numbers for each test and a written summary of the percentiles, can be accessed via the following freely available open science framework link: https://rb.gy/pvhda8. For any further details regarding the project's data, analysis, interpretation or otherwise, please contact lorcan.daly@tus.ie.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

FUNDING

This study received no specific funding in order to be completed.

ETHICAL APPROVAL

The Ethics Committee of the Technological University of the Shannon approved the present study approved the present study.

DATES OF REFERENCE

Submission - 10/10/2024
Acceptance - 16/05/2025
Publication - 08/08/2025

REFERENCES

1. McKay AK, Stellingwerff T, Smith ES, et al. Defining training and performance caliber: a participant classification framework. Int J Sport Physiol Perform. 2022;17(2):317-331. doi: https://doi.org/10.3410/f.741490183.793591815
2. Kelly DT, Cregg CJ, O'Connor PL, Cullen BD, Moyna NM. Physiological and performance responses of sprint interval training and endurance training in Gaelic football players. Eur J Appl Physiol. 2021:1-11. doi: https://doi.org/10.1007/s00421-021-04699-0
3. Mangan S, Collins K, Burns C, O'Neill C. The positional technical and running performance of sub-elite Gaelic football. Sci Med Footb. 2020;4(3):182 -191. doi: https://doi.org/10.1080/24733938.2019.1679872
4. Duggan JD, Moody J, Byrne P, McGahan JH, Kirszenstein L. Considerations and guidelines on athletic development for youth Gaelic athletic association players. Strength & Conditioning Journal. 2022;44(2):76-96.
5. Cullen BD, Roantree MT, McCarren AL, et al. Physiological profile and activity pattern of minor Gaelic football players. J Strength Cond Res. 2017;31(7):1811-1820. doi: https://doi.org/10.1519/jsc.0000000000001667
6. McGuinness E, Beattie K, Lyons M, Lane A, Higginbotham C, Healy R. Peak Speed in Gaelic Games: A Systematic Review of GPS Methods. International Journal of Kinesiology and Sports Science. 2023;11(4):25-36. doi: https://doi.org/10.7575/aiac.ijkss.v.11n.4p.25
7. Vigh-Larsen JF, Junge N, Cialdella-Kam L, et al. Testing in intermittent sports-importance for training and performance optimization in adult athletes. Medicine and science in sports and exercise. 2024;56(8):1505-1537. doi: https://doi.org/10.1249/mss.0000000000003442
8. Mohr M, Foged Vigh-Larsen J, Krustrup P. Muscle glycogen in elite soccer–a perspective on the implication for performance, fatigue, and recovery. Frontiers in Sports

and Active Living. 2022:151. doi: https://doi.org/10.3389/fspor.2022.876534
9. Panduro J, Vigh-Larsen JF, Ermidis G, et al. Acute arm and leg muscle glycogen and metabolite responses to small-sided football games in healthy young men. European Journal of Applied Physiology. 2022;122(8):1929-1937.
10. Bigg JL, Gamble AS, Vermeulen TF, Bigg LM, Spriet LL. Sweat loss and fluid intake of female varsity ice hockey players during on-ice practices and games. The Journal of Strength & Conditioning Research. 2020;34(2):389-395. doi: https://doi.org/10.1519/jsc.0000000000003351
11. Henderson MJ, Grandou C, Chrismas BC, Coutts AJ, Impellizzeri FM, Taylor L. Core Body Temperatures in Intermittent Sports: A Systematic Review. Sports Medicine. 2023:1-24. doi: https://doi.org/10.1007/s40279-023-01892-3
12. Daly LS, Ó Catháin C, Kelly DT. Gaelic football match-play: performance attenuation and timeline of recovery. Sports. 2020;8(12):166. doi: https://doi.org/10.3390/sports8120166
13. O'Keeffe S, O'Connor S, Ní Chéilleachair N. Are internal load measures associated with injuries in male adolescent Gaelic football players? Eur J Sport Sci. 2020;20(2):249-260. doi: https://doi.org/10.1080/17461391.2019.1621950
14. Daly LS, Ó Catháin C, Kelly DT. Does Physical Conditioning Influence Performance Attenuation and Recovery in Gaelic Football? International Journal of Sports Physiology and Performance. 01 Jan. 2022 2022:1-9. doi: https://doi.org/10.1123/ijspp.2021-0342
15. Kelly E, Joanne Banks, Mcguinness S, Watson D. Playing Senior Inter-County Gaelic Games - Experiences, Realities and Consequences. 2018;doi: https://doi.org/10.26504/rs76
16. Daly LS, Catháin CÓ, Kelly DT. The Use of Recovery Strategies in Gaelic Games: A Mixed-Methods Analysis. Int J Sports Physiol Perform. 2023;1(aop):1-10. doi: https://doi.org/10.1123/ijspp.2022-0394
17. Hughes W, Healy R, Lyons M, Higginbotham C, Lane A, Beattie K. The Strength Characteristics of Elite and Subelite Female Gaelic Football Players. J Strength Cond Res. 2022:10.1519. doi: https://doi.org/10.1519/jsc.0000000000004741
18. Byrne LM, Byrne PJ, Byrne EK, Byrne AP, Coyle C. Cross-Sectional Study of the Physical Fitness and Anthropometric Profiles of Adolescent Hurling, Camogie, and Gaelic Football Players. Journal of Strength and Conditioning Research. 2022;36(12):3422-3431. doi: https://doi.org/10.1519/jsc.0000000000004133
19. Roe M, Malone S. Yo-Yo intermittent recovery test performance in subelite gaelic football players from under thirteen to senior age groups. Journal of strength and conditioning research. 2016;30(11):3187-3193. doi: https://doi.org/10.1519/jsc.0000000000001417
20. Cullen BD, Cregg CJ, Kelly DT, Hughes SM, Daly PG, Moyna NM. Fitness profiling of elite level adolescent Gaelic football players. The Journal of Strength and Conditioning Research. 2013;27(8):2096-2103. doi: https://doi.org/10.1519/jsc.0b013e318277fce2
21. Gil SM, Gil J, Ruiz F, Irazusta A, Irazusta J. Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. The Journal of Strength & Conditioning Research. 2007;21(2):438-445. doi: https://doi.org/10.1519/00124278-200705000-00026
22. Till K, Weakley J, Read DB, et al. Applied sport science for male age-grade rugby union in England. Sports Med. 2020;6(1):1-20. doi: https://doi.org/10.1186/s40798-020-0236-6
23. Owen C, Till K, Weakley J, Jones B. Testing methods and physical qualities of male age grade rugby union players: A systematic review. PLoS One. 2020;15(6):e0233796. doi: https://doi.org/10.1371/journal.pone.0233796
24. Pyne D, Gardner A, Sheehan K, Hopkins W. Positional differences in fitness and anthropometric characteristics in Australian football. Journal of Science and Medicine in Sport. 2006;9(1-2):143-150. doi: https://doi.org/10.1016/j.jsams.2005.10.001
25. Marques MC, Izquierdo M, Gabbett TJ, Travassos B, Branquinho L, van den Tillaar R. Physical fitness profile of competitive young soccer players: Determination of positional differences. International Journal of Sports Science & Coaching. 2016;11(5):693-701. doi: https://doi.org/10.1177/1747954116667107
26. Shovlin A, Roe M, Malone S, Collins K. Positional anthropometric and performance profile of elite gaelic football players. The Journal of Strength and Conditioning Research. 2018;32(8):2356-2362. doi: https://doi.org/10.1519/jsc.0000000000002071
27. McCormack S, Jones B, Scantlebury S, Collins N, Owen C, Till K. Using principal component analysis to compare the physical qualities between academy and international youth rugby league players. International Journal of Sports Physiology and Performance. 2021;16(12):1880-1887. doi: https://doi.org/10.1123/ijspp.2021-0049
28. Trecroci A, Milanović Z, Frontini M, Iaia FM, Alberti G. Physical performance comparison between under 15 elite and sub-elite soccer players. Journal of human kinetics. 2018;61:209. doi: https://doi.org/10.1515/hukin-2017-0126
29. Howard SM, Cumming SP, Atkinson M, Malina RM. Biological maturity-associated variance in peak power output and momentum in academy rugby union players. European journal of sport science. 2016;16(8):972-980. doi: https://doi.org/10.1080/17461391.2016.1205144
30. Dimundo F, Cole M, Blagrove RC, et al. The anthropometric, physical, and relative age characteristics of an English Premiership rugby union academy. International Journal of Strength and Conditioning. 2021;1(1)doi: https://doi.org/10.47206/ijsc.v1i1.67
31. Gavin K, Lane A, Dowd K. An Investigation of Youth Gaelic Games Coaching Practices. International Sport Coaching Journal. 2025;1(aop):1-14. doi: https://doi.org/10.1123/iscj.2024-0079
32. Daly LS, Catháin CÓ, Kelly DT. Do players with superior physiological attributes outwork their less-conditioned counterparts? A study in Gaelic football. Biology of Sport. 2023;41(1):163-174. doi: https://doi.org/10.5114/biolsport.2024.129479
33. Clemons J. Construct validity of two different methods of scoring and performing push-ups. The Journal of Strength & Conditioning Research. 2019;33(11):2971-2980. doi: https://doi.org/10.1519/jsc.0000000000002843
34. Glatthorn JF, Gouge S, Nussbaumer S, Stauffacher S, Impellizzeri FM, Maffiuletti NA. Validity and reliability of Optojump photoelectric cells for estimating vertical jump height. J Strength Cond Res. 2011;25(2):556-560. doi: https://doi.org/10.1519/jsc.0b013e3181ccb18d
35. Degens H, Stasiulis A, Skurvydas A, Statkeviciene B, Venckunas T. Physiological comparison between non-athletes, endurance, power and team athletes. European journal of applied physiology. 2019;119:1377-1386. doi: https://doi.org/10.1007/s00421-019-04128-3
36. D'Auria S, Tanner R, Sheppard J, Manning J. Evaluation of various methodologies used to assess sprint performance. 2006.
37. Deprez D, Coutts AJ, Lenoir M, et al. Reliability and validity of

the Yo-Yo intermittent recovery test level 1 in young soccer players. Journal of Sports Sciences. 2014;32(10):903-910. doi: https://doi.org/10.1080/02640414.2013.876088
38. Till K, Tester E, Jones B, Emmonds S, Fahey J, Cooke C. Anthropometric and physical characteristics of English academy rugby league players. J Strength Cond Res. 2014;28(2):319-327. doi: https://doi.org/10.1519/jsc.0b013e3182a73c0e
39. Craig TP, Swinton P. Anthropometric and physical performance profiling does not predict professional contracts awarded in an elite Scottish soccer academy over a 10-year period. European journal of sport science. 2021;21(8):1101-1110. doi: https://doi.org/10.1080/17461391.2020.1808079
40. Boyle E, Warne J, Collins K. Anthropometric and performance profile of elite Gaelic football players comparing position and role. Sport Sciences for Health. 2021;17(3):763-770. doi: https://doi.org/10.1007/s11332-021-00758-3
41. Moreno-Pérez V, Malone S, Sala-Pérez L, Lapuente-Sagarra M, Campos-Vazquez MA, Del Coso J. Activity monitoring in professional soccer goalkeepers during training and match play. International Journal of Performance Analysis in Sport. 2020;20(1):19-30. doi: https://doi.org/10.1080/24748668.2019.1699386
42. Meir R, Newton R, Curtis E, Fardell M, Butler B. Physical fitness qualities of professional rugby league football players: determination of positional differences. J Strength Cond Res. 2001;15(4):450-458. doi: https://doi.org/10.1519/00124278-200111000-00009
43. Morrissey MC, Wu Y, Zuk EF, Livingston J, Casa DJ, Pescatello LS. The Impact of Body Fat on Thermoregulation During Exercise in the Heat: A Systematic Review and Meta-analysis. J Sci Med Sport. 2021;doi: https://doi.org/10.1016/j.jsams.2021.06.004
44. Darrall-Jones JD, Jones B, Till K. Anthropometric, sprint, and high-intensity running profiles of English academy rugby union players by position. J Strength Cond Res. 2016;30(5):1348-1358.
45. Stone NM, Kilding AE. Aerobic conditioning for team sport athletes. Sports Med. 2009;39(8):615-642. doi: https://doi.org/10.2165/00007256-200939080-00002
46. Mohr M, Vigh-Larsen JF, Krustrup P. Muscle Glycogen in Elite Soccer–A Perspective on the Implication for Performance, Fatigue, and Recovery. Frontiers in Sports and Active Living. 2022;4:151. doi: https://doi.org/10.3389/fspor.2022.876534
47. Ó Catháin C, Fleming J, Renard M, Kelly DT. Dietary intake of Gaelic football players during game preparation and recovery. Sports. 2020;8(5):62. doi: https://doi.org/10.3390/sports8050062
48. Bangsbo J, Iaia FM, Krustrup P. The Yo-Yo intermittent recovery test. Sports Medicine. 2008;38(1):37-51.
49. Bongiovanni T, Trecroci A, Cavaggioni L, et al. Importance of anthropometric features to predict physical performance in elite youth soccer: A machine learning approach. Research in Sports Medicine. 2021;29(3):213-224. doi: https://doi.org/10.1080/15438627.2020.1809410
50. Le Gall F, Carling C, Williams M, Reilly T. Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. Journal of science and medicine in sport. 2010;13(1):90-95. doi: https://doi.org/10.1016/j.jsams.2008.07.004
51. Thomas C, Ismail KT, Comfort P, Jones PA, Dos'Santos T. Physical profiles of regional academy netball players. Journal of Trainology. 2016;5(2):30-37. doi: https://doi.org/10.17338/trainology.5.2_30
52. Augusto D, Brito J, Aquino R, et al. Contextual Variables Affect Running Performance in Professional Soccer Players: A Brief Report. Brief Research Report. Front Sports Act Living. 2021 2021;3(350):350. doi: https://doi.org/10.3389/fspor.2021.778813
53. Augusto D, Aquino R, Daly L, Vasconcellos F. Do contextual variables influence the spatial organisations of elite-level Brazilian professional soccer players? Hum Mov. 2023;24(4):44-51. doi: https://doi.org/10.5114/hm.2023.127975
54. Robertson S, Woods C, Gastin P. Predicting higher selection in elite junior Australian Rules football: The influence of physical performance and anthropometric attributes. Journal of Science and Medicine in Sport. 2015;18(5):601-606. doi: https://doi.org/10.1016/j.jsams.2014.07.019
55. França C, Marques A, Ihle A, et al. Associations between muscular strength and vertical jumping performance in adolescent male football players. Human Movement. 2023;24(1)doi: https://doi.org/10.5114/hm.2023.117778
56. Tredrea M, Dascombe B, Sanctuary CE, Scanlan AT. The role of anthropometric, performance and psychological attributes in predicting selection into an elite development programme in older adolescent rugby league players. Journal of sports sciences. 2017;35(19):1897-1903. doi: https://doi.org/10.1080/02640414.2016.1241418
57. Kearney C, Coughlan EK, O'Connell A, Lacey S, Burns C. Bigger but Are They Better? Investigating Growth, Maturation, and Physical Performance Metrics in Underage Gaelic Games Development Squads. The Journal of Strength & Conditioning Research. 2022:10.1519. doi: https://doi.org/10.1519/JSC.0000000000005069
58. Fitzgerald F, Campbell M, Kearney PE, Cumming S. Exploring the existence, strength, and independence of relative age and maturation selection biases: a case study in Gaelic football talent development programmes. Annals of Human Biology. 2024;51(1):2349040. doi: https://doi.org/10.1080/03014460.2024.2349040
59. Ward C, Catháin CÓ, Chéilleachair NN, Grassick S, Kelly DT. Does Resisted Sprint Training Improve the Sprint Performance of Field-Based Invasion Team Sport Players? A Systematic Review and Meta-analysis. Sports Medicine. 2024;54(3):659-672. doi: https://doi.org/10.1007/s40279-023-01952-8
60. Kelly RA, Collins K. The seasonal variations in anthropometric and performance characteristics of elite intercounty Gaelic football players. J Strength Cond Res. 2018;32(12):3466-3473. doi: https://doi.org/10.1519/jsc.0000000000001861