

Differences between playing positions and age categories in body composition and physical performance of Portuguese youth rugby players: An analysis of the Bronco test, CMJ, and 40-m sprint

Short Title: Playing position and age in Portuguese youth rugby

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Abstract

Physical performance in youth rugby reflects the interaction of maturation, playing position and body composition. We analysed 285 assessments from 222 male youth rugby players collected across two seasons (2024: $n = 113$; 2025: $n = 172$), spanning U15–U17 and classified as backs or forwards. Players completed anthropometry and body-composition assessment (InBody 270), countermovement jump (CMJ), squat jump (SJ), CMJ with free arms, T-test, 40-m sprint and the Bronco test (total time, s). Two-way ANOVA (Type III) was run separately for 2024 (2×2 : age $\times$ position) and 2025 (3×2), and linear mixed-effects models were applied to the longitudinal subsample (63 players assessed in both seasons). Position was the most robust factor: forwards were consistently slower than backs in the Bronco in both seasons; the age-grade effect was significant in 2025 and only a non-significant trend in 2024, with no age $\times$ position interaction. In adjusted models, body fat mass (BFM) was the strongest independent predictor of Bronco time, whereas CMJ and fat-free mass (FFM) were non-significant after adjustment. Longitudinally, CMJ improved significantly while fat mass tended to increase. These findings reinforce the relevance of body-composition optimisation and position-specific conditioning across youth age grades.

Keywords: rugby union; body composition; youth athletes; Bronco test; muscle power.

Introduction

Rugby is a high-intensity intermittent collision sport requiring repeated accelerations, decelerations, high-speed running and frequent contact. The tactical and functional roles of forwards and backs impose distinct physical demands, reflected in systematic differences in anthropometry and physical characteristics across age groups (Owen et al., 2020; Till et al., 2020).

During adolescence, growth and biological maturation amplify between-player variability in size, body composition and performance, complicating the interpretation of performance tests and talent identification (Till et al., 2020). Consequently, profiling frameworks in youth rugby increasingly emphasise integrated monitoring batteries that combine body composition and field-based performance assessment to support long-term player development and position-specific conditioning (Kay et al., 2025; Owen et al., 2020).

Rugby performance depends on high levels of strength, speed and endurance, influenced by morphological and physiological factors (Gabbett, 2005; Smart et al., 2014). In youth athletes, developmental and maturational differences further modulate these capacities, so that identifying age- and position-related differences enables coaches to design more individualised and developmentally appropriate programmes (Darrall-Jones et al., 2016).

Lower-body power and speed are commonly monitored in rugby because they capture neuromuscular qualities underpinning sprinting, change of direction and collision tasks. The CMJ and SJ provide practical information on explosive power and are sensitive to training and fatigue, while sprint testing informs acceleration and maximal-speed capacity (Cronin & Hansen, 2005; Smart et al., 2014; Suarez-Arrones et al., 2020). Body composition is also a key determinant of running and repeated-effort performance, as excess fat mass increases the energetic cost of running without contributing to force production; standardised bioelectrical impedance is a practical tool to monitor body composition when laboratory methods are impractical (Campa et al., 2021).

The Bronco test (a 1200-m shuttle) is widely used in rugby to assess high-intensity intermittent running capacity, and field-based 1200-m shuttle performance is associated with maximal aerobic speed and aerobic fitness (Bennett et al., 2024; Weakley et al., 2026). Nevertheless, how Bronco performance relates to body composition and neuromuscular qualities across youth age grades remains underexplored in Portuguese rugby. Therefore, this study aimed to (1) compare body-composition and physical-performance profiles across age categories (U15, U16 and U17) and playing positions (forwards vs backs) over two competitive seasons, and (2) identify predictors of Bronco performance in Portuguese youth rugby players.

Methods

Design and participants

A cross-sectional and longitudinal observational design was used, with assessments at two consecutive competitive timepoints (2024 and 2025). A total of 222 male youth rugby union players contributed 285 assessments. In 2024, U15 (n = 57) and U16 (n = 56) players were assessed (backs n = 54; forwards n = 59); in 2025, U15 (n = 54), U16 (n = 65) and U17 (n = 53) players were assessed

(backs $n = 78$; forwards $n = 94$). A longitudinal subsample of 63 players was assessed in both seasons (U15→U16, $n = 32$; U16→U17, $n = 31$). A separate female cohort and other age groups present in the source database were not part of the present analyses. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable standards for research involving human participants. The data analysed were collected as part of the Portuguese Rugby Federation's athlete monitoring programme. Because these analyses used pre-existing, fully anonymised data from this routine monitoring programme, a separate submission to an institutional research-ethics committee was not sought. Written informed assent was obtained from all participating athletes, and written informed consent was obtained from their parents or legal guardians (all participants were minors) prior to participation. All data were anonymised before analysis.

Instruments and procedures

Body mass, stature and body composition were assessed with a multifrequency bioelectrical impedance analyser (InBody 270), providing body mass (kg), and fat-free mass (FFM), skeletal muscle mass (SMM), body fat mass (BFM) and body fat percentage (BFP); body mass index (BMI) was computed as $\text{mass}/\text{stature}^2$. Lower-body power was assessed with the countermovement jump (CMJ), squat jump (SJ) and CMJ with free arms on an Optojump Next photoelectric system (Microgate, Italy), retaining the best of three trials. Linear speed was measured over 40 m using dual photocells (Witty, Microgate). Change-of-direction ability was assessed with the T-test. Aerobic intermittent capacity was assessed with the Bronco test (five repetitions of 20-, 40- and 60-m shuttles; 1200 m total), recorded as total time (s). Tests were administered by trained assessors under standardised conditions following familiarisation. One implausible SJ value (>65 cm) was identified as a data-entry error and excluded prior to analysis.

Statistical analysis

Descriptive statistics (mean $\pm$ SD) were computed by season, age grade and position. Cross-sectional differences were examined separately for 2024 (2×2) and 2025 (3×2) using two-way ANOVA (Type III sums of squares), with partial eta-squared (η^2) as the effect-size index and Bonferroni-adjusted pairwise comparisons of estimated marginal means when a factor had more than two levels. Residual normality (Shapiro–Wilk, Q–Q plots) and homogeneity of variance (Levene) were inspected. For the longitudinal subsample, linear mixed-effects models (REML) were fitted with athlete as a random intercept; timepoint and a timepoint $\times$ transition-group term estimated within-athlete change for each transition (U15→U16, U16→U17), and a position $\times$ timepoint term tested whether change differed between positions. Predictors of Bronco time were examined with a mixed-effects model (random intercept for athlete) including CMJ, FFM and BFM, with season, age grade and position as covariates; multicollinearity was assessed via VIF, and model fit via marginal/conditional R^2 and the intraclass correlation coefficient (ICC). A parsimonious ordinary-least-squares model (CMJ, FFM, BFM) provided a practical prediction equation. Pearson correlations quantified bivariate associations. Significance was set at $\alpha = .05$; secondary outcomes were interpreted primarily via effect sizes. Analyses were performed in Python (statsmodels).

Results

Cross-sectional differences

Descriptive statistics by age grade and position are presented in Table 1 (2024) and Table 2 (2025); ANOVA results for all outcomes are summarised in Table 3.

Table 1. Descriptive statistics (mean $\pm$ SD), 2024 season, by age grade and position.

Variable	U15 Backs (30)	U15 Forwards (27)	U16 Backs (24)	U16 Forwards (32)
Body mass (kg)	66.6 $\pm$ 8.7	78.2 $\pm$ 12.7	65.9 $\pm$ 8.0	85.8 $\pm$ 13.8
Stature (cm)	174.1 $\pm$ 6.9	177.5 $\pm$ 5.0	175.9 $\pm$ 5.0	182.0 $\pm$ 6.0
BMI (kg·m ⁻²)	21.9 $\pm$ 1.9	24.8 $\pm$ 3.5	21.3 $\pm$ 2.0	25.9 $\pm$ 3.6
FFM (kg)	59.6 $\pm$ 7.9	66.0 $\pm$ 7.9	60.3 $\pm$ 6.5	73.2 $\pm$ 7.0
SMM (kg)	33.9 $\pm$ 4.8	37.6 $\pm$ 4.8	34.3 $\pm$ 3.9	42.1 $\pm$ 4.2
BFM (kg)	7.0 $\pm$ 2.3	12.2 $\pm$ 6.6	5.7 $\pm$ 2.8	12.6 $\pm$ 8.6
BFP (%)	10.4 $\pm$ 3.0	14.9 $\pm$ 6.3	8.4 $\pm$ 3.4	13.8 $\pm$ 7.0
CMJ (cm)	34.3 $\pm$ 5.4	31.0 $\pm$ 6.3	34.9 $\pm$ 4.4	33.0 $\pm$ 6.1
SJ (cm)	34.0 $\pm$ 5.0	30.9 $\pm$ 6.1	33.7 $\pm$ 4.2	31.9 $\pm$ 6.3
CMJ free arms (cm)	41.2 $\pm$ 6.8	37.1 $\pm$ 7.5	40.2 $\pm$ 5.6	38.4 $\pm$ 7.9
40 m (s)	5.6 $\pm$ 0.3	5.8 $\pm$ 0.3	5.5 $\pm$ 0.2	5.8 $\pm$ 0.5
T-test (s)	10.0 $\pm$ 0.7	10.1 $\pm$ 0.7	9.2 $\pm$ 0.4	9.7 $\pm$ 0.6
Bronco (s)	319.9 $\pm$ 63.7	357.5 $\pm$ 33.7	305.0 $\pm$ 21.3	341.4 $\pm$ 32.8

FFM = fat-free mass; SMM = skeletal muscle mass; BFM = body fat mass; BFP = body fat percentage; CMJ = countermovement jump; SJ = squat jump.

Table 2. Descriptive statistics (mean $\pm$ SD), 2025 season, by age grade and position.

Variable	U15 B (28)	U15 F (26)	U16 B (30)	U16 F (35)	U17 B (20)	U17 F (33)
Body mass (kg)	62.6 $\pm$ 12.1	80.1 $\pm$ 18.4	73.3 $\pm$ 9.7	80.6 $\pm$ 15.9	71.0 $\pm$ 8.9	88.1 $\pm$ 9.7
Stature (cm)	172.3 $\pm$ 8.7	174.7 $\pm$ 7.8	177.0 $\pm$ 6.8	178.9 $\pm$ 5.5	177.4 $\pm$ 3.8	182.1 $\pm$ 6.2
BMI (kg·m ⁻²)	21.1 $\pm$ 3.7	26.4 $\pm$ 5.4	23.4 $\pm$ 2.6	25.1 $\pm$ 4.5	22.5 $\pm$ 2.6	26.6 $\pm$ 2.9
FFM (kg)	55.7 $\pm$ 9.3	62.4 $\pm$ 9.8	65.0 $\pm$ 7.5	68.4 $\pm$ 8.5	63.3 $\pm$ 5.1	73.6 $\pm$ 7.1
SMM (kg)	31.5 $\pm$ 5.6	35.4 $\pm$ 5.8	37.3 $\pm$ 4.5	39.3 $\pm$ 5.1	36.2 $\pm$ 3.1	42.3 $\pm$ 4.2
BFM (kg)	6.9 $\pm$ 6.1	17.7 $\pm$ 11.8	8.3 $\pm$ 5.1	12.2 $\pm$ 9.6	7.7 $\pm$ 4.7	14.5 $\pm$ 6.2
BFP (%)	10.3 $\pm$ 7.3	20.4 $\pm$ 9.8	10.9 $\pm$ 5.6	13.7 $\pm$ 8.4	10.3 $\pm$ 4.8	16.2 $\pm$ 5.9
CMJ (cm)	37.5 $\pm$ 5.5	31.2 $\pm$ 6.4	35.9 $\pm$ 6.9	32.1 $\pm$ 5.5	38.3 $\pm$ 5.0	35.1 $\pm$ 5.1
SJ (cm)	37.1 $\pm$ 5.5	30.9 $\pm$ 6.1	35.7 $\pm$ 6.5	32.6 $\pm$ 5.9	37.6 $\pm$ 4.9	34.8 $\pm$ 5.2
CMJ free arms (cm)	43.4 $\pm$ 6.6	35.6 $\pm$ 6.9	40.3 $\pm$ 7.8	36.3 $\pm$ 6.5	44.5 $\pm$ 6.3	41.3 $\pm$ 7.5
40 m (s)	5.7 $\pm$ 0.2	5.9 $\pm$ 0.3	5.5 $\pm$ 0.2	5.7 $\pm$ 0.3	5.6 $\pm$ 0.2	5.8 $\pm$ 0.3
T-test (s)	8.1 $\pm$ 0.4	8.5 $\pm$ 0.6	7.6 $\pm$ 0.8	7.6 $\pm$ 0.6	7.9 $\pm$ 0.5	8.3 $\pm$ 0.6
Bronco (s)	323.2 $\pm$ 23.6	367.9 $\pm$ 56.7	310.6 $\pm$ 27.8	339.4 $\pm$ 31.9	310.1 $\pm$ 22.8	340.2 $\pm$ 29.7

B = backs; F = forwards. SJ for U16 Backs is based on n = 29 (one implausible value, >65 cm, excluded as a data-entry error).

For Bronco time, position was significant in both seasons (2024: $F(1,109) = 21.77$, $p < .001$, $\eta^2 = .166$; 2025: $F(1,166) = 43.14$, $p < .001$, $\eta^2 = .206$), with forwards slower than backs. The age-grade effect was significant in 2025 ($F(2,166) = 6.71$, $p = .002$, $\eta^2 = .075$) but only a non-significant trend in 2024 ($F(1,109) = 3.81$, $p = .053$, $\eta^2 = .034$); the age $\times$ position interaction was negligible in both

seasons ($p \geq .392$). Bonferroni-adjusted comparisons in 2025 indicated the U15 group as the slowest, with the U15–U16 contrast as the principal difference ($p \approx .05$). Significant position effects (forwards differing from backs), with negligible age $\times$ position interactions, were likewise present for the neuromuscular and speed outcomes (CMJ, SJ, CMJ free arms and 40 m). For the T-test, by contrast, the age-grade effect predominated ($\eta^2 = .185$ –.209 across seasons). Age-grade effects were also significant for CMJ, CMJ free arms and 40 m in 2025. Full inferential statistics for every outcome are reported in Table 3.

Table 3. Two-way ANOVA (Type III) for each outcome, by season.

Outcome	Effect	2024 (2 $\times$ 2)	2025 (3 $\times$ 2)
Bronco	Age	F(1,109) = 3.81, $p = .053$, $\eta^2 = .034$	F(2,166) = 6.71, $p = .002$, $\eta^2 = .075$
Bronco	Position	F(1,109) = 21.77, $p < .001$, $\eta^2 = .166$	F(1,166) = 43.14, $p < .001$, $\eta^2 = .206$
Bronco	Age $\times$ Position	F(1,109) = 0.01, $p = .942$	F(2,166) = 0.94, $p = .392$
CMJ	Age	F(1,109) = 1.38, $p = .243$	F(2,166) = 3.42, $p = .035$, $\eta^2 = .040$
CMJ	Position	F(1,109) = 5.94, $p = .016$, $\eta^2 = .052$	F(1,166) = 24.57, $p < .001$, $\eta^2 = .129$
CMJ	Age $\times$ Position	F(1,109) = 0.45, $p = .504$	F(2,166) = 1.12, $p = .330$
SJ	Age	F(1,109) = 0.14, $p = .711$	F(2,165) = 2.45, $p = .089$
SJ	Position	F(1,109) = 5.70, $p = .019$, $\eta^2 = .050$	F(1,165) = 20.54, $p < .001$, $\eta^2 = .111$
SJ	Age $\times$ Position	F(1,109) = 0.43, $p = .513$	F(2,165) = 1.52, $p = .221$
CMJ free arms	Age	F(1,109) = 0.01, $p = .912$	F(2,166) = 6.23, $p = .002$, $\eta^2 = .070$
CMJ free arms	Position	F(1,109) = 4.74, $p = .032$, $\eta^2 = .042$	F(1,166) = 21.33, $p < .001$, $\eta^2 = .114$
CMJ free arms	Age $\times$ Position	F(1,109) = 0.73, $p = .396$	F(2,166) = 1.72, $p = .182$
40 m	Age	F(1,109) = 1.34, $p = .249$	F(2,166) = 5.62, $p = .004$, $\eta^2 = .063$
40 m	Position	F(1,109) = 13.29, $p < .001$, $\eta^2 = .109$	F(1,166) = 18.68, $p < .001$, $\eta^2 = .101$
40 m	Age $\times$ Position	F(1,109) = 0.22, $p = .639$	F(2,166) = 0.38, $p = .684$
T-test	Age	F(1,109) = 24.72, $p < .001$, $\eta^2 = .185$	F(2,166) = 21.99, $p < .001$, $\eta^2 = .209$
T-test	Position	F(1,109) = 5.74, $p = .018$, $\eta^2 = .050$	F(1,166) = 5.27, $p = .023$, $\eta^2 = .031$
T-test	Age $\times$ Position	F(1,109) = 2.81, $p = .097$	F(2,166) = 2.79, $p = .064$

η^2 reported for significant effects; $\eta^2 \approx .01$ small, .06 medium, .14 large.

Correlations and predictors of Bronco performance

Across all assessments ($n = 285$), Bronco time correlated positively with fatness indices (BFM: $r = .53$; BFP: $r = .51$; both $p < .001$) and, more weakly, with FFM ($r = .24$) and SMM ($r = .23$); a negative bivariate association was found with CMJ ($r = -.27$, $p < .001$) (Table 5). In the adjusted mixed-effects model (Table 4), BFM was the strongest independent predictor of Bronco time ($B = 2.40 \text{ s} \cdot \text{kg}^{-1}$, 95% CI 1.71–3.09, $\beta = .46$, $p < .001$), and forwards were slower than backs ($B = 20.5 \text{ s}$, 95% CI 11.3–29.7, $p < .001$); U16 and U17 were faster than U15 ($B = -15.5 \text{ s}$, $p = .001$; $B = -19.9 \text{ s}$, $p = .003$), whereas season had no effect ($p = .949$). After adjustment, CMJ ($B = 0.45 \text{ s} \cdot \text{cm}^{-1}$, $p = .277$) and FFM ($B = 0.07 \text{ s} \cdot \text{kg}^{-1}$, $p = .793$) were non-significant; multicollinearity was low (VIF 1.3–1.7). The unconditional ICC was .28, and the model explained a marginal/conditional R^2 of .35/.40. The parsimonious prediction equation was Bronco (s) = $297.0 + 2.81 \cdot \text{BFM (kg)} + 0.04 \cdot \text{FFM (kg)} + 0.09 \cdot \text{CMJ (cm)}$ ($R^2 = .28$, SEE = 35.3 s), in which only BFM was significant. Thus, the apparent CMJ–Bronco association was largely accounted for by body fat: once BFM was controlled, CMJ no longer contributed independently.

Table 4. Mixed-effects model predicting Bronco time (s); random intercept for athlete.

Predictor	B (95% CI)	β	p
Intercept	286.5 (246.0, 327.0)	—	< .001
Season (2025 vs 2024)	−0.3 (−9.1, 8.6)	—	.949
Age U16 (vs U15)	−15.5 (−24.8, −6.2)	—	.001
Age U17 (vs U15)	−19.9 (−32.9, −6.9)	—	.003
Position (forwards vs backs)	20.5 (11.3, 29.7)	—	< .001
CMJ (cm)	0.45 (−0.36, 1.25)	.07	.277
FFM (kg)	0.07 (−0.47, 0.61)	.02	.793
BFM (kg)	2.40 (1.71, 3.09)	.46	< .001

n = 285 assessments (222 athletes). Unconditional ICC = .28; marginal R^2 = .35; conditional R^2 = .40; VIF 1.3–1.7. Parsimonious prediction model: Bronco (s) = 297.0 + 2.81·BFM + 0.04·FFM + 0.09·CMJ (R^2 = .28; SEE = 35.3 s); only BFM significant.

Table 5. Pearson correlations with Bronco time (n = 285).

Variable	r with Bronco (s)	p
BFM (kg)	.53	< .001
BFP (%)	.51	< .001
FFM (kg)	.24	< .001
SMM (kg)	.23	< .001
CMJ (cm)	−.27	< .001

Longitudinal change (subsample)

In the subsample assessed in both seasons (n = 63; U15→U16, n = 32; U16→U17, n = 31), CMJ improved within athletes from U15 to U16 (B = +2.65 cm, 95% CI 1.26–4.03, p < .001), with a similar gain across U16→U17 (ICC = .75). Bronco time tended to improve from U15 to U16 (B = −9.9 s, 95% CI −28.3 to 8.5, p = .293) with negligible change across U16→U17 (ICC = .30), and the change did not differ by position (position × timepoint, p = .162). Body fat increased modestly in the older transition (BFP: +2.2 percentage points across U16→U17, p = .003; ICC = .87). Overall, within-athlete neuromuscular power improved with age, whereas intermittent-running capacity changed little, and these patterns were independent of playing position, corroborating the cross-sectional findings.

Discussion

Forwards were heavier and showed higher BMI and body fat than backs, whereas backs demonstrated superior CMJ and Bronco performance. These positional differences were robust across seasons and are consistent with previous rugby evidence (Owen et al., 2020; Smart et al., 2014; Till et al., 2020). The magnitude of the position effect on Bronco ($\eta^2 \approx .17$ –.21) clearly exceeded that of age grade, indicating that positional role is already a meaningful determinant of intermittent-running performance during the formative years. To our knowledge, this is the first study to integrate bioimpedance-derived body composition with Bronco performance across the U15–U17 age grades in Portuguese rugby, combining cross-sectional and within-athlete longitudinal evidence.

Body fat mass was the strongest independent predictor of Bronco time, and the positive correlations of Bronco with BFM and BFP are consistent with a negative association between excess adiposity and intermittent-running performance, plausibly through the increased energetic cost of transporting non-force-producing mass. Importantly, although CMJ correlated with Bronco at the bivariate level, this association did not persist after adjusting for body composition, indicating that the apparent role of lower-body power was largely confounded by adiposity rather than reflecting an independent determinant. This nuances the common assumption that lower-body power directly underpins high-intensity intermittent running: here the apparent CMJ–Bronco link was largely an artefact of shared variance with adiposity, so that in developing players body composition, rather than neuromuscular power per se, appears to be more strongly associated with 1200-m shuttle performance—reinforcing calls for multidimensional profiling that does not interpret single physical qualities in isolation (Kay et al., 2025; Owen et al., 2020). Fat-free mass showed a small, non-significant coefficient and should not be over-interpreted. Collectively, these results identify body composition—particularly fat mass—as the principal modifiable predictor of aerobic-intermittent performance in this population, reinforcing the value of monitoring BFM (not merely total body mass).

The weaker age-grade effects, and the non-significant age effect on Bronco in 2024, should be interpreted in light of biological maturation, which was not controlled and which amplifies variability between U15 and U17. The longitudinal data add nuance: within-athlete CMJ improved across age transitions, whereas Bronco changed little and body fat tended to rise, suggesting that neuromuscular development outpaces aerobic-intermittent development in this age range and that body-composition management warrants attention as players mature. Benchmarked against published norms, the present Bronco times are consistent with the developmental status of the sample: elite male Super Rugby athletes complete the test in approximately 5:11 min:s (≈ 311 s) on average, with backs faster than forwards and front-rowers slowest (Weakley et al., 2026). The present sub-elite youth backs (≈ 305 – 325 s) approached these adult professional values, whereas forwards (≈ 340 – 368 s) were expectedly slower; crucially, the backs-faster-than-forwards ordering was preserved across age grades and seasons, situating the cohort within the expected developmental range for age-grade rugby (Bennett et al., 2024; Owen et al., 2020).

Limitations and practical applications

Limitations include the predominantly cross-sectional design (partially offset by the longitudinal subsample), the male-only sample, the estimation of body composition by bioelectrical impedance rather than a criterion method (e.g., DXA), and the absence of maturation control; future work should incorporate maturity indices (e.g., maturity offset/age at peak height velocity; Mirwald et al., 2002). Critically, because somatic maturation was not quantified, it cannot be disentangled from playing position: at these ages earlier-maturing players are frequently allocated to forward roles, so the observed positional differences in body composition—and part of the BFM–Bronco association—may partly reflect maturational status rather than positional demands per se, and the age-grade and positional effects should be read as developmental associations rather than maturation-independent contrasts. Because 63 players contributed to both seasons, the two cross-sectional samples are not fully independent of each other; this was mitigated by analysing seasons separately and modelling repeated measures longitudinally. For the same reason, the bivariate correlations in Table 5 (pooled across 285 assessments) treat repeated measurements as independent and their significance is likely optimistic; they are reported descriptively, with formal inference resting on the random-intercept mixed-effects

models. Finally, T-test times differed markedly between seasons, consistent with a protocol/configuration change, so this outcome should be compared only within season. Practically, the prediction model and the BFM–Bronco association support individualised, position-specific conditioning that prioritises body-composition optimisation alongside aerobic-running capacity across youth age grades. Because body fat increased across the U16→U17 transition while neuromuscular power continued to improve, practitioners should monitor fat mass specifically (not body mass alone) and aim to reduce it—particularly in forwards, who carried the highest adiposity—while preserving fat-free mass; the prediction equation offers a pragmatic but approximate, illustrative estimate (standard error of the estimate ≈ 35 s, to be validated in larger independent samples) of intermittent-running readiness from routine bioimpedance and CMJ data.

Conclusions

In male Portuguese youth rugby players, body composition—particularly fat mass—is the principal modifiable predictor of Bronco performance, and positional differences are evident and stable across age grades. Combining body-composition assessment with neuromuscular (CMJ) monitoring provides a practical framework for evaluating and developing aerobic-intermittent fitness and for guiding position-specific player development.

References

- Bennett, T., Marshall, P., Barrett, S., Malone, J. J., & Towlson, C. (2024). Validation of field-based running tests to determine maximal aerobic speed in professional rugby league. *PLOS ONE*, 19(7), e0306062. <https://doi.org/10.1371/journal.pone.0306062>
- Campa, F., Toselli, S., Mazzilli, M., Gobbo, L. A., & Coratella, G. (2021). Assessment of body composition in athletes: A narrative review of available methods with special reference to bioelectrical impedance analysis. *Nutrients*, 13(5), 1620. <https://doi.org/10.3390/nu13051620>
- Cronin, J. B., & Hansen, K. T. (2005). Strength and power predictors of sports speed. *Journal of Strength and Conditioning Research*, 19(2), 349–357. <https://doi.org/10.1519/14323.1>
- Darrall-Jones, J., Jones, B., & Till, K. (2016). Anthropometric, sprint, and high-intensity running profiles of English academy rugby union players by position. *Journal of Strength and Conditioning Research*, 30(5), 1348–1358. <https://doi.org/10.1519/JSC.0000000000001234>
- Gabbett, T. J. (2005). Physiological and anthropometric characteristics of junior and senior rugby league players. *British Journal of Sports Medicine*, 39(9), 675–680. <https://doi.org/10.1136/bjsm.2005.018275>
- Kay, J., Weakley, J., Till, K., Read, D., Phibbs, P., & Jones, B. (2025). The multidimensional profiling of youth male rugby union players: A systematic scoping review, nominal group technique and survey. *Journal of Sports Sciences*. <https://doi.org/10.1080/02640414.2025.2536410>
- Mirwald, R. L., Baxter-Jones, A. D. G., Bailey, D. A., & Beunen, G. P. (2002). An assessment of maturity from anthropometric measurements. *Medicine & Science in Sports & Exercise*, 34(4), 689–694. <https://doi.org/10.1097/00005768-200204000-00020>
- Owen, C., Till, K., Weakley, J., & Jones, B. (2020). Testing methods and physical qualities of male age grade rugby union players: A systematic review. *PLOS ONE*, 15(6), e0233796. <https://doi.org/10.1371/journal.pone.0233796>
- Smart, D. J., Hopkins, W. G., Quarrie, K. L., & Gill, N. D. (2014). The relationship between physical fitness and game behaviours in rugby union players. *European Journal of Sport Science*, 14(Suppl. 1), S8–S17. <https://doi.org/10.1080/17461391.2011.635812>

- Suarez-Arrones, L., Gonzalo-Skok, O., Carrasquilla, I., Asián-Clemente, J., Santalla, A., Lara-Lopez, P., & Núñez, F. J. (2020). Relationships between change of direction, sprint, jump, and squat power performance. *Sports*, 8(3), 38. <https://doi.org/10.3390/sports8030038>
- Till, K., Weakley, J. J. S., Read, D. B., Phibbs, P. J., Darrall-Jones, J., & Jones, B. (2020). Applied sport science for male age-grade rugby union in England. *Sports Medicine – Open*, 6(1), 14. <https://doi.org/10.1186/s40798-020-0236-6>
- Weakley, J., Murphy, S., Kan, M., Thurlow, F., Mitchell, L., Whelan, B., Williams, P., King, A. J., & Read, D. B. (2026). A 10-year analysis of the Bronco fitness test in male and female Super Rugby athletes: The effect of sex and positional group. *Journal of Strength and Conditioning Research*, 40(5), e479–e484. <https://doi.org/10.1519/JSC.0000000000005381>

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