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Dynamic balance performance varies by position but not by age group in elite Rugby Union players – a normative study

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ABSTRACT

This cohort study aimed to provide normative Y Balance Test scores for an elite Rugby Union population, while investigating the effect player age groups (senior/under-20), playing positions (forwards/backs) and anthropometrics (height and body mass) had on performance. 261 elite male under-20 (n = 50) and senior (n = 211) players completed baseline Y Balance Test during the 2015/2016 season. One-way ANCOVA and post-hoc t-tests were used to investigate the effect playing position, player group, height and weight had on performance. The cohort was then stratified into groups (age group and/or playing position), and normative percentiles were presented. There was a statistically significant difference ($p < 0.05$) in Y Balance Test performance between playing positions, when controlling for age group. This difference did not remain when controlling for player body mass. Post-hoc analysis demonstrated that backs had a longer normalised reach distance, with medium-large and small-medium effect sizes for the under-20 and senior cohorts respectively. The one-way ANCOVA analysis suggests that this difference is likely due to the larger differences in player body mass between forward and back playing positions. The normative values presented in this paper may be used by clinicians and researchers to aid injury prevention and rehabilitation strategies.

Key Words

Dynamic Balance

Dynamic Postural Control

Y Balance Test

Elite Rugby Union

Normative

INTRODUCTION

Rugby Union is a field based contact sport eliciting a variety of physiological responses due to the demands of high-intensity linear and multi-directional movements and frequent contact (Duthie, Pyne, & Hooper, 2003). Key physical attributes required for success in Rugby Union include cardiovascular fitness, strength, power, range of motion, agility and balance (Duthie, et al., 2003). Players are broadly categorised into two positional units; forwards (ball-winners) and backs (ball-carriers), with key anthropometric profiles (forwards have a greater height and body mass) differentiating the positional units (Darrall-Jones, Jones, & Till, 2016; Zemski, Slater, & Broad, 2015). Additionally, previous research has established that as adolescent elite Rugby Union players progress to meet the requirements of competing in their respective positions at an elite senior level, the nature of their body composition, and their performance in sport specific tasks changes to reflect their specialisation (Darrall-Jones, Jones, & Till, 2015; Darrall-Jones, et al., 2016).

The maintenance of dynamic balance is central to Rugby Union performance, with individuals required to complete complex multi-directional movements at high velocity, while sustaining constant pressure and contact from the opposition. The Star Excursion Balance Test (SEBT) is a commonly utilised clinical dynamic balance assessment, capable of providing a valid and reliable measure of dynamic balance performance (Gribble, Hertel, & Plisky, 2012). It requires an individual to move from a position of bilateral to unilateral stance, perform a maximal reach excursion, and return to the starting position in a controlled manner, in eight defined directions (Gribble, et al., 2012). Previous research has established the redundancy of five of the eight reach directions (Hertel, Braham, Hale, & Olmsted-Kramer, 2006), resulting in the development of a commercially available instrumented dynamic balance assessment tool (functionalmovement.com, Danville, VA), the Y Balance Test (YBT) (Plisky et al., 2009). Such assessments demand a combination of many of the domains required for optimal rugby performance, such as strength, range of motion, proprioception and balance, thus challenging the sensorimotor subsystems (Gribble, et al., 2012). Previous research has demonstrated the role these assessments play in identifying those at risk of sustaining a lower extremity injury (Gribble et al., 2015; C. A. Smith, Chimera, & Warren, 2015; Stiffler et al., 2017a), differentiating lower limb musculoskeletal injuries (Aminaka and Gribble, 2008; Doherty et al., 2015; Gribble, Hertel, Denegar, & Buckley, 2004; Herrington, Hatcher, Hatcher, & McNicholas, 2009; Hertel, et al., 2006), and as an objective outcome measure, capable of tracking recovery following an injury (Clagg, Paterno, Hewett, & Schmitt, 2015; Doherty et al., 2016; Hale, 2007) in a range of American collegiate sports. As such, both medical teams and strength and conditioning personnel are frequently interested in the quantification of dynamic balance performance.

The evaluation of an individual's dynamic balance performance using the YBT and SEBT is typically completed in one of two ways: (1) reach distances and asymmetries (dominant leg vs non-dominant leg) are compared to a population normative reference value; (2) reach distances are compared to an individual's previous baseline score, allowing for direct inference of an individual's improvement or deterioration in performance. As an example, clinicians often evaluate athletes during pre-season to establish if they may be at an increased risk of sustaining a lower extremity injury (Gribble, et al., 2015; J. L. Smith, Hutton, & Eldred, 1974), with limb asymmetry and poor performance being associated with an increased likelihood of sustaining a lower limb injury across a range of populations (Gribble, et al., 2015; C. A. Smith, et al., 2015; Stiffler, et al., 2017a). However, due to time commitments and the burdens of high-level sport, clinicians frequently do not have access to an individual's own healthy baseline score. As such, if an athlete sustains an injury, clinicians must rely on population reference norms to inform their decision regarding when the individual may have returned to pre-injury levels of dynamic balance performance.

While clinical thresholds and normative values can provide guidance relating to an athlete's injury risk, there is evidence that differences in dynamic balance performance may be influenced by factors such as player height and weight (Gribble and Hertel, 2003; Ozunlu, Basari, & Baltaci, 2010), and that differences may exist between sports, sexes and age groups (McCann et al., 2015; Stiffler, Sanfilippo, Brooks, & Heiderscheit, 2015; Teyhen et al., 2014). Thus, Stiffler and colleagues (2015) recommended that normalised reach distance cut-off scores should only be used within the context of the sport~~,~~ and level of participation in which they were developed. Additionally, Gribble and colleagues (2012) called for the collection of normative data using sport specific populations to be leveraged by clinicians and researchers.

To date no normative values have been presented in the literature for an elite Rugby Union population, or investigated what factors (playing position; age group; anthropometrics) may influence balance performance. Establishing population specific normative values for the YBT assessment will augment clinical practice in two key ways. Firstly, such information may aid clinicians in determining when a player has returned to pre-injury levels of dynamic balance performance, providing an objective outcome measure to ensure that the athlete has met key performance indicators prior to return to sport. Secondly, such information allows clinicians and strength and conditioning personnel to implement neuromuscular control training interventions to improve an individual's dynamic balance, in an attempt to mitigate a potential risk factor for lower limb injury (Gribble, et al., 2015; C. A. Smith, et al., 2015; Stiffler et al., 2017b).

Therefore, the aim of this study was to provide accurate normative YBT reference scores for an elite Rugby Union population. In doing so, we investigated the differences in YBT performance between player age groups (senior/under-20), and positional units (forwards/backs) to establish the most appropriate stratification. A concurrent aim was to establish what key anthropometric factors may contribute to any differences in performance observed. It was hypothesised that senior players would possess superior dynamic balance performance when compared with under-20 players, while backs would possess superior dynamic balance performance when compared with forwards. The differences in performance between groups may be explained by differences in anthropometric profiles.

METHODOLOGY

PARTICIPANTS

Two hundred and sixty-one male elite Rugby Union players, consisting of 50 under-20 players, aged 19-20 years, and 211 senior players, aged 21-37 years were recruited from the Irish National under-20 squad and the four Irish professional Rugby Union clubs. Participants were excluded from this study if they had sustained a lower limb injury in the last 6 months, had vestibular, visual or balance impairment and any neurological disease. Ethical approval was obtained from the University Research Ethics board and all participants read the information leaflet and provided informed consent prior to testing. All participants rights were protected, and participants were advised that they had the right to withdraw from the study at any point.

TESTING PROCEDURE

Baseline YBT testing was conducted as part of a wider study protocol, with participants completing the YBT protocol in the morning prior to training to reduce the residual effects of fatigue on YBT performance (Johnston, Dolan, Reid, Coughlan, & Caulfield, 2017). Baseline evaluation was conducted by two Chartered Physiotherapists (WJ and CD) with extensive experience in administering the YBT. Furthermore, previous research has demonstrated the excellent (0.99-1.00) inter-rater reliability of the instrumented YBT (Plisky, et al., 2009). As per previously published guidelines, the YBT requires the individual to complete four practice trials followed by three recorded reach excursions in three defined directions; anterior (ANT), posteromedial (PM) and posterolateral (PL), on dominant (DM) and non-dominant (ND) stance legs (Gribble, et al., 2012). Players were required to repeat the reach excursion if they applied support to the sliding block, raised the heel of the stance foot from the centre plate, placed the reaching foot on the ground, kicked the plate to gain more distance, removed their hands from their hips, or were unable to maintain their balance during the task. YBT testing took place on a hard surface, with athletes required to complete the protocol in bare feet.

Players' leg lengths were obtained by measuring the distance between the anterior-superior iliac spine and the most distal part of the medial malleolus on the same limb. Reach distances were normalised to the length of the players stance leg as per previously published guidelines using the following formula (Gribble, et al., 2012):

$$\text{Normalised Reach Distance} = \frac{\text{Reach distance (cm)}}{\text{Leg Length (cm)}} \text{ x } \frac{100}{1}$$

The average of the three recorded trials was used for analysis, to ensure a reliable measure of dynamic balance (Gribble, et al., 2012).

Statistical Analysis

Descriptive statistics for age, height, weight, BMI and leg length are presented through means ± standard deviations (SD) (table 1). Paired-samples t-tests indicated no significant differences between individuals' dominant and non-dominant limbs (ANT $p = 0.74$; PM $p = 0.12$; PL $p = 0.21$), as such the average of both stance legs was used for the analysis. To investigate if normalised YBT reach distances differed when comparing player groups (age groups/playing position groups), one-way analysis of covariance (ANCOVA) was used individually for each reach direction. If there was a statistically significant effect, post-hoc independent sample t-tests were used to investigate the effects of age group (senior/under-20) and playing position (forward/back) on YBT reach distances. To investigate the effect key anthropometric factors (height and weight) had on YBT performance, one-way ANCOVA analyses were conducted to determine if there was a statistically significant difference in normalised reach distances between groups when controlling for height and/or weight. The level of significance was adjusted for the number of reach directions using a Bonferonni correction. Cohens D effect sizes (*d*) were calculated for each independent t-test comparison using the method proposed by Cohen, with small, medium and large effect sizes ranging from 0.02 - 0.049, 0.05 - 0.079 and ≥0.08 respectively (Cohen, 2013). Partial eta squared **(**ηp^2**)** was used as an estimate of effect size for the one-way ANCOVA, with a small, medium and large effect sizes ranging from 0.01 - 0.089, 0.09 - 0.24 and ≥0.25 respectively. Based on the findings of this analysis, the cohort was then stratified into groups (age group and/or playing position), and percentiles were calculated to present normative reference values.

RESULTS

Descriptive information related to player age, height, weight, BMI and leg length, stratified by playing position and age group, is presented in table 1.

		Mean (SD)		Effect Size (*d*)	
		Forwards	**Backs**	**Senior v Under-20**	**Forwards v Backs**
Age (years)	**Senior**	26.5 (4.2)	25.5 (5.5)	**1.8***	**0.3***
	Under-20	19.7 (0.5)	18.9 (3.9)		
Height (cm)	**Senior**	189.0 (7.2)	182.9 (5.5)	**0.2***	**0.6***
	Under-20	188.0 (6.8)	174.5 (36.0)		
Body Mass (kg)	**Senior**	111.5 (7.8)	93.6 (8.2)	**0.5***	**1.8***
	Under-20	106.1 (7.4)	86.5 (20.3)		
BMI (kg/m^2)	**Senior**	31.3 (2.8)	27.9 (1.7)	**0.4***	**1.4***
	Under-20	30.1 (2.4)	27.3 (2.8)		
DM Leg Length (cm)	**Senior**	101.6 (5.5)	97.4 (4.2)	0.2	**0.9***
	Under-20	102.3 (5.7)	97.9 (4.4)		
ND Leg Length (cm)	**Senior**	101.6 (5.5)	97.2 (4.2)	0.1	**0.9***
	Under-20	102.6 (5.5)	97.9 (4.1)		

Table 1: Presents the demographic information for each group. Additionally, Independent sample t-test comparison between age-group and position groups are presented using Cohens D effect size, with statistically significant differences (P < 0.05) denoted in **bold** with an *.

One-way ANCOVAs were used to investigate the effect of playing position on normalised reach distance, when controlling for age group. Statistically significant differences (ηp^2 = 0.05 ANT; ηp^2 = 0.06 PM; ηp^2 = 0.05 PL) were observed between positional units when controlling for age group, but not between age groups (ηp^2 = 0.01 ANT; ηp^2 = 0.01 PM; ηp^2 <0.01 PL) when controlling for positional units. Post-hoc analysis demonstrated that backs reached further than forwards across both age groups, with a medium-large effect size for the under-20 group (*d* = 0.7 ANT; *d* = 0.9 PM; *d* = 0.7 PL), and small-medium effect size for the senior group (*d* = 0.4 ANT; *d* = 0.5 PM; *d* = 0.4 PL) (table 2). When the under-20 and senior cohorts were considered together, backs demonstrated a statistically significantly longer (*d* = 0.5 ANT; *d* = 0.5 PM; *d* = 0.5 PL) normalised reach distance across all three directions.

Table 3 demonstrates that when controlling for player height, the significant difference between positional unit reach distance was maintained. However, when controlling for player weight, no significant differences (p > 0.05) between forwards and backs were observed. Furthermore, there were no statistically significant (p > 0.05) differences between age groups when controlling for player height or weight across all three reach directions.

		Normalised Reach (%) Mean (SD)		**Forward v Back**		
		Forwards	**Backs**	**Mean Difference**	**95% CI**	**Effect Size**
ANT	**Senior**	56.1 (6.3)	58.4 (4.9)	**2.32***	0.83 - 3.81	0.4
	Under-20	57.2 (5.1)	60.5 (4.3)	3.34	0.20 – 6.48	0.7
PM	**Senior**	100.2 (9.1)	104.0 (7.2)	**3.91***	1.72 – 6.12	0.5
	Under-20	101.0 (6.6)	106.3 (5.2)	**5.38***	1.87 – 8.89	0.9
PL	**Senior**	97.0 (8.8)	100.4 (6.7)	**3.50***	1.41 – 5.58	0.4
	Under-20	97.9 (6.7)	102.1 (5.5)	3.92	0.10 – 7.74	0.7

Table 2: Presents the post-hoc normalised reach distance (%) comparison of the positional units for the Senior and under-20 cohorts. Independent sample t-test comparison between age-group and position groups are presented using Cohens D effect size, with statistically significant differences (P < 0.05) denoted in **bold** with an *.

Independent	Covariate	Dependent	P Value	Partial Eta Squared (ηp^2)
Position	Height (cm)	ANT	**<0.01**	0.04
		PM	**<0.01**	0.04
		PL	**<0.01**	0.03
	Body Mass (kg/m^2)	ANT	>0.05	0.01
		PM	>0.05	0.01
		PL	>0.05	0.01

Table 3: presents the one-way ANCOVA results investigating the differences in YBT reach distances (dependent variable) between positional units (independent variable), when controlling for height and body mass (covariates). Statistically significant effects are highlighted in **bold** and with an *. Partial Eta Squared presents a measure of effect size.

Based on the one-way ANCOVA and post-hoc analysis results, the cohort was stratified into playing position groups when determining the normative reference percentiles for the elite rugby union cohort (table 2).

Reach Direction	Position	Normalised Reach (%) Percentiles						
		5th	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**
ANT	**Back**	50.8	52.9	54.9	59.1	61.9	65.4	67.2
	Forward	47.0	48.5	52.2	56.4	60.3	64.2	66.3
PM	**Back**	91.5	94.9	100.5	105.1	109.6	112.6	115.3
	Forward	89.2	90.9	94.6	100.4	105.9	110.6	114.5
PL	**Back**	88.3	93.3	97.1	100.7	105.4	108.9	110.0
	Forward	84.5	88.0	91.8	97.2	102.2	107.3	110.1

Table 4: Presents the normalised reach distance (%) percentiles for the entire cohort, stratified by playing position.

DISCUSSION

This study set out to present normative reference values for an elite Rugby Union population, providing clinicians and researchers with accurate and representative population normative scores for the YBT. In doing so, this study has identified differences in dynamic balance performance between key positional units (forwards vs backs), while establishing that there is no difference between senior and under-20 age groups. Furthermore, we have identified that the increased body mass possessed by the forward players likely contributes to decreased YBT performance, when compared to the back players.

The one-way ANCOVA analyses demonstrate that there are differences in normalised reach distances between forwards and backs, when controlling for the player age group. Conversely, no difference was observed between age-groups when controlling for playing position. Backs had a significantly longer normalised reach distance than forwards, for the senior age-group across all reach directions, with the senior backs on average having a normalised reach distance 2.3% (ANT), 3.9% (PM) and 3.5% (PL) greater than the forwards. There was only a difference between playing positions for the under-20 cohort in the PM reach direction (table 3), with the under-20 backs having a normalised reach distance 5.4% (PM) greater than the forwards in the PM direction. While there was no significant difference between under-20 positional units in the ANT and PL reach directions, the Cohens D analysis demonstrates that playing position has a medium effect on normalised reach distance, with forwards on average having a normalised reach distance 3.3% and 3.9% less than backs for the ANT and PL reach directions, respectively. A potential explanation for the non-significant result despite the medium effect size may be the smaller sample size recruited for the under-20 comparison (n = 24 forwards; n =26 backs) and the implementation of a Bonferroni correction, potentially increasing the chance of a type 2 error (Freiman, Chalmers, Smith Jr, & Kuebler, 1978; Perneger, 1998).

An important aspect to consider when comparing dynamic balance perfromance are the anthropometric characteristics of the respective groups, and the impact this may have on performance. The results from this study demonstrate that forwards had a statistically significantly greater height, weight, BMI and leg length when compared to the backs (medium-large effect size). On average, forwards were 7.7cm taller, 18.5kg heavier, had a BMI of 3.3 kg/m2 greater and had longer DM (4.2cm) and ND (4.4cm) leg lengths than backs. These clear anthropometric differences between positional units are expected due to the diverse physical needs required by the different playing positions. These differences are likely because forwards are typically involved in the close contact strength based physical aspects of rugby, requiring a greater body mass and height. Conversely, backs are typically engaged in more multi-directional and high speed running tasks, requiring a smaller, more mobile athlete (Kaplan, Goodwillie, Strauss, & Rosen, 2008). The findings of this analysis are consistent with previous research published in the area demonstrating anthropometric differences between forwards and backs at senior and academy elite Rugby Union levels (Darrall-Jones, et al., 2015, 2016; Zemski, et al., 2015). When the cohort was stratified by age-group, senior players demonstrated a statistically significantly greater weight, height and BMI than the under-20 cohort, with a small effect size. The larger anthropometric profile of the senior cohort may be expected due to the specialisation and physical maturation that occurs as the athlete’s progress from under-20 to senior elite levels.

One-way ANCOVA analysis were conducted to investigate if the differences in normalised reach distances (dependent variable) observed between playing position (independent variables) is maintained when controlling for player weight or height (covariate). Table 3 demonstrates that when controlling for player height, the significant difference in YBT performance between positions is maintained; however, when controlling for player weight, there is no statistically significant difference between forwards and backs. The findings from this analysis suggest that while there is a significant difference between forwards and backs YBT performance, the significantly greater body mass (table 1) possessed by the forwards likely contributes to their reduced YBT reach distances, when compared to the backs. The results demonstrated in this study are supported by previous reports in the literature which demonstrated reduced dynamic balance performance during the SEBT when individuals' completed the task while carrying extra weight (Ozunlu, et al., 2010). However, it is important to note that the findings demonstrated in these two studies must be compared with caution due to the vastly different methodologies employed. Ozunlu and colleagues (2010) utilised the SEBT protocol, recruited adolescent basketball players and added additional body weight, while our study leveraged the YBT, recruited a cohort of rugby union players and investigated the effect of differences in body mass on dynamic balance performance.

Previous research carried out by Coughlan and colleagues (2014) investigating dynamic balance performance in elite junior Rugby Union players (under-19 and under-18) established that there are no significant differences in SEBT reach distances between forwards and backs. The results of our study have demonstrated that there are significant differences between positional units across both senior and under-20 cohorts. The differing results observed are likely due to the increased positional specialisation which occurs as players progress towards under-20 and senior levels of elite Rugby Union. At junior-level, players have yet to fully complete their physical and technical development as Rugby Union players. Thus, it is hypothesised that as the players specialise in their respective positions, undergo increased levels of strength, conditioning and pre-habilitation specific to their position (Darrall-Jones, et al., 2015, 2016), individuals dynamic balance performance may change to mirror the demands of that position. Alternatively, it must be considered that players may progress from underage to elite under-20 and senior level because of their superior dynamic balance performance capability. An important consideration when comparing the results obtained in this study and those with previously published studies leveraging the SEBT, is the use of different reach distance testing methods. Previous research has demonstrated significant differences between the normalised reach distances obtained using the YBT and SEBT for the ANT reach direction. However, there are no significant differences between the two testing methods when considering the PM and PL reach directions (Coughlan, Fullam, Delahunt, Gissane, & Caulfield, 2012). As such, direct comparison between studies using the SEBT and our study can be conducted for the PM and PL reach directions only, when hands are positioned on hips.

One of the key hypotheses from this study was that dynamic balance performance would differ between senior and under-20 elite Professional Rugby Union players. Interestingly, the findings of this study contradict the original hypothesis, as the one-way ANCOVA analyses demonstrated that there was no significant difference ($p > 0.05$) in normalised YBT reach distance between senior and under-20 players. One potential explanation for this is highlighted by the significant confounding effect which player body mass (covariate) had on dynamic balance performance; conversely, there was no significant effect of player height on YBT perfromance (table 3). While there was a significant difference in body mass between both groups (age groups and positional units), there is a much larger magnitude effect of player position (d = 1.8) on body mass than player age group (d = 0.5). When considering the one-way ANCOVA and post-hoc analysis together, the smaller difference in body mass observed between senior and under-20s (mean difference 7.3kg) than between forwards and backs (mean difference 18.5kg) may help to explain why no significant difference was observed between the two age groups.

Although other studies have found adaptations that progress with age, such as sprint speed (Gabbett, 2002), vertical jump, agility, and maximal aerobic power (Barr, Sheppard, Gabbett, & Newton, 2014), our results suggest that balance capacity may be developed earlier in Rugby players' careers. As such, when our results are viewed in conjunction with those presented by Barr (2014) and Gabbett (2002), it may indicate that a players' balance capacity develops early in their career, whilst their power, speed and strength continue to improve towards senior level.

The primary aim of this study was to present YBT performance reference scores for elite Rugby Union, based on the appropriate stratifications determined from the playing position and age group comparisons. Based on the above comparisons, the cohort was divided by playing position for the normative data presentation. No previous studies have presented YBT reference scores for an elite Rugby Union population, thus the findings of this study are significant as they provide clinicians and researchers with accurate normative scores. This has the potential to augment clinical practice by providing accurate population specific reference values which can help clinicians and strength and conditioning coaches determine when an athlete may be ready to return to play, and identify suboptimal performance, allowing for the implementation of balance training interventions to mitigate potential risk factors for lower limb injury (Gribble, et al., 2015; C. A. Smith, et al., 2015; Stiffler, et al., 2017b).

While no previous studies have investigated YBT performance in under-20 and senior elite Rugby Union populations, previous research has investigated SEBT performance across a range of sporting populations (Coughlan, et al., 2014; Gribble, et al., 2015; C. A. Smith, et al., 2015). Coughlan and colleagues (2014) previously reported SEBT results, stratified by forward and back position, for a cohort of elite junior Rugby Union players. For both the PM and PL reach directions, the cohort presented in our study demonstrated a greater normalised reach distance than the junior Rugby Union cohort. This may be expected due to increased specialisation and the effect of training which occurs as players progress towards senior Rugby Union. Additionally, when comparing the results obtained in this study with those of elite division 1 collegiate athletes (basketball, golf, ice hockey, soccer, American football and wrestling) we see the Rugby Union cohort has superior PL reach direction performance, while the collegiate cohort demonstrated superior performance in the PM reach direction (Stiffler, et al., 2015). However, due to the different testing methods used in these studies, comparisons should be made with caution.

There are two key contextual factors that need to be acknowledged surrounding this study. Firstly, while this study investigated the effect of player body mass and height on YBT performance, it is possible that other key anthropometric characteristics such as body fat percentage and muscle mass may influence performance. However, as this was outside the scope of the present study further research is required to investigate the effects of various anthropometric profiles on dynamic balance performance. Secondly, all players who participated in this study were affiliated with the Irish Rugby Football Union. While the players affiliated with the Irish Rugby Football Union represent many different nations, most are Irish males, progressing through a unified academy system. As a result, these results may not be representative of players who progressed through the academy system of other Rugby Union nations.

CONCLUSION

This study is the first to present normative reference scores for the YBT in an elite rugby union population and investigate the effect playing position (forward/back), age group (senior/under-20) and key anthropometric characteristics have on dynamic balance performance. The findings of this study demonstrate that there is no significant difference in YBT performance between senior and under-20 cohorts. However, backs have a significantly greater normalised reach distance when compared to forwards which may be explained by the forwards greater body mass. As such, the normative reach distances presented in this paper were stratified by playing position. These findings are of note as they suggest that when assessing dynamic balance performance, clinicians and strength and conditioning professionals should consider forwards and backs separately. These findings are significant as they provide clinicians working in elite Rugby Union with accurate, population specific normative YBT reference values. This has the potential to impact clinical practice as it allows clinicians to compare an athletes scores with the appropriate normative reference. This will allow clinicians to determine what percentile of performance the player falls into, potentially helping to inform when a player is ready to progress to the next level of rehabilitation following an injury, or inform when the implementation of injury prevention interventions may be appropriate.

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