

Please cite the Published Version

Dobbin, Nicholas, Highton, Jamie, Moss, Samantha and Twist, Craig (2019) The discriminant validity of standardised testing battery and its ability to differentiate anthropometric and physical characteristics between youth, academy and senior professional rugby league players. *International Journal of Sports Physiology and Performance*, 14 (8). pp. 1110-1116. ISSN 1555-0273

DOI: <https://doi.org/10.1123/ijsp.2018-0519>

Publisher: Human Kinetics

Version: Accepted Version

Downloaded from: <https://e-space.mmu.ac.uk/622194/>

Additional Information: This is an Author Accepted Manuscript of a paper accepted for publication by Human Kinetics in *International Journal of Sports Physiology and Performance*.

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1 Abstract

2 **Purpose:** To assess a standardised testing battery's ability to differentiate anthropometric and
3 physical qualities between youth, academy and senior rugby league players, and determine the
4 discriminant validity of the battery.

5 **Methods:** A total of 729 rugby league players from multiple clubs within England categorised
6 as youth ($n = 235$), academy ($n = 362$) and senior ($n = 132$) players completed a standardised
7 testing battery that included the assessment of anthropometric and physical characteristics
8 during preseason. Data was analysed using magnitude-based inferences and discriminant
9 analysis.

10 **Results:** Academy players were most likely taller and heavier than youth players (effect size
11 (ES) = 0.64 to 1.21), with possibly to most likely superior CMJ, medicine ball throw and prone
12 Yo-Yo IR1 performance (ES = 0.23 to 1.00). Senior players were likely to most likely taller
13 and heavier (ES = 0.32 to 1.84), with possibly to most likely superior 10 and 20 m sprint times,
14 CMJ, CoD, medicine ball throw and prone Yo-Yo IR1 compared to youth and academy (ES =
15 -0.60 to 2.06). The magnitude of difference appeared to be influenced by playing position. For
16 the most part, the battery possessed discriminant validity with an accuracy of 72.2%.

17 **Conclusion:** The standardised testing battery differentiates anthropometric and physical
18 qualities of youth, academy and senior players as a group and, in most instances, within
19 positional groups. Furthermore, the battery is able to discriminate between playing standards
20 with good accuracy and might be included in future assessments and rugby league talent
21 identification.

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38 Key words: talent identification; team sport; playing position; fitness; profiling

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40 Introduction

41 In an attempt to improve sporting success at both club and national standards, governing bodies
42 such as the Rugby Football League (England), have resourced Talent Identification and
43 Development (TID) programmes to aid selection and training processes for young ‘talented’
44 players.¹ Clubs are also encouraged to develop young players, with financial incentives offered
45 by the governing body that lifts salary restrictions on players eligible for both academy and
46 senior rugby. This, in theory, offers young players a pathway into senior rugby league while
47 allowing financially inferior teams to supplement their squad with “home grown” talent.² In
48 rugby league, the majority of professional clubs run a TID programme, whereby players aged
49 14 and 15 and those aged 16 and 18 years are contracted to scholarship and academy teams,
50 respectively.³ Such programmes are designed to recognise players with potential, enabling
51 them to excel early in their development⁴⁻⁶ via appropriate coaching, welfare, and sport science
52 provision.^{5,7}

53 Entry onto a TID programme is multidimensional and typically includes physical, technical,
54 tactical, social and perceptual skills^{5,6,8} as well as considering maturation.^{2,4,8} The
55 anthropometric and physical characteristics of rugby league players appear important and can
56 discriminate between playing standards,⁹⁻¹¹ positions,^{12,13} those selected and not-selected onto
57 a TID programme¹⁴ and age categories.¹⁵ For example, Tredrea et al.¹⁴ observed that those
58 players selected onto a TID programme were faster and more powerful than non-selected
59 players. Till et al.⁴ also reported that a combination of anthropometric and physical
60 characteristics accurately discriminated between amateur and professional status in rugby
61 league (sensitivity > 83%). Collectively, these studies indicate anthropometric and physical
62 characteristics can be used to make informed decisions on a player’s progression and
63 development as well as identifying ‘talent’; albeit, the need for reliable measures of
64 anthropometric and physical characteristics that can discriminate between standards (i.e.
65 discriminant validity) are required.^{2,3}

66 The majority of studies to date examining the anthropometric and physical characteristics of
67 rugby league players have collected data from a single club with relatively small sample
68 sizes.^{11,14,16} These limitations could be addressed with a national standardised testing battery
69 that provides normative data on physical qualities for youth, academy and senior rugby league
70 players from multiple clubs. To this end, a reliable testing battery was recently introduced that
71 allowed youth, academy and senior players to be assessed efficiently using the same procedures
72 with minimal cost.¹⁷ What remains unclear is how the specific components of this battery
73 differentiate between performance standards in male rugby league players and the discriminant
74 validity of the testing battery as a whole. Accordingly, this study aimed to investigate
75 differences in anthropometric and physical qualities between youth, academy and senior rugby
76 league players across multiple clubs and thus establish the discriminant validity of a
77 standardised testing battery.

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79 Methods

80 Participants and Design

81 With institutional ethics approval, 729 male youth ($n = 235$), academy ($n = 362$) and senior (n
82 $= 132$) rugby league players from 12 individual clubs participated in the study (Table 1). Youth
83 players were affiliated with a scholarship programme and academy players were contracted to

84 a professional club. Senior players were professional and had competed at least one full
85 competitive season in the European Super League. Players at each standard were classified as
86 back row forwards, props, hookers, halves, centres and fullback/winger and was based on the
87 position they played most often.¹³

88 During the first two weeks of the Super League preseason, participants first completed
89 measures of stature to the nearest 0.1 cm (Seca, Leicester Height Measure, Hamburg, Germany)
90 and body mass to the nearest 0.1 kg (Seca, 813, Hamburg, Germany) wearing minimal clothing
91 and no footwear before commencing the testing battery.¹⁷ All testing, which took place at the
92 club's own training ground on artificial turf, was preceded by 48 hours of no leisure- or club-
93 based physical activity and participants were instructed to arrive in a fed and hydrated state.
94 Participants were divided into two groups with group one completing the sprint and
95 countermovement jump test whilst group two completed the change of direction test and
96 medicine ball throw. The groups then swapped and came together to complete the prone Yo-
97 Yo IR1. All measures were conducted by the same researcher in a standardised order and with
98 no verbal encouragement provided. All participants were familiar with the procedures having
99 completed these tests before as part of routine club monitoring activities.

100 **Procedures**

101 Sprint performance was measured using electronic timing gates (Brower, Speedtrap 2, Brower,
102 Utah, USA) positioned at 0, 10 and 20 m, 150 cm apart and at a height of 90 cm. Participants
103 began each sprint from a two-point athletic stance 30 cm behind the start line. Two maximal
104 20 m sprints were recorded to the nearest 0.01 s with two minutes between each attempt and
105 the best 10 and 20 m sprint times used for analysis possessing a coefficient of variation (CV)
106 of 4.2 and 3.6%, respectively.¹⁷

107 Participants completed two countermovement jumps (CMJ) with 2-minutes passive recovery
108 between each attempt. Participants placed their hands on their hips and started upright before
109 flexing at the knee to a self-selected depth and extending up for maximal height, keeping their
110 legs straight throughout. Jumps that did not meet the criteria were not recorded, and participants
111 were asked to complete an additional jump. Jump height was recorded using a jump mat (Just
112 Jump System, Probotics, Huntsville, Alabama, USA) and corrected before peak height was
113 used for analysis,¹⁸ with a CV of 5.9%.¹⁷

114 Change of direction (CoD) performance was measured using electronic timing gates (Brower,
115 Speedtrap 2, Brower, Utah, USA) placed at the start/finish line 150 cm apart and at a height of
116 90 cm. The test consisted of different cutting manoeuvres over a 20 x 5 m course (see Ref 17)
117 with each effort interspersed by 2-minutes passive recovery. Participants started in two-point
118 athletic stance 30 cm behind the start line and completed one trial on the left; the timing gates
119 were then moved, and a second trial was performed on the right in a standardised order before
120 the times were combined (CV = 2.5%).¹⁷ Failure to place both feet around each cone resulted
121 in disqualification and the trial being repeated.

122 To assess whole-body muscle function, participants began standing upright with a medicine
123 ball (dimensions: 4 kg, 21.5 cm diameter) above their head before lowering the ball towards
124 their chest whilst squatting down to a self-selected depth. With their feet shoulder width apart,
125 in contact with the ground and behind a line that determined the start of the measurement, they
126 were then instructed to extend up pushing the ball forwards striving for maximum distance.
127 Distance was measured to the nearest centimetre using a tape measure from the back of the
128 start line to the rear of the ball's initial landing imprint on the artificial surface. Participants
129 completed two trials interspersed by 2-minutes recovery, with the maximum distance used (CV
130 = 9.0%).¹⁷

131 The prone Yo-Yo IR1 required participants to start each 40 m shuttle in a prone position with
132 their head behind the start line, legs straight and chest in contact with the ground. Shuttle speed
133 was dictated by an audio signal commencing at 10 km·h⁻¹ and increasing 0.5 km·h⁻¹
134 approximately every 60 s to the point at which the participants could no longer maintain the
135 required running speed. The final distance achieved was recorded after the second failed
136 attempt to meet the start/finish line in the allocated time. The reliability (CV% = 9.9%)¹⁷ and
137 concurrent validity of this test have been reported.¹⁹

138 **Statistical analysis**

139 Data are presented as mean ± SD. Magnitude-based inferences and effect sizes (ES) with 90%
140 confidence limits were used, with ES calculated as the difference between trials divided by the
141 pooled SD. Threshold values for effect sizes were: 0.0-0.2, *trivial*; 0.21-0.6, *small*; 0.61-1.2,
142 *moderate*; 1.21-2.0, *large*; >2.01, *very large*.²⁰ Threshold probabilities for a mechanistic effect
143 based on the 90% confidence limits were: 25-75% possibly, 75-95% likely, 95-99% very likely
144 and > 99.5 most likely.²¹ Effects with confidence limits spanning a likely small positive or
145 negative change were classified as unclear. Interpretation about the magnitude of difference
146 was also assessed with reference to the 'required change' (typical error + smallest worthwhile
147 change) for each test.¹⁷ Statistical analysis was conducted using a predesigned spreadsheet for
148 independent groups.²² To identify which measures included in the standardised testing battery
149 discriminate between youth, academy and senior players, a stepwise discriminant analysis was
150 applied with playing standard included as the dependent variable and performance tests as
151 predictor variables. Analysis was performed using SPSS version 25 with alpha set at 0.05.

152

153 **Results**

154 Analysis revealed *trivial* to *very large* differences between playing standards in several
155 anthropometric and physical qualities (Table 1). Compared to youth players, academy and
156 senior players were most likely taller and heavier, with senior players likely taller and most
157 likely heavier than academy players. Differences in 10 and 20 m sprint times were likely trivial
158 between youth and academy players but were possibly to very likely lower for senior players
159 compared to youth (20 m only) and academy players. Countermovement jump height was most
160 likely higher for academy players compared to youth, and most likely higher for senior players
161 compared to youth and academy players. Differences in CoD time were likely trivial between
162 youth and academy, and most likely faster for senior players. Medicine ball throw distance for
163 senior was most likely higher compared to youth and academy, and most likely higher for
164 academy compared to youth players. Prone Yo-Yo IR1 distance was most likely higher for
165 senior players compared to youth and academy players, with distance possibly higher for
166 academy compared to youth.

167 *****INSERT TABLE 1 HERE*****

168 Normative data for each playing position at youth, academy and senior standard are presented
169 in Table 2, with the magnitude of differences presented in Figure 1. Within-positional group
170 differences ranged from *trivial* to *very large*, and for the most part, indicated that the
171 differences between senior and academy players was smaller than between senior and youth
172 players.

173 *****INSERT TABLE 2 HERE*****

174 *****INSERT FIGURE 1 HERE*****

175 Stepwise discriminant analysis identified that a combination of seven predictor variables would
176 successfully and significantly discriminate between youth, academy and senior players ($P <$
177 0.000). The variables were 20 m sprint time ($\Delta = 0.976$), change of direction time ($\Delta = 0.942$),
178 prone Yo-Yo IR1 distance ($\Delta = 0.931$), stature ($\Delta = 0.872$), countermovement jump height (Δ
179 $= 0.792$), body mass ($\Delta = 0.651$) and power pass ($\Delta = 0.631$). The squared canonical correlation
180 was 0.560 meaning these eight performance measures combined accounted for 56.0% of the
181 overall variance in the data set. Cross-validation classification indicated that the discriminant
182 analysis corresponded with an accuracy of 72.2% overall, equating to 68.9% (162/235) of
183 youth players, 79.0% (286/362) for academy players and 59.1% (78/132) for senior players.

184

185 Discussion

186 This study assesses the ability of a reliable testing battery to differentiate anthropometric and
187 physical characteristics between youth, academy and senior rugby league players and explores
188 how these tests discriminate between playing standards. Results revealed different
189 anthropometric and physical profiles at senior compared to youth and academy standards, and
190 that all but 10 m sprint time were able to discriminate between youth, academy and senior
191 players. The proposed testing battery is sensitive and can differentiate anthropometric and
192 physical profiles within positional groups between youth, academy and senior rugby league
193 players.

194 Anthropometric characteristics differentiated between playing standards reaffirming their
195 importance in rugby league.^{13,15,16} The difference observed between youth and academy players
196 is expected and likely reflects maturation¹⁵ as well as the greater training volume and physical
197 demands of senior compared to academy match-play. For example, the relative number of
198 defensive tackles (forwards: 0.47 ± 0.23 *cf.* 0.34 ± 0.13 $n \cdot \text{min}^{-1}$; backs: 0.16 ± 0.11 *cf.* $0.13 \pm$
199 0.08 $n \cdot \text{min}^{-1}$ for senior and academy, respectively) and offensive carries (forwards: 0.20 ± 0.10
200 *cf.* 0.12 ± 0.06 $n \cdot \text{min}^{-1}$; backs: 0.15 ± 0.08 *cf.* 0.06 ± 0.04 $n \cdot \text{min}^{-1}$ for senior and academy,
201 respectively)²³ likely explains the requirement of greater body mass in senior players. In
202 agreement with Morehen et al.¹³ for senior players but also for youth and academy, we observed
203 large positional variation in stature and body mass. Differences in stature between youth and
204 senior players ranged from *moderate* to *large*, whereas between academy and senior players,
205 the magnitude was lower. *Large* differences in body mass were observed within positional
206 groups between youth and academy players but was reduced to *moderate* when comparing
207 academy to senior players. These results demonstrate that stature and body mass can
208 discriminate between playing standards and should be included as part of a TID programme in
209 rugby league.

210 Whilst smaller scale studies have inferred sprint speed differentiates between performance
211 standards in rugby league,^{11,14,16} this study observed *trivial* differences in 10 m and 20 m sprint
212 times between youth and academy players. This might be explained by the large increase in
213 body mass²⁴ as players progress from youth to academy, meaning an impaired technical
214 capacity²⁵ and players needing to overcome a greater inertia when sprinting from a stationary
215 start. Despite senior players being heavier than both youth and academy, they possess similar
216 or faster sprint times that suggests they could generate greater force and power during the
217 sprints.²⁵ These observations reaffirm the importance of senior players possessing both high
218 speed and high body mass in order to generate momentum into collisions,²⁶ though it should be
219 noted that 10 m sprint times were excluded during the stepwise discriminate analysis. The
220 within-position difference between playing standards revealed differences in 10 and 20 m
221 sprint times between academy and senior wingers, halves, props and backrow forwards but not

222 centres or hookers; albeit, few of these differences in sprint performance exceeded the ‘required
223 change’.¹⁷ We propose that 10 m sprint times *per se* might not discriminate between youth and
224 academy players regardless of playing position but that 20 m sprints times can discriminate
225 between playing standards.

226 Senior players possessed most likely faster CoD time compared to youth and academy players,
227 with the mean difference exceeding the ‘required change’ (0.76 *cf.* 0.67 s).¹⁷ However, similar
228 to previous findings,¹¹ there was no meaningful difference in CoD between youth and academy
229 players. Again, the faster CoD times for senior players is likely explained by increased
230 exposure to specific training practices that enable greater muscle power contributing to change
231 of direction ability.²⁷ Whilst only *trivial* differences existed between youth and academy mean
232 CoD times, a *small* difference was observed for hookers and props, though did not exceed the
233 ‘required change’.¹⁷ The CoD test was able to differentiate senior wingers/fullbacks, hookers
234 and back row forwards from academy and youth players. The similarity between youth and
235 academy players could be explained by the *trivial* differences in 10 and 20 m sprint times as
236 well as the potentially varied exposure to accelerating, decelerating and cutting mechanics
237 during training (i.e. 1 to 3 years). Discriminant analysis revealed that CoD is a significant
238 predictor and should be include in future testing batteries for the purpose of TID.

239 A *moderate* difference in CMJ was observed between youth and academy players, and
240 academy and senior players, with the mean differences exceeding the ‘required change’ (2.9
241 cm).¹⁷ Similar observations for the medicine ball throw revealed *moderate* differences between
242 youth and academy, and academy and senior, all that exceeded the ‘required change’ of 0.7
243 m.¹⁷ Further, discriminant analysis revealed both CMJ and medicine ball throw as predictors
244 of playing standard, though it is also important to recognise the within-position difference
245 between groups. For example, differences in CMJ between youth and academy players ranged
246 from *small* to *moderate* and were greater than the ‘required change’ for all positions.
247 Differences in CMJ between academy and senior players were in agreement with previous
248 research,^{9,28} ranging from *small* to *large* and were greater than 2.9 cm. Positional differences
249 in the distance achieved during the medicine ball throw between youth and academy players
250 ranged from *small* and *large*, exceeding 0.7 m for all positions except props. Positional
251 differences in medicine ball throw between academy and senior players were more varied
252 ranging from *small* to *large*. The *large* effect for CMJ and medicine ball throw between
253 academy and senior props might suggest that this position becomes specialised as players
254 progress through to senior rugby and are required to develop power to a greater extent than
255 other playing positions.

256 *Small* differences that did not exceed the ‘required change’ (48 *cf.* 120 m) suggest the prone
257 Yo-Yo IR1 was unable to differentiate between youth and academy players. However, when
258 combined with the six additional variables, the stepwise discriminant analysis revealed the
259 prone Yo-Yo IR1 as a significant predictor of playing standard. The *large* increase in body
260 mass (ES = 1.21) from youth to academy probably impacts negatively on the older player’s
261 ability to get up from the prone position and perform intermittent shuttle running.²⁹ While
262 academy coaches might focus on increasing body mass to aid running momentum and impact
263 forces during the collision³ as players progress from youth rugby, they should be mindful of
264 the detrimental trade-off on rugby-specific high intensity running. In contrast, *moderate*
265 differences exceeding 120 m were observed between younger (i.e. youth and academy) and
266 senior players. Whilst senior players also possess greater body mass, they seemingly tolerate
267 this better during the prone Yo-Yo IR1 probably because of the smaller increases in body mass
268 from academy to senior rugby (ES = 0.70) and greater emphasis on specific high intensity
269 training. Collectively, the ability to get up from the prone position, accelerate and perform

270 repeated intermittent running, while also maintaining a high body mass, is important for elite
271 rugby league players. Positional differences for the prone Yo-Yo IR1 between youth and
272 academy halves were *trivial* whereas all other positional differences were *small*. A *trivial*
273 difference was also observed when comparing academy and senior halves; *small* for
274 wingers/fullbacks and centres; *moderate* for hookers and back row forwards; and *large* for
275 props. These observations might reflect differences in position-specific training as players
276 progress from academy to senior rugby and that based on the discriminant analysis should be
277 incorporated into future assessments of a player's high-intensity intermittent running ability.

278 Discriminate analysis determined, that seven of the eight performance measures included in
279 the battery (i.e. stature, body mass, 20 m sprint times, CMJ height, CoD time, medicine ball
280 throw distance and prone Yo-Yo IR1 distance) discriminated between youth, academy and
281 senior players. These accounted for 56% of the variance between youth, academy and senior
282 players, with the remaining 44% accounted for by other variables associated with sporting
283 performance (e.g. technical, tactical, social and psychological skills). Overall, the analysis
284 possessed a predictive accuracy of 72.2%, which equated to 68.9% for youth players, 79.0%
285 for academy players and 59.1% for senior players. These results suggest that a combination of
286 seven performance measures were able to place youth and academy players to a greater degree
287 of accuracy compared to senior players where a large (41.1%) proportion of players were
288 incorrectly placed into the academy group. Furthermore, a third (31.1%) of youth players were
289 incorrectly identified as academy players while 12.4% and 8.6% of academy players were
290 incorrectly placed within the youth and senior groups, respectively. Our results indicate a
291 degree of overlap in the physical characteristics between youth and academy, and senior and
292 academy players, suggesting that additional factors beyond physical characteristics also play
293 an important role in talent progression and identification. Nonetheless, the high degree of
294 predictive accuracy suggests that practitioners can use this testing battery to discriminate
295 between performance standards in rugby league.

296 Whilst this study provides data on elite rugby league players across multiple clubs, inherent
297 limitations exist. All data was collected at the start of the preseason period and might not reflect
298 the 'optimal' anthropometric and physical characteristics of players.³⁰ We also acknowledge
299 no measure of muscle strength within the battery, although recent work has reported the
300 construct validity of mid-thigh pull dynamometer for discriminating between youth and senior
301 rugby league players¹⁰ that could be included in the standardised battery.

302 **Practical Applications**

303 The standardised testing battery is able to differentiate between playing standards and,
304 excluding 10 m sprint time, possesses discriminant validity. The testing battery can also, for
305 the most part, be used to differentiate within playing positions between youth, academy and
306 senior standards. Finally, the data represents normative data for UK-based youth, academy and
307 senior rugby league players. As such, practitioners in rugby league can use this battery and the
308 data presented to monitor players and support the decision-making process concerning a
309 player's development or progression through performance standards in rugby league.

310 **Conclusion**

311 This study demonstrates the discriminant validity of a standardised testing battery for assessing
312 anthropometric and physical qualities between youth, academy and senior rugby league
313 players. Our results revealed that, for the most part, senior players possessed superior
314 anthropometric and physical characteristics compared to youth and academy players, with
315 fewer clear differences between youth and academy players. Furthermore, playing position
316 influenced the magnitude of difference between performance standards and should be

317 considered when assessing the anthropometric and physical characteristics to inform talent
318 identification and monitor player development in rugby league.

319

320 **Acknowledgements**

321 The authors thank all participants and Super League clubs who took part in the study. The
322 authors have no funding or conflicts of interest to disclose.

323

324

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Table 1. Anthropometric and physical characteristics for youth, academy and senior rugby league players.

Characteristic	Performance standard			Effect size \pm 90% CI		
	Youth (<i>n</i> = 235)	Academy (<i>n</i> = 365)	Senior (<i>n</i> = 132)	Youth <i>cf.</i> Academy	Youth <i>cf.</i> Senior	Academy <i>cf.</i> Senior
Age (years)	15.1 \pm 0.8	17.5 \pm 2.0	23.7 \pm 4.3	2.65 \pm 0.17 <i>Most likely</i> \uparrow	8.11 \pm 0.48 <i>Most likely</i> \uparrow	3.60 \pm 0.32 <i>Most likely</i> \uparrow
Stature (cm)	172.6 \pm 6.9	180.7 \pm 6.4	182.7 \pm 5.8	0.64 \pm 0.13 <i>Most likely</i> \uparrow	0.92 \pm 0.16 <i>Most likely</i> \uparrow	0.32 \pm 0.15 <i>Likely</i> \uparrow
Body mass (kg)	73.6 \pm 10.6	87.5 \pm 11.7	95.6 \pm 10.0	1.21 \pm 0.13 <i>Most likely</i> \uparrow	1.84 \pm 0.15 <i>Most likely</i> \uparrow	0.70 \pm 0.14 <i>Most likely</i> \uparrow
10 m sprint (s)	1.83 \pm 0.11	1.84 \pm 0.11	1.82 \pm 0.09	0.14 \pm 0.13 <i>Likely trivial</i>	-0.06 \pm 0.16 <i>Likely trivial</i>	-0.21 \pm 0.15 <i>Possibly</i> \downarrow
20 m sprint (s)	3.16 \pm 0.16	3.15 \pm 0.16	3.09 \pm 0.12	-0.06 \pm 0.14 <i>Likely trivial</i>	-0.42 \pm 0.16 <i>Very likely</i> \downarrow	-0.35 \pm 0.14 <i>Very likely</i> \downarrow
CMJ height (cm)	33.3 \pm 6.8	38.1 \pm 6.3	42.5 \pm 5.2	0.63 \pm 0.12 <i>Most likely</i> \uparrow	1.12 \pm 0.12 <i>Most likely</i> \uparrow	0.70 \pm 0.14 <i>Most likely</i> \uparrow
Change of direction (s)	20.31 \pm 1.22	20.44 \pm 1.30	19.68 \pm 0.84	0.10 \pm 0.13 <i>Likely trivial</i>	-0.46 \pm 0.14 <i>Most likely</i> \downarrow	-0.60 \pm 0.13 <i>Most likely</i> \downarrow
Medicine ball throw (m)	6.3 \pm 0.9	7.1 \pm 0.8	8.1 \pm 0.8	1.00 \pm 0.14 <i>Most likely</i> \uparrow	2.06 \pm 0.16 <i>Most likely</i> \uparrow	1.12 \pm 0.15 <i>Most likely</i> \uparrow
Prone Yo-Yo IR1 (m)	727 \pm 252	775 \pm 233	930 \pm 277	0.23 \pm 0.13 <i>Possibly</i> \uparrow	0.74 \pm 0.16 <i>Most likely</i> \uparrow	0.61 \pm 0.17 <i>Most likely</i> \uparrow

Data are presented as mean \pm SD, with effect sizes and magnitude-based inference based on the difference between groups. \downarrow and \uparrow represents less than and greater than, respectively.

Table 2. Position-specific anthropometric and physical qualities

	Winger/Fullback	Centres	Halves	Hooker	Prop	Back Row Forwards	
Youth	Stature (cm)	174.6 ± 5.9	177.1 ± 5.2	172.9 ± 8.4	171.6 ± 7.2	178.4 ± 5.1	179.2 ± 6.2
	Body mass (kg)	69.3 ± 9.7	72.6 ± 7.5	66.4 ± 8.1	68.7 ± 10.5	85.3 ± 9.4	77.3 ± 8.3
	10 m sprint (s)	1.82 ± 0.09	1.81 ± 0.12	1.83 ± 0.13	1.85 ± 0.10	1.87 ± 0.11	1.82 ± 0.11
	20 m sprint (s)	3.12 ± 0.14	3.13 ± 0.15	3.19 ± 0.18	3.21 ± 0.17	3.22 ± 0.15	3.15 ± 0.16
	CMJ height (cm)	33.3 ± 6.7	34.1 ± 6.8	34.0 ± 6.4	34.6 ± 6.5	30.1 ± 7.3	33.7 ± 6.9
	Medicine ball throw (m)	6.4 ± 0.7	6.1 ± 1.2	5.9 ± 0.8	6.0 ± 0.8	6.8 ± 0.8	6.4 ± 0.6
	Change of direction (s)	19.78 ± 1.63	20.19 ± 0.96	20.36 ± 0.88	20.49 ± 1.10	20.81 ± 1.27	20.44 ± 1.04
	Prone Yo-Yo IR1 (m)	756 ± 248	742 ± 252	808 ± 232	776.8 ± 335	591.2 ± 249	702.2 ± 216
Academy	Stature (cm)	180.9 ± 6.5	181.4 ± 5.4	176.4 ± 5.0	173.8 ± 6.2	183.0 ± 6.1	183.0 ± 4.9
	Body mass (kg)	82.2 ± 9.5	85.3 ± 6.7	78.1 ± 6.8	78.1 ± 8.7	99.7 ± 11.7	90.9 ± 8.4
	10 m sprint (s)	1.80 ± 0.09	1.81 ± 0.09	1.83 ± 0.09	1.83 ± 0.09	1.91 ± 0.10	1.85 ± 0.12
	20 m sprint (s)	3.08 ± 0.15	3.10 ± 0.13	3.12 ± 0.14	3.11 ± 0.16	3.28 ± 0.15	3.16 ± 0.15
	CMJ height (cm)	41.9 ± 7.3	39.8 ± 5.8	38.3 ± 6.0	38.7 ± 5.3	34.2 ± 5.0	37.2 ± 5.3
	Medicine ball throw (m)	7.2 ± 0.9	7.3 ± 0.8	6.8 ± 0.8	6.8 ± 0.8	7.2 ± 0.8	7.3 ± 0.7
	Change of direction (s)	19.95 ± 1.27	20.11 ± 1.11	20.21 ± 1.06	20.08 ± 0.98	21.31 ± 1.46	20.54 ± 1.21
	Prone Yo-Yo IR1 (m)	773 ± 241	799 ± 226	871 ± 206	960 ± 256	615 ± 147	769 ± 215
Senior	Stature (cm)	180.4 ± 3.7	185.5 ± 5.8	178.3 ± 5.3	177.8 ± 4.1	187.4 ± 4.8	183.8 ± 4.7
	Body mass (kg)	90.3 ± 7.5	91.9 ± 8.1	90.2 ± 8.4	88.7 ± 6.3	107.7 ± 4.6	97.8 ± 8.9
	10 m sprint (s)	1.77 ± 0.08	1.83 ± 0.09	1.84 ± 0.07	1.82 ± 0.10	1.85 ± 0.10	1.82 ± 0.08
	20 m sprint (s)	3.01 ± 0.11	3.08 ± 0.10	3.14 ± 0.08	3.11 ± 0.11	3.13 ± 0.14	3.10 ± 0.12
	CMJ height (cm)	45.2 ± 4.8	43.0 ± 5.4	41.9 ± 4.0	44.3 ± 5.2	40.9 ± 4.5	41.0 ± 5.6
	Medicine ball throw (m)	8.0 ± 0.8	8.1 ± 0.6	7.8 ± 0.8	7.7 ± 0.7	8.5 ± 0.8	8.1 ± 0.9
	Change of direction (s)	19.09 ± 0.65	20.01 ± 1.06	19.65 ± 0.72	19.32 ± 0.67	20.15 ± 0.81	19.75 ± 0.70
	Prone Yo-Yo IR1 (m)	889 ± 224	885 ± 211	914 ± 255	1160 ± 275	834 ± 286	979 ± 307

Data are presented as mean ± SD. Youth - winger/fullback, centre, halves, hooker, prop and back row forwards; $n = 48, 34, 38, 19, 33$ and 63 , respectively. Academy – winger/fullback, centre, halves, hooker, prop and back row forward; $n = 60, 56, 46, 33, 70$ and 97 , respectively. Senior – winger/fullback, centre, halves, hooker, prop and back row forward; $n = 26, 16, 19, 12, 26$ and 33 , respectively.

Figure 1. Within position comparisons for anthropometric and physical characteristics between youth, academy and senior players. Data expressed as an effect size \pm 90% confidence limits. Magnitude-based inferences are included to demonstrate the certainty in difference between groups using the following qualitative descriptors: *possibly* *, *likely* **, *very likely* ***, *most likely* ****.