International Journal of Strength and Conditioning

Ashcroft, P. T., Williams, K. L., Raymond, W. R., Evans, N. J., Williams, R. S., Partridge, N. P. H., & Williams, M. D. (2026). Fitness Characteristics of the Welsh Rugby Union Schools and Colleges League Players.
International Journal of Strength and Conditioning
https://doi.org/10.47206/ijsc.v6i1.469

Fitness Characteristics of the Welsh Rugby Union Schools and Colleges League Players

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ABSTRACT

Purpose: The study aimed to establish physical fitness standards for the 16–18-year-old rugby union players who compete in the Welsh Rugby Union's National Schools and Colleges (WSC) league.

Methods: Testing was undertaken at the end of pre-season, by 261 male players (17.0±0.6 years; 85.9±14.7 kg; 179.3±6.3 cm) and included: 40 m sprint, countermovement jump, 10/5 repeated jump, isometric belt squat, isometric hip adductor and abductor strength, 30-15 intermittent fitness test, and eccentric knee flexor strength. Descriptive statistics are reported for the entire sample as well as position groups (forwards and backs) and individual positions. Differences to the sample mean were identified using analysis of means and quantified using Cohen's *d* effect size.

Results: The prop, scrum half, outside half, center, and back three positions had the most notable deviations from the sample means, reflecting their specific roles. Comparisons were made to school and academy players of similar age and to senior professionals, to assess the physical status of the WSC players and determine the gap between competition levels. Except for the 30-15 intermittent fitness test, the WSC data was within previously reported ranges for schoolboy and academy players of similar age. The largest differences between WSC and senior professional players was in body mass and strength variables.

Conclusion: This information could be used to support talent identification, player tracking, and for the development of national standards and benchmarks (see supplemental materials).

Keywords: Rugby fitness, Physical profiling, Youth athletes

INTRODUCTION

Rugby Union is a physically demanding team sport, characterized by frequent short, high-intensity efforts, and heavy contact. Since the sport turned professional in 1995, senior players have become substantially bigger, heavier (4,24,29,39), and better physically conditioned (29,41) and the modern game is played at a far higher intensity and involves much greater physical contact (19,36). The development of the necessary physical and technical characteristics is a longitudinal process, with young players requiring several years of structured physical and skills-based training to prepare them for senior competition. Physical profiling is an important part of this process, used to assess the physical capacities of players, identify talent and track changes as individuals progress towards senior competition.

The anthropometric and physical characteristics of individuals involved in regional academy or national age-grade rugby union programs have been well documented (9,15–17,20,26,28,33,34,45,47). Of particular interest are the differences between players at different points of the development pathway and the extent to which these attributes evolve and influence progression. Research shows that forwards are taller, heavier, and stronger than backs across all junior age groups (e.g. U13 to U20), whilst backs are faster and aerobically fitter (16,20,34). Clear differences in stature, body mass, and strength have been reported across age categories (14,18,33). However, evidence for improved speed and endurance is mixed (38,47), with body mass having a mediating effect on these variables (2,7). Peeters et al (33) found that 10 m and 50 m sprint times distinguished between U16, U18 and U20 players and were faster in those who subsequently achieved international status. In contrast, other studies have reported a plateau in sprint performance beyond 15 or 16 years of age (13,18,25,27). Speed alone does not differentiate between academy players and those playing at either professional (21) or senior international level (2). However, marked differences in sprint momentum have been reported with advancing age (7,13,14,18,27,33); and between junior and senior elite players (2,21). Mixed findings have also been reported for endurance measures, with some reporting significant differences in repeated high intensity running ability between age groups (16,20) and others not (13,14,27). Clearly, when considering the development of academy aged rugby union players, there is a need to consider body mass and its influence on performance.

Data for the physical attributes of junior players who sit outside of the academy system are currently limited. In Wales, this includes the Welsh schools and colleges (WSC) league players, who are part of the national player pathway and have the potential to progress into an academy program. To address this issue, the Welsh Rugby Union (WRU) has recently committed to investing greater support in their National Schools and Colleges League, which sits within the Development Phase of its pathway. This program includes the best 16 school and college teams from across Wales, who compete between September and December each year. Teams are made of 16–18-year-old male school/college students, most of whom are not signed with an academy team. As part of the recently revised league license, each team is now required to participate in biannual (pre- and post-season) physical profiling for the purpose of talent identification, player tracking and to support the development of national standards.

Little is known about the anthropometric and physical fitness characteristics of individual playing positions. Positional responsibilities differ (6,16,19,28,36), and whilst common, the classification of players simply as a forward or back may not provide an adequate representation of the anthropometric and physical requirements of individual playing positions. A more detailed understanding of this may allow the coach to better develop players in accordance requirements of position. It may also help coaches signpost players to positions that suit their characteristics and offer them the best opportunities for success. However, at present, just one study has described the anthropometric and physical fitness characteristics of school rugby union players (15).

The purpose of this study was to report position specific anthropometric and physical fitness data for the WSC league players and in so doing so, establish standards of this previously undescribed population. A secondary aim was to compare the WSC results to previously reported rugby union data for school and academy players of the same age group (i.e. U18) and senior professional players. Publication of this information provides an evaluation of the physical status of WSC players and highlights the gaps that exist between different levels of competition.

METHODS

Eleven teams licensed to compete in the WSC league visited the university at separate times at the end of the pre-season period (September 2023) to participate in a battery of physical fitness tests, which included the measurement of stature, body mass, linear speed, lower body strength qualities and intermittent running endurance. Teams undertook all their testing during a 4-hour slot, and all the teams were assessed within an 8-day period. The test battery and protocols were consistent with those used by the WRU academy and national teams, with the addition of the Isometric Belt Squat and hip adductor and abductor tests.

Subjects

A total of 261 male junior rugby union players (17.0 ± 0.6 years; 85.9 ± 14.7 kg; 179.3 ± 6.3 cm; birth quartiles: Q1 = 30%, Q2 = 28%, Q3 = 21%, and Q4 = 21%) from 11 of the 12 schools and colleges that were WSC league licensed at the time of the study took part. To be eligible to participate in the study, players were required to: (1) be registered with the league to play for the respective team, and (2) and deemed injury free and able to participate in testing by the team coach. Ethics approval for the study was obtained from the University of South Wales Faculty Ethics Committee Review Board (220902LR), and informed guardian assent was provided prior to testing.

Players were classified based on position group (i.e. forward or back) and their playing position: prop (loose head and tight head props), hooker, second row (left and right locks), back (blindside and openside flankers and number 8) scrum half, outside half, center (inside and outside centers), and back 3 (left wing, right wing, and full back). Positions were reported by the participants at the time of testing.

Procedures

Participants were asked to refrain from heavy training or competition for 48 hours before testing. Prior to physical testing, and upon the completion of the anthropometric measurements, teams completed a standardized warm-up, which consisted of jogging, active stretching and progressive jumping and sprinting. Physical fitness tests were then performed in the order listed: 40-m sprint, countermovement jump, 10/5 repeated jump, isometric belt squat, hip adductor and abductor strength (measured at 90° and then 0° hip and knee flexion), 30–15 intermittent fitness test, and eccentric knee flexor strength during the Nordic hamstring exercise.

Anthropometric Testing

Anthropometric measurements were taken wearing shorts and a tee-shirt and with shoes off. Body mass was recorded to the nearest 0.1 kg, using calibrated scales (Seca 799, Birmingham, United Kingdom). Stature was recorded to the nearest 0.1 cm, using a stadiometer (Seca 225, Birmingham, United Kingdom).

Sprint Testing

Sprint testing was conducted indoors on artificial turf (4 Gen, FIFA approved) using electronic timing gates (SmartSpeed Pro, VALD Performance, Brisbane, Australia), which have been shown to demonstrate strong reliability (CV = 2.5%) (30). The timing gates were positioned 0.9 m above the ground at 10 m increments. Sprints were initiated from a staggered stance, with the front foot placed 50 cm behind the start line and participants were not permitted to rock back prior to starting. Participants completed 3 trials, with a minimum of 3-min rest provided between attempts. Additional trials were performed if an improvement in 40 m sprint time was observed. The fastest time for each distance was considered for the analyses. The first 10-m split time was taken as a measure of acceleration. Whilst the mean velocity from the fastest 10-m split time (10mpeak) was calculated (i.e. 10-m / split time [s]) and used to represent maximum speed (Young et al, 2008). 20 m, 30 m and 40 m sprint times are also reported to provide normative values for these distances. Sprint momentum was calculated by multiplying the mean velocity for first the 10-m split by body mass (3).

Jump Testing

The countermovement jump (CMJ) and 10/5 Repeated Jump (10/5) tests were performed using a portable dual force plate system (ForceDecks Lite, VALD Performance, Brisbane, Australia), placed inside a wooden frame. The force plates sample at a rate of 1000 Hz. The start of a jump was identified as a 20 N deviation from body weight force. Jump variables were automatically calculated by the ForceDecks iOS application (v1.9.0) at the time of testing and then extracted from the ForceDecks software (v2.08899) afterwards.

The CMJ test was performed with the hands on the hips. Participants were instructed to “dip down and jump as high as possible” and no attempt was made to control the depth or speed of the countermovement. Participants were given 5-10 s rest between attempts. A minimum of 3 trials were performed, with more required if an improvement was observed at the final trial. The following measures were reported, and the best attempt was used for analysis:

- Jump Height (CMJ_{JH}): calculated based on the impulse momentum principle.
- Peak Power (CMJ_{PP}): maximum instantaneous power during the propulsive phase of the jump.
- Relative Peak Power ($CMJ_{PP/BM}$): calculated by dividing PP by body mass.
- Peak Force (CMJ_{PF}): maximum instantaneous force during the propulsive phase of the jump.

Excellent reliability (CV < 6%) has been reported for these measures during a CMJ on the ForceDecks force plates (23).

The 10/5 repeated jump test (10/5) was modified from the protocol originally described by Harper (22). Participants stood with hands on hips and initiated the test by performing 3-5 small bounces to set a rhythm and get a feel for the required ground contact time. They then continued, performing a minimum of 10 maximal effort repeated jumps whilst attempting to limit contact time to < 250 ms. More repetitions were permitted if the participant felt they needed it to achieve their maximum performance. This approach was incorporated to ensure that the best 5 jumps were observed. Research (43) has shown that when the 10/5 test is performed according to original guidelines (22) the best jumps occurred between the 7th and 10th repetitions. The 5 jumps with the highest reactive strength index (RSI) values were analyzed to determine the following variables:

- Average Jump Height (10/5$_{JH}$): mean JH for the 5 best jumps. JH was estimated using the flight time method.
- Average Reactive Strength Index (10/5RSI): mean RSI for the 5 best jumps. RSI was calculated by dividing flight time (time between take-off and landing) divided by CT (time between landing and take-off).
- Average Contact Time (10/5$_{CT}$): mean CT for the 5 best jumps.

Participants received 30-45 s rest between attempts. Since, body position during flight and landing will affect flight time, participants were instructed to keep their legs straight while in the air and ensure they take-off and land in the same location. Failure to do this resulted in the trial being discarded. A minimum of 3 trials were performed. Additional jumps were performed if jumping/landing technique failed to meet these criteria, if the 10/5$_{CT}$ exceeded 250 ms, or if an improvement was observed across the trials. The best attempt was used for analysis. Excellent reliability (CV < 3%) has been reported for these measures obtained using the ForceDecks force plates (42).

Maximum Strength Testing

Maximum leg extensor strength was assessed using the Isometric Belt Squat test ($ISO^{Belt\ Squat}$), shown in the figure. The $ISO^{Belt\ Squat}$ was performed on a portable dual force plate system (ForceDecks Lite, VALD Performance, Brisbane, Australia) sampling at a rate of 1000 Hz. Participants wore a belt (SpudInc, Columbia, USA) that was attached, via a chain, to a metal tray (ForceDecks Lite, VALD Performance, Brisbane, Australia) positioned beneath the force plates. The length of the chain was adjusted to accommodate different statures, with participants adopting a position resembling the start of the second pull of the clean (i.e. feet hip-width apart, a knee angle of 125° and upright torso with the shoulders positioned over the middle of the foot). Once this set up was established, participants were instructed to stand still, with their hands on their hips during a 3 s countdown and then push their feet into the ground as hard as possible for 3-5 s. Participants completed a warm-up trial at 50% of perceived maximum effort, followed by 3 testing trials performed with maximum effort. One min recovery was provided between efforts and additional trials were performed if peak force differed by more than 250 N between trials (9). A trial was deemed acceptable if the force trace plateaued after reaching a distinct peak, indicating the development of maximal volitional force. Maximum strength (Belt Squat$_{PF}$) was determined as the highest force produced, which was calculated by the ForceDecks iOS application (v1.9.0) at the time of testing and then extracted from the ForceDecks software (v2.08899) afterwards. The best attempt was used for analysis. We have observed excellent reliability (CV = 6.7%; ICC = 0.94) when implementing the $ISO^{Belt\ Squat}$ test in

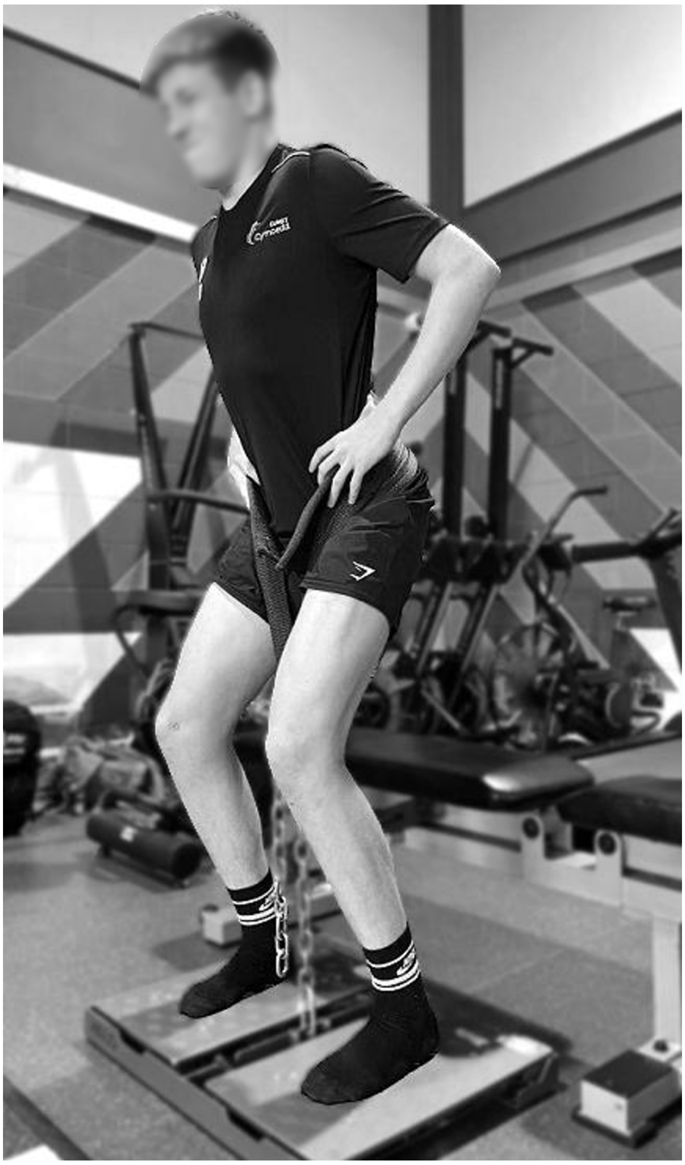

Figure 1. Demonstration of the isometric belt squat test

accordance with these protocols.

Hip adductor and abductor strength were measured isometrically for the left and right legs using the ForceFrame testing system (VALD Performance, Brisbane, Australia), which sampled at 50 Hz. Participants performed the test lying supine on the ground in 2 positions: (1) 90° flexion at the hip and knee and the load cells aligned to medial and lateral aspects of each knee, and (2) 0° flexion at the hip (i.e. hips in neutral and legs extended) and the load cells aligned with the ankle malleoli. Once positioned correctly, participants were instructed to squeeze the inner pads as hard as possible with both legs to assess hip adductor strength (i.e. ADD90). Hip abductor strength was assessed by pushing as hard as possible against the outer pads (i.e. ABD90). Participants completed a warm-up trial at 50% of perceived maximum effort, followed by 3 maximal efforts sustained for 3-5 s. 5-10 s recovery was provided between efforts. This process was repeated for the 0° position (i.e. ADD0 and ABD0). A trial was deemed acceptable if the force trace plateaued after reaching a distinct peak, indicating the development of maximal volitional force. The peak hip adductor (i.e. $ADD90_{PF}$ and $ADD0_{PF}$) and abductor force (i.e. $ABD90_{PF}$ and $ABD0_{PF}$) and torque (i.e. $ADD90_{torque}$, $ABD90_{toque}$, $ADD0_{torque}$, and $ABD0_{torque}$) for both legs was calculated for each position and the best attempt was used for analysis. Torque was calculated by multiplying peak force by thigh length. Excellent reliability (CV = 6.3%) has been reported using with the ForceFrame device using similar test positions (38).

Eccentric knee flexor strength was assessed for the left and right legs with the NordBord testing system (VALD Performance, Brisbane, Australia), which sampled at 50 Hz. The test was performed at the end of the session (approximately 10 minutes after the completion of the 30:15 Intermittent Fitness Test) due to the potential negative impact of supra-maximal eccentric exercise on performance. The test was performed in accordance with the standardized protocol previously described (31). Participants set up by kneeling on the device's padded platform, with ankles secured immediately superior to the lateral malleolus by individual ankle braces and the hands held in front of the chest. From this position, they were instructed to lower themselves to the ground as slowly as possible, while applying maximal resistance with both legs and keeping the trunk and hips in a neutral position. Participants completed a warm-up trial at 50% of perceived maximum effort, followed by 2 maximum effort trials, separated by 5-10 s of rest. Peak force ($Nordic_{PF}$) and torque ($Nordic_{torque}$) were recorded for both legs and the best attempt was used for analysis. $Nordic_{torque}$ was calculated by multiplying $Nordic_{PF}$ by shank length. Excellent reliability (CV = < 8.6%) has been reported using similar testing protocols (31).

Endurance Testing

The 30-15 Intermittent Fitness Test ($30\text{-}15^{IFT}$) was performed in accordance with protocols outlined by Buchheit (5). The test consisted of 30 s of shuttle runs performed over a 40 m course, interspersed by 15-s of recovery. Running speed was controlled by a pre-recorded beep and the test started at 8 $km.h^{-1}$, with increments of 0.5 $km.h^{-1}$ after each 45 s stage. During the 15 s recovery period, participants walked forward towards the closest line, at the end or Centre of the course, where they began the next stage. The test ended when a participant was no longer able maintain the imposed running speed or when they were unable to reach a 3-m zone around each line at the time of the beep signal on 3 consecutive occasions. The velocity of the last completed stage ($30\text{-}15^{VIFT}$) was retained for analysis.

Statistical Analyses

Statistical analyses were performed using JMP Pro version 17.0.0 (JMP Statistical Discovery; SAS Institute Cary, NC). Descriptive statistics (mean and standard deviation) were reported for all variables for the sample, position groups (i.e. forwards and backs), and individual positions. Analysis of means (ANOM) was used to identify which position(s) were outside the sample means for a given variable. ANOM is a multiple comparison method that uses a 95% upper decision limit (UDL) and 95% lower decision limit (LDL), to determine positions outside the sample means for a variable. Suggesting a characteristic outside the average player (i.e., outside the group average). The absolute and standardized mean difference (Cohen's *d* effect size) between forwards and backs and amongst individual positions and the sample mean was calculated and the magnitude of the difference was interpreted according to the criteria outlined by Cohen (8): 0.2 = small, 0.5 = medium, 0.8 = large, and 1.2 = very large.

Table 1. Anthropometric, speed, power, reactivity and endurance characteristics of the Welsh school and college rugby union players and differences between the forwards and backs*

	Sample			Forwards			Backs			Mean difference	Lower CL Dif	Upper CL Dif	*P*-value	*d*	Inference
	N	Mean	SD	N	Mean	SD	N	Mean	SD						
Anthropometric															
Stature (cm)	252	179.4	6.4	137	180.3	6.5	115	178.2	6.0	-2.2	-3.7	-0.6	0.01	0.34	Small
Body mass (kg)	252	85.9	14.7	137	93.8	14.5	115	76.6	8.0	-17.2	-20.1	-14.4	<.0001	1.17	Large
Speed															
10 m sprint (s)	252	1.84	0.12	135	1.90	0.12	117	1.78	0.09	-0.11	-0.14	-0.08	<.0001	0.91	Large
20 m sprint (s)	252	3.18	0.22	135	3.28	0.23	117	3.06	0.14	-0.22	-0.27	-0.17	<.0001	1.00	Large
30 m sprint (s)	252	4.40	0.31	135	4.55	0.32	117	4.24	0.18	-0.31	-0.37	-0.25	<.0001	1.01	Large
40 m sprint (s)	252	5.64	0.43	135	5.84	0.47	117	5.41	0.24	-0.43	-0.52	-0.34	<.0001	0.99	Large
Peak velocity (m/s)	252	8.32	0.67	135	8.05	0.67	117	8.66	0.50	0.61	0.49	0.78	<.0001	1.01	Large
Sprint mom (kg.m/s)	243	466	70	132	497	71	111	430	49	-66	-82	-51	<.0001	0.95	Large
Power															
CMJ height (cm)	241	34.7	6.7	129	31.9	6.0	112	37.9	6.0	5.9	4.4	7.5	<.0001	0.88	Large
CMJ peak power (W)	237	4399	723	127	4539	753	110	4237	652	-301	-481	-121	0.00	0.42	Small
CMJ relative peak power (W/kg)	237	51.8	7.4	127	48.8	7.0	110	55.2	6.3	6.4	4.7	8.1	<.0001	0.86	Large
CMJ peak force (N)	237	2144	381	127	2264	396	110	2007	313	-257	-348	-166	<.0001	0.67	Medium
Reactivity															
10/5 height (cm)	219	26.9	6.1	114	24.9	5.5	105	29.1	5.9	4.1	2.6	5.7	<.0001	0.68	Medium
10/5 RSI (AU)	218	2.41	0.45	113	2.23	0.40	105	2.60	0.43	0.38	0.26	0.49	<.0001	0.83	Large
10/5 contact time (ms)	218	204	25	113	209	24	105	198	24	-11	-18	-5	0.00	0.46	Small
Endurance															
30-15 VIFT (m/s)	198	4.86	0.53	111	4.67	0.53	87	5.10	0.43	0.44	0.30	0.57	<.0001	0.82	Large

**Data are presented as mean ± SD, mean difference, 95% lower and upper confident limits, p-values, Cohen's d effect size (d), and inference based on Cohen's criteria (8). Sprint mom = sprint momentum over the initial 10 m; CMJ = countermovement jump; 10/5 = 10/5 repeated jump; RSI = reactive strength index; 30/15 VIFT = 30-15 intermittent fitness test drop out speed.*

Table 2. Strength characteristics of the Welsh school and college rugby union players and differences between the forwards and backs*

	Sample			Forwards			Backs			Mean difference	Lower CL Dif	Upper CL Dif	*P*-value	*d*	Inference
	N	Mean	SD	N	Mean	SD	N	Mean	SD						
Strength															
Belt squat peak force (N)	230	5013	1280	127	5171	1317	103	4818	1211	-353	-682	-24	0.04	0.28	Small
ADD-90 peak force (N)	239	367.2	70.4	127	369.2	68.1	112	364.9	73.2	-4.3	-22	14	0.64	0.06	Trivial
ABD-90 peak force (N)	241	325.6	74.4	129	342.5	76.8	112	306.2	66.7	-36.3	-54	-18	<.0001	0.49	Small
ADD-0 peak force (N)	233	182.3	44.2	124	181.5	45.7	109	183.3	42.7	1.9	-10	13	0.75	0.04	Trivial
ABD-0 peak force (N)	233	175.4	36.5	124	183.6	37.0	109	166.1	33.8	-17.5	-27	-8	0.00	0.48	Small
ADD-90 peak torque (N.m)	228	155.9	32.3	121	156.8	31.7	107	155.0	33.1	-1.8	-10	7	0.68	0.06	Trivial
ABD-90 peak torque (N.m)	230	138.5	33.3	123	145.9	34.2	107	129.9	30.1	-16.1	-24	-8	0.00	0.48	Small
ADD-0 peak torque (N.m)	222	160.1	41.3	118	160.7	42.4	104	159.4	40.2	-1.3	-12	10	0.82	0.03	Trivial
ABD-0 peak torque (N.m)	222	154.3	34.1	118	163.3	34.6	104	144.2	30.7	-19.1	-28	-10	<.0001	0.56	Medium
Nordic peak force (N)	166	350.9	80.2	90	358.7	85.3	76	341.7	73.3	-17.1	-41	7	0.17	0.21	Small
Nordic peak torque (N.m)	158	159.8	41.3	87	165	44	71	154	38	-11	-23	2	0.10	0.26	Small

**Data are presented as mean ± SD, mean difference, 95% lower and upper confident limits, p-values, Cohen's d effect size (d), and inference based on Cohen's criteria (8). ADD-90 = peak adductor force/torque at 90° hip and knee flexion; ABD-90 = peak abductor force/torque at 90° hip and knee flexion; ADD-0 = peak adductor force/torque at 0° hip and knee flexion; ABD-0 = peak abductor force/torque at 0° hip and knee flexion; CMJ = countermovement jump.*

RESULTS

Tables 1 and 2 show the anthropometric and physical fitness characteristics of the sample, forwards and backs (mean ± SD), along with the differences (mean difference,95% CI, *p* values, and effect sizes) between the two positional groups.

Position Group Differences

Forwards were taller and heavier than backs. In terms of physical fitness, forwards were slower across all sprint variables but demonstrated a higher sprint momentum. Forwards recorded greater CMJ_{PP} and CMJ_{PF} outputs, yet backs performed higher CMJ_{JH} and $CMJ_{PP/BM}$. In the 10/5 test, forwards had lower JH^{AVG} and RSI^{AVG} and longer CT^{AVG}. Forwards exhibited higher strength in the Belt $Squat_{PF}$, $ABD90_{PF}$, $ABD90_{toque}$, $ABD0_{PF}$ and $ABD0_{toque}$. No differences were observed for the $ADD90_{PF}$, $ADD90_{torque}$, $ADD0_{PF}$, and $ADD0_{torque}$, or Nordic tests ($Nordic_{PF}$, and $Nordic_{torque}$). Forwards achieved a lower $30\text{-}15^{VIFT}$.

Positional Differences

Tables 3 and 4 show the anthropometric and physical fitness profiles (mean ± SD) for each position. The shaded areas identify those variables above the 95% UDL (dark) or below the 95% LDL (light) the sample mean. Tables 5 and 6 show the ranking of individual positions and the provides the differences (absolute and Cohen's d effect size) to the sample mean.

Overall, the prop (19/36), scrum half (13/36), outside half (10/39), center (16/36) and back 3 (12/36) positions deviated from the sample means for the greatest number of variables. The back rowers remained within the decision limits for all variables.

Compared to the sample mean: props and second rows were heavier, whilst scrum halves, outside halves, and back 3 players were all lighter. Second rows were taller, whilst hookers, scrum halves, and outside halves were all shorter in stature. Props were slower for all sprint distances and had a lower $10m_{peak}$. The centers and back 3 players were faster for all sprint distances and had a lower $10m_{peak}$. Sprint momentum was higher in props and second rows and lower for scrum halves, outside halves, and back 3 positions. In the CMJ, props performed below the sample mean for CMJ_{JH} and $CMJ_{PP/BM}$ scores, but above it for CMJ_{PP} and CMJ_{PF}. Centers and back 3 players were higher for CMJ_{JH} and $CMJ_{PP/BM}$, whilst scrum halves and outside halves were lower for CMJ_{PP} and CMJ_{PF}. Scrum halves were also below the sample mean for $CMJ_{PP/BM}$. For the 10/5 jumps, Props and second rows performed below the sample mean for 10/5 JH_{AVG} and RSI_{AVG} and above it for CT_{AVG}. Scrum halves and back 3 players performed better for the 10/5 RSI_{AVG}. Props performed above the sample mean for the Belt $Squat_{PF}$, $ABD90_{PF}$, $ABD0_{PF}$, $ABD90_{torque}$, and $ABD0_{torque}$. Centers had greater $ADD90_{PF}$, $ADD0_{PF}$, $ADD90_{torque}$, $ADD0_{torque}$, and $Nordic_{torque}$. The Back 3 players were below the sample mean for $ABD90_{PF}$. The scrum halves and outside halves were lower for $ABD0_{PF}$ and $ABD0_{torque}$. Scrum halves had lower $Nordic_{torque}$. There were no positional differences for $Nordic_{PF}$. $30\text{-}15^{VIFT}$ was lower than the sample mean for props and hookers and higher for scrum halves, outside halves and centers.

DISCUSSION

The primary aim of this study was to report physical fitness data for 16–18-year-old male rugby union players who compete in the WSC league. Data for this population is lacking, since this level of player typically falls outside the regional and national age-grade programs that have the infrastructure to collect such information. We anticipate that this information could be used to support talent identification, benchmarking, and player development and aid in the creation of population specific standards. The secondary aim was to compare the WSC cohort to previously reported rugby union data for school and academy players of the same age group (i.e. U18) and senior professional players. An understanding of these differences provides context and an opportunity to evaluate the status of the WSC league players' physical characteristics and better understand the gaps that exist between different competition levels.

Anthropometric differences were observed between the WSC forwards and backs, which is to be expected, given the different roles played. Interestingly, whilst the forwards were substantially heavier than backs (d = 1.44), there was a much smaller difference in stature (d = 0.34). Whilst similar findings have been reported for U18 academy (14,17,45,46) and senior players (3,12,35), these studies found far greater differences between position groups (height: d = 1.01 to 2.10; body mass: d = 1.90 to 3.44). These findings suggest that the gap between the forwards and backs is likely to grow as players advance in age and experience

Table 3. Anthropometric, speed, power, reactivity and endurance characteristics of the Welsh school and college rugby union players by position*

	Prop			Hooker			2nd Row			Back Row			Scrum Half			Outside Half			Center			Back 3		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Anthropometric																								
Stature (cm)	39	179.5	6.8	22	176.0	3.9	20	187.9	5.0	56	180.0	5.3	23	173.9	5.1	24	176.2	6.2	26	179.9	4.2	42	180.6	5.9
Body mass (kg)	39	107.2	13.8	23	89.1	10.1	20	93.2	12.7	56	86.6	10.1	22	71.0	5.9	24	74.1	7.5	26	81.2	5.6	42	77.6	8.3
Speed																								
10 m sprint (s)	40	1.97	0.11	22	1.88	0.10	23	1.88	0.12	52	1.85	0.12	24	1.81	0.10	22	1.80	0.07	28	1.76	0.09	41	1.78	0.10
20 m sprint (s)	40	3.40	0.21	22	3.26	0.18	23	3.25	0.26	52	3.20	0.21	24	3.10	0.16	22	3.10	0.11	28	3.03	0.13	41	3.04	0.14
30 m sprint (s)	40	4.71	0.30	22	4.52	0.23	23	4.51	0.34	52	4.43	0.32	24	4.30	0.19	22	4.29	0.13	28	4.20	0.17	41	4.20	0.19
40 m sprint (s)	40	6.06	0.41	22	5.79	0.31	23	5.82	0.54	52	5.68	0.47	24	5.50	0.25	22	5.48	0.18	28	5.36	0.23	41	5.36	0.26
Peak velocity (m/s)	40	7.71	0.63	22	8.06	0.46	23	8.05	0.62	52	8.30	0.69	24	8.45	0.39	22	8.53	0.39	28	8.74	0.51	41	8.79	0.57
Sprint mom (kg.m/s)	39	546	69	22	475	50	20	501	70	52	468	60	22	392	36	22	407	38	26	462	36	40	440	48
Power																								
CMJ height (cm)	39	28.8	6.0	21	33.0	5.5	19	31.4	4.9	51	34.3	5.8	24	37.6	5.8	22	35.4	5.3	26	38.7	5.7	39	38.7	6.6
CMJ peak power (W)	38	4933	742	20	4461	709	19	4369	672	51	4351	715	24	3973	405	22	3880	550	26	4639	618	37	4312	683
CMJ rel. peak power (W/kg)	38	45.9	7.2	20	50.2	7.2	19	48.0	6.1	51	50.9	6.6	24	55.7	6.7	22	52.5	5.9	26	56.8	5.7	37	55.4	6.5
CMJ peak force (N)	38	2543	334	20	2213	321	19	2170	427	51	2122	361	24	1934	197	22	1913	337	26	2113	330	37	2013	304
Reactivity																								
10/5 height (cm)	32	21.6	5.3	19	26.3	3.8	17	27.2	6.6	47	26.0	5.0	22	29.4	6.7	21	27.4	4.6	24	29.5	5.0	37	29.3	6.7
10/5 RSI (AU)	32	2.02	0.40	19	2.42	0.35	17	2.27	0.45	46	2.30	0.38	22	2.67	0.53	21	2.60	0.37	24	2.53	0.39	37	2.59	0.42
10/5 contact time (ms)	32	216	24	19	195	23	17	220	21	46	206	24	22	200	27	21	196	25	24	202	21	37	196	23
Endurance																								
30-15 VIFT (m/s)	34	4.33	0.48	18	4.52	0.52	17	4.74	0.44	42	4.97	0.42	19	5.18	0.32	19	5.29	0.35	17	5.15	0.40	32	4.93	0.48

**Data are presented as mean ± SD. The shaded areas identify those variables above (dark) and below (light) the sample mean, based on 95% decision limits.*
Sprint mom = sprint momentum over the initial 10 m; CMJ = countermovement jump; 10/5 = 10/5 repeated jump; RSI = reactive strength index; 30/15 VIFT = 30-15 intermittent fitness test drop out speed.

Table 4. Strength characteristics of the Welsh school and college rugby union players by position*

	Prop			Hooker			2nd Row			Back Row			Scrum Half			Outside Half			Center			Back 3		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Strength																								
Belt squat peak force (N)	38	5842	1443	20	5070	1079	19	4576	1209	50	4927	1161	20	4581	1260	22	4521	1048	24	5223	1313	37	4860	1176
ADD-90 peak force (N)	37	384.2	71.6	21	366.7	57.6	19	351.4	57.9	51	368.3	73.6	23	333.3	52.8	22	345.8	54.0	27	403.8	67.5	39	364.3	83.9
ABD-90 peak force (N)	38	374.7	78.3	22	332.2	60.7	19	313.3	66.6	51	335.3	79.6	23	289.4	63.5	22	288.4	61.6	27	347.0	53.1	39	295.0	67.9
ADD-0 peak force (N)	37	178.5	45.0	20	173.5	30.9	19	180.3	43.0	49	188.2	52.1	23	169.5	40.0	22	170.1	31.4	26	209.3	44.3	37	180.5	42.2
ABD-0 peak force (N)	37	197.2	35.1	20	181.2	30.8	19	167.8	38.5	49	182.0	39.2	23	153.1	23.7	22	154.5	25.0	26	180.6	35.9	37	168.2	34.8
ADD-90 peak torque (N.m)	37	161.4	32.9	18	146.6	21.4	16	156.9	28.0	50	157.0	34.9	22	138.7	25.5	21	145.4	23.5	25	173.7	29.2	39	157.4	37.8
ABD-90 peak torque (N.m)	38	157.1	35.3	19	134.7	27.0	16	140.6	29.1	50	143.4	35.7	22	119.6	27.6	21	123.3	27.2	25	147.7	24.0	39	127.8	32.5
ADD-0 peak torque (N.m)	37	156.6	41.8	17	144.6	24.0	16	169.6	36.8	48	166.6	48.4	22	144.5	36.8	21	146.5	31.0	24	185.8	42.5	37	158.5	38.1
ABD-0 peak torque (N.m)	37	173.4	35.9	17	151.4	22.1	16	155.8	31.8	48	162.2	36.7	22	129.3	23.0	21	133.8	23.0	24	161.6	32.8	37	147.7	31.6
Nordic peak force (N)	28	376.9	84.3	14	356.8	83.8	11	340.7	79.2	38	353.3	89.1	18	310.9	73.0	15	318.1	83.4	17	386.3	58.0	25	343.8	62.0
Nordic peak torque (N.m)	28	172.6	43.2	12	150	37	9	168	46	38	162.5	45.8	17	129	31	14	145	37	15	189.3	31.9	25	155	30

**Data are presented as mean ± SD. The shaded areas identify those variables above (dark) and below (light) the sample mean, based on 95% decision limits.*
ADD-90 = peak adductor force/torque at 90° hip and knee flexion; ABD-90 = peak abductor force/torque at 90° hip and knee flexion; ADD-0 = peak adductor force/torque at 0° hip and knee flexion; ABD-0 = peak abductor force/torque at 0° hip and knee flexion; CMJ = countermovement jump.

Table 5. Anthropometric, speed, power, reactivity and endurance rankings by position and differences to the sample mean*

Stature	Mass	10 m Sprint	20 m Sprint	30 m Sprint	40 m Sprint
2nd row: +8.5 cm, *d* = 1.34	Prop: +21.3 kg, *d* = 1.45	Center: -0.08 s, *d* = 0.68	Center: -0.15 s, *d* = 0.68	Center: -0.20 s, *d* = 0.66	Center: -0.28 s, *d* = 0.65
Back 3: +1.3 cm, *d* = 0.20	2nd row: +7.2 kg, *d* = 0.49	Back 3: -0.07 s, *d* = 0.56	Back 3: -0.14 s, *d* = 0.63	Back 3: -0.20 s, *d* = 0.66	Back 3: -0.28 s, *d* = 0.64
Back row: +0.6 cm, *d* = 0.10	Hooker: +3.1 kg, *d* = 0.21	Outside half: -0.04 s, *d* = 0.35	Outside half: -0.08 s, *d* = 0.35	Outside half: -0.11 s, *d* = 0.37	Outside half: -0.16 s, *d* = 0.37
Center: +0.5 cm, *d* = 0.08	Back row: +0.6 kg, *d* = 0.04	Scrum half: -0.03 s, *d* = 0.25	Scrum half: -0.08 s, *d* = 0.35	Scrum half: -0.10 s, *d* = 0.33	Scrum half: -0.14 s, *d* = 0.32
Prop: +0.1 cm, *d* = 0.02	Center: -4.7 kg, *d* = 0.32	Back row: +0.01 s, *d* = 0.05	Back row: +0.02 s, *d* = 0.10	Back row: +0.03 s, *d* = 0.09	Back row: +0.04 s, *d* = 0.08
Outside half: -3.2 cm, *d* = 0.50	Back 3: -8.3 kg, *d* = 0.57	2nd row: +0.04 s, *d* = 0.29	2nd row: +0.07 s, *d* = 0.31	2nd row: +0.11 s, *d* = 0.36	Hooker: +0.15 s, *d* = 0.36
Hooker: -3.4 cm, *d* = 0.54	Outside half: -11.8 kg, *d* = 0.80	Hooker: +0.04 s, *d* = 0.30	Hooker: +0.08 s, *d* = 0.37	Hooker: +0.11 s, *d* = 0.37	2nd row: +0.18 s, *d* = 0.42
Scrum half: -5.4 cm, *d* = 0.86	Scrum half: -14.9 kg, *d* = 1.01	Prop: +0.12 s, *d* = 0.99	Prop: +0.22 s, *d* = 1.00	Prop: +0.31 s, *d* = 1.01	Prop: +0.42 s, *d* = 0.96

Peak Velocity	Sprint Momentum	CMJ Height	CMJ Peak Power	CMJ Relative Peak Power	CMJ Peak Force
Back 3: -0.47 s, *d* = 0.71	Prop: +79.5 kg.m/s, *d* = 1.13	Center: +4.0 cm, *d* = 0.60	Prop: +535 W, *d* = 0.74	Center: +5.0 W/kg, *d* = 0.67	Prop: +398 N, *d* = 1.04
Center: +0.42 m/s, *d* = 0.63	2nd row: +35.3 kg.m/s, *d* = 0.50	Back 3: +4.0 cm, *d* = 0.59	Center: +240 W, *d* = 0.33	Scrum half: +3.9 W/kg, *d* = 0.52	Hooker: +68 N, *d* = 0.18
Outside half: -0.21 m/s, *d* = 0.31	Hooker: +8.6 kg.m/s, *d* = 0.12	Scrum half: +2.9 cm, *d* = 0.44	Hooker: +63 W, *d* = 0.09	Back 3: 3.6 W/kg, *d* = 0.48	2nd row: +26 N, *d* = 0.07
Scrum half: +0.13 m/s, *d* = 0.19	Back row: +1.4 kg.m/s, *d* = 0.02	Outside half: +0.7 cm, *d* = 0.11	2nd row: -29 W, *d* = 0.04	Outside half: +0.7 W, *d* = 0.09	Back row: -0.9 W, *d* = 0.12
Back row: -0.02 m/s, *d* = 0.04	Center: -4.0 kg.m/s, *d* = 0.06	Back row: -0.4 cm, *d* = 0.06	Back row: -47 W, *d* = 0.07	Back row: -0.9 W, *d* = 0.12	Center: -32 N, *d* = 0.08
Hooker: -0.26 m/s, *d* = 0.40	Back 3: -26.0 kg.m/s, *d* = 0.37	Hooker: -1.7 cm, *d* = 0.25	Back 3: -87 W, *d* = 0.12	Hooker: -1.6 W/kg, *d* = 0.22	Back 3: - 131 N, *d* = 0.34
2nd row: -0.27 m/s, *d* = 0.41	Outside half: -58.7 kg.m/s, *d* = 0.84	2nd row: -3.3 cm, *d* = 0.49	Scrum half: -426 W, *d* = 0.59	2nd row: -3.7 W, *d* = 0.50	Scrum half: - 211 N, *d* = 0.55
Prop: -0.61 m/s, *d* = 0.92	Scrum half: -73.9 kg.m/s, *d* = 1.05	Prop: -5.9 cm, *d* = 0.87	Outside half: -519 W, *d* = 0.72	Prop: -5.8 W/kg, *d* = 0.79	Outside half: -232 N, *d* = 0.61

10/5 Height	10/5 RSI	10/5 Contact Time	30-15VIFT
Center: + 2.6 cm, *d* = 0.43	Scrum half: +0.26 AU, *d* = 0.57	Hooker: -9 ms, *d* = 0.38	Outside half: +0.43 m/s, *d* = 0.80
Scrum half: +2.5 cm, *d* = 0.41	Outside half: +0.19 AU, *d* = 0.42	Back 3: -8 ms, *d* = 0.33	Scrum half: +0.32 m/s, *d* = 0.60
Back 3: +2.4 cm, *d* = 0.40	Back 3: +0.18 AU, *d* = 0.40	Outside half: -8 ms, *d* = 0.31	Centers: +0.29 m/s, *d* = 0.54
Outside half: 0.5 cm, *d* = 0.08	Center: +0.13 AU, *d* = 0.28	Scrum half: -4 ms, *d* = 0.15	Back row: +0.11 m/s, *d* = 0.20
2nd row: 0.3 cm, *d* = 0.05	Hooker: 0.01 AU, *d* = 0.02	Center: -2 ms, *d* = 0.06	Back 3: +0.07 m/s, *d* = 0.14
Hooker: -0.6 cm, *d* = 0.10	Back row: -0.11 AU, *d* = 0.24	Back row: +2 ms, *d* = 0.10	2nd row: -0.12 m/s, *d* = 0.23
Back row: -0.9 cm, *d* = 0.14	2nd row: -0.13 AU, *d* = 0.30	Prop: +12 ms, *d* = 0.48	Hooker: -0.32 m/s, *d* = 0.63
Prop: -5.3 cm, *d* = 0.88	Prop: -0.39 AU, *d* = 0.85	2nd row: +16 ms, *d* = 0.65	Props: -0.52 m/s, *d* = 0.99

**Absolute and standardized mean differences (Cohen's d) between the sample mean and individual positions are presented. The shaded areas identify those variables above (dark) and below (light) the sample mean, based on 95% decision limits. CMJ = countermovement jump; 10/5 = 10/5 repeated jump; RSI = reactive strength index; 30/15 VIFT = 30-15 intermittent fitness test drop out speed.*

Table 6. Strength rankings by position and differences to the sample mean

Belt Squat$_{PF}$	Nordic$_{PF}$	Nordic$_{torque}$	ADD-90$_{PF}$	ABD-90$_{PF}$
Props: +829 N, *d* = 0.65	Center: +36.6 n, *d* = 0.52	Center: +29.5 N.m, *d* = 0.71	Center: +36.6 N, *d* = 0.52	Props: +49.1 N, *d* = 0.66
Centre: +211 N, *d* = 0.16	Prop: +17.0 N, *d* = 0.24	Prop: +12.9 N.m, *d* = 0.31	Prop: +17.0 N, *d* = 0.24	Center: +21.4 N, *d* = 0.29
Hooker: +57.4 kg, *d* = 0.04	Back row: +1.1 N, *d* = 0.02	2nd row: +7.8 N.m, *d* = 0.19	Back row: +1.1 N, *d* = 0.02	Back row: +9.7 N, *d* = 0.13
Back row: -86 N, *d* = 0.07	Hooker: -0.5 N, *d* = 0.01	Back row: +2.7 N.m, *d* = 0.06	Hooker: -0.5 N, *d* = 0.01	Hooker: +6.6 N, *d* = 0.09
Back 3: -153 N, *d* = 0.12	Back 3: -2.9 N, *d* = 0.04	Back 3: -5.2 N.m, *d* = 0.12	Back 3: -2.9 N, *d* = 0.04	2nd row: -12.3 N, *d* = 0.17
Scrum half: -432 N, *d* = 0.34	2nd row: -15.8 N, *d* = 0.23	Hooker: -9.5 N.m, *d* = 0.23	2nd row: -15.8 N, *d* = 0.23	Back 3: -30.6 N, *d* = 0.41
2nd row: -436 N, *d* = 0.34	Outside half: -21.4 N, *d* = 0.30	Outside half: -15.2 N.m, *d* = 0.37	Outside half: -21.4 N, *d* = 0.30	Scrum half: -36.3 N, *d* = 0.49
Outside half: -492 N, *d* = 0.38	Scrum half: -33.9 N, *d* = 0.61	Scrum half: -30.5 N.m, *d* = 0.74	Scrum half: -33.9, *d* = 0.48	Outside half: -37.2, *d* = 0.50

ADD-0$_{PF}$	ABD-0$_{PF}$	ADD-90$_{torque}$	ABD-90$_{torque}$	ADD-0$_{torque}$	ABD-0$_{torque}$
Center: +27.0 N, *d* = 0.61	Props: +21.8 N, *d* = 0.60	Center: 17.7 N.m, *d* = 0.55	Props: +18.6 N.m, *d* = 0.56	Center: 25.7 N.m, *d* = 0.62	Props: +19.0 N.m, *d* = 0.56
Back row: +5.9 N, *d* = 0.13	Back row: +6.6 N, *d* = 0.18	Prop: +5.5 N.m, *d* = 0.17	Center: +9.3 N.m, *d* = 0.28	2nd row: +9.5 N.m, *d* = 0.23	Back row: +7.9 N.m, *d* = 0.23
2nd row: +2.0 N, *d* = 0.05	Hooker: +5.8 N, *d* = 0.16	Back 3: +1.4 N.m, *d* = 0.04	Back row: +5.0 N.m, *d* = 0.15	Back row: +6.5 N.m, *d* = 0.16	Center: +7.3 N.m, *d* = 0.21
Back 3: -1.8 N, *d* = 0.04	Center: + 5.2 N, *d* = 0.14	Back row: +1.1 N.m, *d* = 0.03	2nd row: +2.1 N.m, *d* = 0.06	Back 3: -1.6 N.m, *d* = 0.04	2nd row: +1.5 N.m, *d* = 0.04
Prop: -3.9 N, *d* = 0.09	Back 3: -7.2 N, *d* = 0.20	2nd row: +0.9 N.m , *d* = 0.03	Hooker: -3.8 N.m, *d* = 0.11	Prop: -3.5 N.m, *d* = 0.08	Hooker: -2.9 N.m, *d* = 0.09
Hooker: -8.9 N, *d* = 0.20	2nd row: -7.6 N, *d* = 0.21	Hooker: -9.4 N.m, *d* = 0.29	Back 3: -10.7 N.m, *d* = 0.32	Hooker: -15.5 N.m, *d* = 0.38	Back 3: -6.7 N.m, *d* = 0.20
Outside half: -12.2 N, *d* = 0.28	Outside half: -20.9 N, *d* = 0.57	Outside half: -10.5 N.m, *d* = 0.33	Outside half: -15.2 N.m, *d* = 0.46	Outside half: -13.6 N.m, *d* = 0.33	Outside half: -20.5 N.m, *d* = 0.60
Scrum half: -12.8 N, *d* = 0.29	Scrum half: -22.3 N, *d* = 0.61	Scrum half: -17.2 N.m, *d* = 0.53	Scrum half: -18.9 N.m, *d* = 0.57	Scrum half: -15.6 N.m, *d* = 0.38	Scrum half: -25.1 N.m, *d* = 0.74

**Absolute and standardized mean differences (Cohen's d) between the sample mean and individual positions are presented. The shaded areas identify those variables above (dark) and below (light) the sample mean, based on 95% decision limits. ADD-90 = peak adductor force/torque at 90° hip and knee flexion; ABD-90 = peak abductor force/torque at 90° hip and knee flexion; ADD-0 = peak adductor force/torque at 0° hip and knee flexion; ABD-0 = peak abductor force/torque at 0° hip and knee flexion.*

further physical development.

Forwards were slower than the backs for all speed measures (*d* = -1.02 to -1.16). However, they had a higher sprint momentum (*d* = 1.07) and greater levels of absolute power (*d* = 0.43) and force (d = 0.71) in the CMJ. The backs produced greater relative power (CMJ_{JH}: *d* = 0.98; $CMJ_{PP/BM}$: *d* = 0.95), reactive strength (JH_{AVG}: *d* = 0.72; RSI_{AVG}: *d* = 0.91), and endurance ($30\text{-}15^{VIFT}$: *d* = 0.90). Forwards demonstrated greater absolute strength in the Belt $Squat_{PF}$ (*d* = 0.28) and both measures of hip abduction (*d* = 0.48 to 0.58). However, there was no difference in hip adduction or Nordic performance. Forwards were slower than the backs for all speed measures (*d* = -1.02 to -1.16). However, they had a higher sprint momentum (*d* = 1.07) and greater levels of absolute power (*d* = 0.43) and force (*d* = 0.71) in the CMJ. The backs demonstrated greater relative power (CMJ_{JH}: *d* = 0.98; $CMJ_{PP/BM}$: *d* = 0.95), reactive strength (JH_{AVG}: *d* = 0.72; RSI_{AVG}: *d* = 0.91), and endurance ($30\text{-}15^{VIFT}$: *d* = 0.90). Differences in strength were far less pronounced. Forwards demonstrated greater strength in the Belt $Squat_{PF}$ (*d* = 0.28). Forwards were stronger in all measures of hip abduction (*d* = 0.48 to 0.58). However, there was no difference in hip adduction or Nordic performance.

When comparing to other age matched cohorts, the stature of the WSC forward group was within ranges previously reported for U18 school forwards (180.6 to 182.6 cm) (15,34,37). However, they were 3.4 to 7.9 cm (*d* = 0.53 to 1.20) shorter than U18 academy forwards (14,17,18,33,34,37,44). The backs height was in the ranges reported for U18 school and academy backs (178.0 to 180.3 cm) (10,14,15,17,18,33,34,37,44). To our knowledge, this is the first study to describe the physical fitness characteristics of schoolboy forwards and backs. Therefore, no comparative data is available. Compared to U18 academy forwards, WSC forwards were slower (10 m = 0.06 to 0.14 s, *d* = 0.47 to 1.23; 20 m = 0.05 to 0.14 s, *d* = 0.22 to 0.64; 40 m = 0.21 s, *d* = 0.46) and had a lower sprint momentum (4.5 to 45.5 kg.m/s, *d* = 0.06 to 0.67) (14,17,33,45). They were also less explosive (CMJ_{JH}: 2.0 to 4.2 cm, *d* = 0.37 to 0.72) (14,17,33,45) and demonstrated a lower $30\text{-}15^{VIFT}$ (0.39 m/s, *d* = 0.76) (14). In contrast, data collected for the backs was comparable to U18 academy backs for sprint times (10 m range = 1.65 to 1.81 s; 20 m range = 2.93 to 3.02 s; 30 m = 4.18 to 4.28 s; 40 m = 5.34 s), sprint momentum (range = 407 to 487 kg.m/s) (14,17,33,45), and explosiveness (CMJ_{JH} range = 36.3 to 41.7 cm) (20,39,50). However, like the forwards, the backs exhibited a lower 30-15VIFT (0.23 m/s, *d* = 0.56) than their U18 academy counterparts (14).

The WSC forwards were 8.1 to 10.7 cm (*d* = 1.17 to 1.66) shorter and 16.8 to 22.7 kg (*d* = 1.29 to 1.65) lighter (1,3,11,12,20,35,47) than senior professional forwards. For backs, the difference in stature was less pronounced (2.7 to 5.3 cm, *d* = 0.46 to 0.86) (1,3,11,12,20,35,47). However, the difference in body mass was very large (13.9 to 19.3 kg, *d* = 1.73 to 2.37) (1,3,11,12,20,35,47). Both position groups were slower than professional players when measured over 10 m (forwards: 0.05 to 0.12 s, *d* = 0.38 to 0.97; backs: 0.05 to 0.12 s, *d* = 0.61 to 1.47) and 20 m (forwards: 0.12 to 0.21 s, *d* = 0.55 to 1.21; backs: 0.10 to 0.18 s, *d* = 0.75 to 1.39) (11,35,40), and there was a very large difference in sprint momentum (forwards: 11.6 kg.m/s, *d* = 1.71; backs: 96.6 kg.m/s, *d* = 1.98) (2). Very large differences between both position groups and senior counterparts have been found in the CMJ_{PP} (forwards: 1260 W, *d* = 1.75; backs: 1092 W, *d* = 1.70) and CMJ_{PF} (forwards: 758 N, *d* = 2.01; backs: 593 N, *d* = 1.99), yet small to moderate differences for CMJ_{JH} (forwards: 3.4 cm, *d* = 0.60; backs: 3.4 cm, *d* = 0.62) and $CMJ_{PP/BM}$ (forwards: 1.9 W/kg, *d* = 0.28; backs:2.8 W/kg, *d* = 0.46) (1). However, there is a less obvious difference in 10/5JH (forwards: 0.2 cm, *d* = 0.02; backs: 2.5 cm, *d* = 0.45) and 10/5RSI (forwards: -0.17 AU, *d* = 0.42; backs: 0.29 AU, *d* = 0.72) (1). The forwards and backs were substantially weaker than their senior counterparts in the Belt $Squat_{PF}$ (forwards: 2248 N, *d* = 1.67; backs: 1425 N, *d* = 1.16), $ADD90_{PF}$ (forwards: 81 N, *d* = 1.12; backs: 80 N, d = 0.99), $ADB90_{PF}$ (forwards: 56 N, *d* = 0.69; backs: 38, *d* = 0.56), $ADD0_{PF}$ (forwards: 33.N, *d* = 0.69; backs: 25 N, *d* = 0.56), $ADB0_{PF}$ (forwards: 43 N, *d* = 1.13; backs: 37 N, *d* = 1.00) and $Nordic_{PF}$ (forwards: 104 N, *d* = 1.12; backs: 77 N, *d* = 1.01) (1).

Classifying players based on positions groups (i.e. forwards and backs) is common. However, this designation may overlook the differences between individual positions. Given that each position is required to perform specific game tasks (6,16,19,28,36), it's reasonable to expect that the anthropometric and physical profiles of individual positions will differ. However, research describing position-specific attributes is limited (15,18,20,24,32,41,46) and this is the first study that we're aware of to report both the anthropometric and physical fitness characteristics of U18 school or college players.

Based on our findings, the props were the most distinct position, sitting outside the sample mean for the greatest number of variables, with a mixture of positive and negative deviations. Their largest difference was in body mass (d = 1.45), which was 21.3 kg higher than the group average and 14.0 kg heavier than the second heaviest position. Props also scored above the sample mean for sprint momentum and most of the absolute strength measures. These observations are consistent with previous research (10,15,18,24,41,46) and reflect the important role that the position plays in contesting possession during set pieces and breakdowns (6,16). Unsurprisingly, a large body mass comes at the expense of sprinting, jumping, and intermittent running ability, which were lower than for any other position and far below the sample mean (d = 0.89 to 1.01). However, these physical attributes can be seen as less important, given that props are required to perform the fewest number of sprints and cover the least distance (6).

The WSC props were heavier than previously reported U18 school (14.8 kg) (15) and U18/19 academy props (2.8 to 6.4 kg, d = 0.23 to 0.47) (10,18,46), although stature was comparable to both groups. They were 4.5 to 5.5 cm (d = 0.84 to 1.06) shorter and 6.3 to 14.5 kg (d = 0.66 to 1.26) lighter than senior professional props (1,20,24). Measures of sprint speed and momentum were within the ranges reported for U18/19 academy props (20,47) but were markedly lower than senior props (10 m = 0.12 s, d = 1.03; sprint momentum = 68 kg.m/s, d = 0.96) (41). The props were substantially weaker and less powerful than senior professional props (Belt Squat$_{PF}$: 2215 N, d = 1.59; ADD-90$_{PF}$: 86 N, d = 1.14; ABD-90$_{PF}$: 62 N, d = 0.73; ADD-0$_{PF}$: 35 N, d = 0.74; ABD-0$_{PF}$: 48 N, d = 1.38; Nordic$_{PF}$: 107 N, d = 1.03; CMJ$_{JH}$: 3.8 cm, d = 0.70; CMJ$_{PP}$: 850 W, d = 1.17; CMJ$_{PP/BM}$: 1.6 W/g, d = 0.24; CMJ$_{PF}$: 544 N, d = 1.57) (1). At present, no 30-15VIFT comparative data exists for the props or any other position.

The hookers were within the sample means for all variables apart from stature and 30-15^{VIFT}. The position is something of a hybrid. Whilst often seen as a smaller, more athletic version of a prop, hookers also possess similar characteristics to back rowers and have been classified as an extra back row player in some studies (16). It's also relatively common for back row players to transition to the hooker position during the late development/early performance phase, often if they lack the height required to be a good lineout option. The optimum anthropometric and physical profile likely depends on the role the hooker is required to play, and how much importance placed on scrummaging or open-field play. The hookers examined were shorter than both the props (3.6 cm, d = 0.60) and back row players (4.0cm, d = 0.81). Body mass was much lower than the props (18.1 kg, d = 1.44), but slightly higher than the back rowers (2.5 kg, d = 0.25). The hooker's sprint performance was the same as second rowers, whilst faster than props (d = 0.57 to 0.78), and slightly slower than back rowers (d = 0.26 to 0.38). The hookers outperformed the props for CMJ$_{JH}$ (4.2 cm, d = 0.72), CMJ$_{PP/BM}$ (4.2 W, d = 0.59), 10/5JH (4.7 cm, d = 0.98), 10/5$_{RSI}$ (0.39 AU, d = 1.04) and 10/5CT (21 ms, d = 0.90). The hookers were weaker than the props (d= 0.12 to 1.00) in the strength tests and comparable to back rowers. 30-15^{VIFT} was higher than props (0.19 m/s, d = 0.38), but below all other positions.

The WSC hookers were the same height as previously reported U18 school hookers (15), but shorter than both U18/19 academy (2.1 to 4.1 cm, d = 0.58 to 1.15) (10,18,46) and senior professional hookers (5.0 to 7.1 cm, d = 1.28 to 1.95) (1,20,24). Body mass was higher than U18 school hookers (7.9 kg, d = 0.78) (15), but lower than both U18/19 academy (2.3 to 5.5 kg, d = 0.24 to 0.58) (10,18,46) and senior professional hookers (15.3 to 21.1 kg, 1.49 to 2.24) (1,20,24). Sprint performance was in line with values reported for U18/19 and academy hookers; although, sprint momentum was lower (23 to 88 kg.m/s, d = 0.46 to 1.76) (18,46). The hookers were also slower (10 m: 0.07 s, d = 0.69) than senior players and produced far lower sprint momentum (105 kg.m/s, d= 2.09) (41). Strength and power measures were markedly lower than senior professional hookers (Belt Squat$_{PF}$: 2703 N, d = 2.31; ADD-90$_{PF}$: 60 N, d = 1.02; ABD-90$_{PF}$: 58 N, d = 0.77; ADD-0$_{PF}$: 37 N, d = 1.13; ABD-0$_{PF}$: 51 N, d = 1.53; Nordic$_{PF}$: 102 N, d = 1.18; CMJ$_{JH}$: 3.5 cm, d = 0.67; CMJ$_{PP}$: 1052 W, d = 1.61; CMJ$_{PP/BM}$: 1.5 W/g, d = 0.24; CMJ$_{PF}$: 714 N, d = 2.54; 10/5$_{JH}$: 1.2 cm, d = 0.28; 10/5$_{RSI}$: 0.21 AU, d = 0.56) (1).

The second row was the tallest position in the WSC cohort, measuring 8.5 cm (d = 1.34) above the group average. They were also in the second heaviest position and produced the second highest sprint momentum. These findings are to be expected, given the important role the position plays jumping in the lineout and pushing in the scrum. Combined with props, second rowers also engage in the highest number of rucks and mauls (16). The second rowers in this group were average for all other measures except 10/5$_{CT}$, which was below the sample mean.

The WSC second row players were shorter than previously reported U18 school (1.2 cm, d = 0.32) (15), U18/19 academy (2.1 to 6.3 cm, d = 0.54 to 1.25) (10,18,46), and senior professional second rowers (9.9 to 12.1 cm (d = 2.07 to 2.64) (1,20,24). Based on this finding, it's possible that, unless they grow further, these players may have difficulty progressing further in this position. Those who possess the required physical fitness attributes may consider transitioning to the back row, as their height more closely resembles senior professional players of this position (1,20,24). The WSC second row players were heavier (8.3 kg, d = 0.65) than U18 school second rowers (15), but lighter than U18/19 academy (2.0 to 6.0 kg, d = 0.18 to 0.58) (10,18,46) and senior professionals (20.0 to 26.5 kg, d = 1.55 to 2.73) (1,20,24). Sprint performance was comparable to previously reported U18/19 academy second rows and sprint momentum was at the lower end of the range (501 to 522 kg.m/s) (18,46). When compared to their senior counterparts, the second rowers were slower (10 m: 0.09 s, d = 0.72) and had a much lower sprint momentum (110 kg.m/s, d= 1.56) (41). WSC second rowers performed below senior professional second rowers in all strength (Belt Squat$_{PF}$: 1743 N, d = 1.31; ADD-90$_{PF}$: 85 N, d = 1.15; ABD-90$_{PF}$: 60 N, d = 0.88; ADD-0$_{PF}$: 34 N, d = 0.70; ABD-0$_{PF}$: 56 N, d = 1.45; Nordic$_{PF}$: 106 N, d = 1.31) and power tests (CMJ$_{JH}$: 4.1 cm, d = 0.85; CMJ$_{PP}$: 1558 W, d = 2.55; CMJ$_{PP/BM}$: 2.2 W/g, d = 0.40; CMJ$_{PF}$: 849 N, d = 2.26) except for the 10/5 (10/5$_{JH}$: 3.7 cm, d = 0.64; 10/5RSI: 0.02 AU, d = 0.06) (1).

The back rowers were average for all anthropometric and physical fitness variables. This may reflect the versatility required to play this position, with back rowers assuming a mixture of forward and back responsibilities and physical characteristics. Whilst typically involved in fewer rucks and mauls than the other forward positions, back rowers cover greater distance, and more tackles than another position (6,16). They also complete a similar number of sprints to the inside backs (scrum half, outside half, and centers) (6,16).

The WSC back row players were the same height as previously reported U18 school back rowers (15), but shorter than their U18/19 academy (0.04 cm to 6.0 cm, d = 0.01 to 1.15) (10,18,46) and senior professional back row players (8.3 to 11.0 cm, d = 1.62 to 2.23) (1,20,24). Body mass was higher (8.5 kg, d = 0.85) than U18 school back rowers (15), but lower than U18/19 academy (1.6 to 5.0 kg, d = 0.18 to 0.51) (10,18,46) and senior professionals (19.5 to 23.0 kg, d = 1.94 to 2.50) (1,20,24). Sprint performance and momentum was within the ranges previously reported for U18/19 academy back rowers (10 m: 1.80 to 1.90; sprint momentum: 464 to 501 kg.m/s) (18,46), but markedly lower than senior players (10 m: 0.09 s, d = 0.75; sprint momentum: 10.9 kg.m/s, d = 1.82) (41). WSC back rowers performed below senior professional players in all strength (Belt Squat$_{PF}$: 2282 N, d = 2.00; ADD-90PF: 76 N, d = 1.05; ABD-90$_{PF}$: 30 N, d = 0.40; ADD-0$_{PF}$: 30 N, d = 0.54; ABD-0$_{PF}$: 23 N, d = 0.59; Nordic$_{PF}$: 100 N, d = 1.09) and power tests (CMJ$_{JH}$: 2.8 cm, d = 0.52; CMJPP: 1506 W, d = 2.10; CMJ$_{PP/BM}$: 2.6 W/g, d = 0.40; CMJ$_{PF}$: 879 N, d = 2.34; 10/5$_{RSI}$: 0.14 AU, d = 0.38) except for the 10/5JH: 1.7 cm, d = 0.34) (1). Future research may wish to examine the anthropometric and physical differences between the individual back row positions (i.e. blindside flanker, openside flanker, and number 8), given the subtle differences in their roles.

The scrum half was the shortest and lightest position, measuring 5.4 cm (d = 0.86) and 14.9 kg (d = 1.01) below the sample mean. This finding is consistent with the previous research in youth and senior professional rugby union (10,15,18,32,46). It's thought that a short stature makes it easier for the scrum half to collect and quickly pass the ball off the floor during rucks. The scrum halves were above the sample mean for CMJPP/BM (3.9 W/kg, d = 0.52), 10/5RSI (0.26 AU, d = 0.57), and 30-15^{VIFT} (0.32 m/s, d = 0.60). The last finding is unsurprising, given that the position is involved in most phases of play and usually covers the greatest distance during game (6).

The scrum halves examined were equivalent to previously reported U18 school scrum halves in terms of stature and body mass (15). They were taller than U18/19 academy scrum halves (1.9 to 6.1 cm, d = 0.39 to 1.17) (10,18,46), but slightly shorter than senior professionals 1.5 cm to 3.2 cm (d = 0.33 to 0.70) (1,20). Body mass was the same as South African U18 academy scrum halves (18) but lower than Irish U18/19 academy scrum halves (3.7 to 4.2, d = 0.60 to 0.65) (10,46) and much lower than senior professionals (10.9 to 13.9 kg, d = 2.17 to 2.36) (1,20,24). Sprint performance was the same as previously reported for U18/19 academy scrum halves; whilst sprint momentum was at the lower end of the range (391 to 418 kg.m/s) (18,46). There was a moderate difference in sprint performance (10 m: 0.09 s, d = 0.93) and very large difference in sprint momentum (124 kg.m/s, d = 3.44) between the scrum halves examined and values reported for senior halfbacks (scrum- and outside half positions). WSC scrum halves performed below senior professional players in all strength (Belt Squat$_{PF}$: 1394 N, d = 1.13; ADD-90$_{PF}$: 109 N, d = 1.46; ABD-90$_{PF}$: 35 N, d = 0.52; ADD-0$_{PF}$: 10 N, d = 0.27; ABD-0$_{PF}$: 21 N, d = 0.75; Nordic$_{PF}$: 66 N, d = 0.85) and power tests (CMJ$_{JH}$: 4.3 cm, d = 0.80; CMJ$_{PP}$: 810 W, d = 1.85; CMJ$_{PP/BM}$: 2.3 W/g, d = 0.37; CMJ$_{PF}$: 433 N, d = 2.13; 10/5JH: 4.7 cm, d = 0.75; 10/5$_{RSI}$: 0.36 AU, d = 0.76) (1).

The outside halves had a similar overall profile to scrum halves, although they were slightly taller (2.3 cm, d = 0.40) and heavier (3.1 kg, d = 0.46). They were also above the sample mean in the 30-15^{VIFT}, ranking higher than any other position. Like the scrum half, the outside half is involved with many phases of play and is a key decision maker and distributor of the ball to the backline players.

The WSC outside halves were shorter (2.8 cm, d = 0.46) than U18 school outside halves, but comparable in terms of body mass (15). They were shorter and lighter than U18/19 academy (1.4 to 3.8 cm, d = 0.22 to 0.70; 0.9 to 7.4 kg, d = 0.11 to 1.03) (10,18,46) and senior professional outside halves (3.9 to 6.3 cm, d = 0.66 to 1.02; 13.9 to 15.1 kg, d = 2.00 to 2.37) (1,20). Sprint performance and momentum was within the ranges previously reported for U18/19 academy outside halves (10m: 1.70 to 1.90 s; momentum: 395 to 473 kg.m/s) (18,46). There was a moderate difference in sprint performance (10 m: 0.09 s, d = 0.93) and very large difference in sprint momentum (124 kg.m/s, d = 3.44) between the outside halves examined and values reported for senior halfbacks (scrum- and outside half positions) (41). WSC outside halves performed below senior professional players in all strength (Belt Squat$_{PF}$: 1337 N, d = 1.19; ADD-90PF: 108 N, d = 1.79; ABD-90PF: 62 N, d = 0.98; ADD-0PF: 23 N, d = 0.59; ABD-0PF: 31 N, d = 1.00; Nordic$_{PF}$: 67 N, d = 0.81) and power tests (CMJ$_{JH}$: 3.3 cm, d = 0.66; CMJ$_{PP}$: 1119 W, d = 1.96; CMJ$_{PP/BM}$: 4.4 W/g, d = 0.70; CMJ$_{PF}$: 651 N, d = 1.98; 10/5$_{JH}$: 4.5 cm, d = 0.95; 10/5$_{RSI}$: 0.38 AU, d = 1.09) (1).

The centers were the only position to be average or better for all anthropometric and physical fitness variables. They were comparable to the back 3 players in sprint and jump performance, but were heavier, stronger, and demonstrated greater high intensity running ability. On the hand, the back 3 players performed slightly better in the 10/5 test, suggesting slightly better reactive ability. The centers were the strongest position, except for the props. These physical characteristics reflect the role the center is required to play in attack and defense, with the position performing a high number of sprints, and involved in many tackles and rucks (16,19,36). In contrast the back 3 tend to specialize in the running aspects of the game, and generally prioritize speed over size and strength.

The WSC centers were the same height as previously reported U18 school (15) and U18/19 academy centers (10,18,46), although shorter than senior professionals (4.3 to 7.1 cm, d = 1.01 to 1.59) (1,20,24). Body mass was greater (3.1 kg, d = 0.55) than U18 school centers, but lower (0.8 to 5.8 kg, d = 0.15 to 1.02) than U18/19 academy (10,18,46), and senior professionals (14.8 to 19.7 kg, d = 2.27 to 2.87) (1,20,24). Sprint performance was slightly faster than previously reported for U18/19 academy centers (10m: 0.04 s, d = 0.45), while sprint momentum was within the range (447 to 473 kg.m/s) (18,46). There was a moderate difference in sprint performance (10 m: 0.06 s, d = 0.71) and large difference in sprint momentum (60 kg.m/s, d = 1.65) between the centers examined, and values previously reported for senior centers (41). WSC centers performed below senior professional players in all strength (except ABD-90$_{PF}$) (Belt Squat$_{PF}$: 1009 N, d = 0.81; ADD-90$_{PF}$: 32 N, d = 0.38; ABD-90$_{PF}$: 3 N, d = 0.05; ADD-0$_{PF}$: 25 N, d = -0.50; ABD-0$_{PF}$: 40 N, d = 9.8; Nordic$_{PF}$: 71 N, d = -1.17) and jump tests (CMJ$_{JH}$: 2.1 cm, d = 0.39; CMJ$_{PP}$: 587 W, d = 1.89; CMJ$_{PP/BM}$: 0.3 W/g, d = 0.06; CMJ$_{PF}$: 587 N, d = 1.89; 10/5$_{JH}$: 1.3 cm, d = 0.27; 10/5$_{RSI}$: 0.26 AU, d = 0.69) (1). However, these differences were of a lower magnitude than other positions, suggesting that the gap between WSC and senior professional centers is smaller than other positions.

The WSC back 3 players were taller (2.6 cm, d = 0.44) and heavier (5.2 kg, d = 0.62) than previously reported schoolboy back 3 players (15). They were comparable to U18/19 academy players in terms of height, but not body mass (5.5 kg, d = 0.71) (46). When compared to senior professional back 3 players, WSC back 3 were 2.5 to 6.4 cm (d = 0.47 to 1.13) shorter and 14.7 to 18.7 kg (d = 1.76 to 2.37) lighter (1,20,24). Sprint performance was slightly faster than previously reported for U18/19 academy back 3 players centers (10m: 0.02 s, d = 0.25). Yet, sprint momentum was lower (22 kg.m/s' d = 0.45), due to the difference in body mass (46). When compared to senior professionals back 3 players, there was a large difference in sprint performance

(10 m: 0.10 s, *d* = 0.98) and very large difference in sprint momentum (91 kg.m/s, *d* = 1.91). (41). WSC back 3 players performed below senior professionals in all strength (Belt $Squat_{PF}$: 1665 N, *d* = 1.31; ADD-90_{PF}: 83 N, *d* = 0.96; ABD-90_{PF}: 52 N, *d* = 0.78; ADD-0_{PF}: 32 N, *d* = 0.85; ABD-0_{PF}: 46 N, *d* = 1.37; $Nordic_{PF}$: 83 N, *d* = 1.24) and power tests (CMJJH: 3.9 cm, *d* = 0.67; CMJ_{PP}: 1230 W, *d* = 1.97; $CMJ_{PP/BM}$: 5.3 W/g, *d* = -0.85; CMJ_{PF}: 646 N, *d* = 2.26; 10/5JH: 1.8 cm, *d* = 0.29; $10/5_{RSI}$: 0.26 AU, *d* = 0.64) (1).

CONCLUSIONS

The purpose of this study was to describe the anthropometric and physical fitness characteristics of the junior rugby union players who compete in the WSC league. Data for this population (i.e. U18 school/college players) is currently limited, and to our knowledge, this is the first study to report this data for position groups (i.e. forwards and backs) and individual playing positions. Comparisons were also made between the WSC players and previously reported rugby union data to provide context and a better understanding of the gaps that exist between different competition levels. Except for the 30-15, the WSC data was within previously reported ranges for schoolboy and academy players of similar age. Compared to senior professional players, the largest differences were in body mass and strength variables. We anticipate that this information could be used to support talent identification, player tracking, and for the development of national standards and benchmarks (see supplemental materials: WSC normative data tables).

LIMITATIONS

Several limitations should be acknowledged. Firstly, testing was completed at the end of the pre-season period (1 or 2 weeks before the first fixture), during the beginning of the academic year. Whilst all the WSC teams undertook training during this period, this was not controlled by the research team. Similarly, although players were asked to refrain from strenuous training during the 48 hours prior to testing, there was no way to determine that these instructions were followed. It's therefore possible that some players were tested in a deconditioned or fatigued state. Findings are also limited to the tests undertaken and may not be transferable to other forms of assessment. For example, the ISO^{Belt}_{Squat} was selected as the test of maximum lower-body strength, to account for the varied training backgrounds of participants. However, currently this test has limited use by practitioners who generally incorporate dynamic/iso-inertial forms of maximum strength assessment. Similarly, strength assessments were limited to the lower body. Future research may wish to include some form of upper body strength assessment as differences between school and academy players have been report (26).

FUTURE RECOMMENDATIONS

This study should be viewed as the starting point for this population. Future research will examine the longitudinal changes in anthropometric and physical fitness parameters and the influence of these attributes on game performance (e.g. GPS data, KPIs), injuries, and player progression.

ACKNOWLEDGEMENTS

The authors thank players and staff who participating in this project and the University of South Wales students who assisted with data collection.

CONFLICTS OF INTEREST

Independent of this study, and following its completion, Dr. M. Williams took up a paid position with VALD Technologies

FUNDING

No funding was received in order for this study to be completed.

ETHICAL APPROVAL

Ethics approval for the study was obtained from the University of South Wales Faculty Ethics Committee Review Board (220902LR).

DATES OF REFERENCE

Submission - 02/11/2024
Acceptance - 08/05/2025
Publication - 31/08/2026

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